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Short communication

An efficient direct conversion of THP ethers into acetates using Amberlyst-15☆

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Abstract

An efficient direct conversion of THP ethers into the corresponding acetates has been achieved in high yields and short reaction times by treatment with acetic anhydride in the presence of Amberlyst-15 as a catalyst. The catalyst works under the heterogeneous conditions and it can be recovered and reused.

Keywords: THP ether; Acetate; Amberlyst-15; Heterogeneous catalyst

The interconversion of one protecting group of a functionality into another is highly useful in multistep organic synthesis. Thus the development of such interconversion in single-step avoiding the intermediate step of going back to the original functionality is being important in recent years [1]. Tetrahydrohydropyranyl (THP) ether is one of the most useful protecting groups for an alcohol and this ether is reasonably stable under strong basic conditions. However, THP ether is not suitable for use under strongly acidic media. On the other hand, acetate, another important hydroxyl protecting group, is stable to acidic conditions. Thus the interconversion of an THP ether into acetate is an useful transformation in organic synthesis. A limited number of methods are known for such conversion using AcOH/AcCl [2a], $TiCl_4/Ac_2O$ [2b], In/I_2-EtOAc [2c], $In(OTf)_3/Ac_2O$ [2d] and $ZrCl_4$ [2e]. However, most of the methods are associated with certain drawbacks such as high temperatures, long reaction times, unsatisfactory yields and applicability for THP ethers of only *primary* alcohols.

We have recently observed that THP ethers can easily be converted into the corresponding acetates by treatment with Ac_2O in the presence of Amberlyst-15 as a catalyst (Scheme 1).

A series of THP ethers were converted into the corresponding acetates (Table 1) following the above method. The conversion underwent smoothly at room temperature within a short period of time (1–2 h). The yields of the acetates were high (85–92%). The deprotection of THP ethers [3a] and acetylation of alcohols [3b] using Amberlyst-15 were previously known. Here we utilized the catalyst for single-step conversion of THP ethers into acetates. We tried to carry out the conversion in different solvents such as CH_2Cl_2, THF, CH_3CN, Et_2O and hexane (Table 2). However, CH_2Cl_2 was found to be the best in terms of yields of the products. We also conducted the transformation using 50, 100 and 150 mg of the catalyst to convert 1 mmol of the substrate and observed that the amount of 100 mg was sufficient for this purpose (Table 2).

THP ethers of both *primary* and *secondary* alcohols underwent the conversion here smoothly. Several functional groups such as alkyl ether, OBn, Oallyl, OTs and halogen remained unaffected. No isomerization of double and triple bonds were observed. Epimerization of a chiral centre also did not occur. The method was applicable for the conversion of a THP ether of a long chain alcohol into the corresponding acetate. The structures of all the acetates prepared here were established from their spectral (^{1}H NMR and MS) data and also by direct comparison

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Table 1
Conversion of THP ethers into acetates[a]

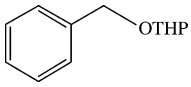
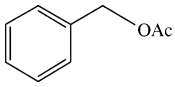
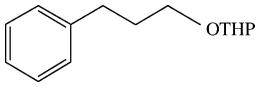
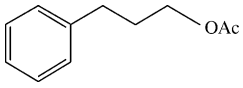
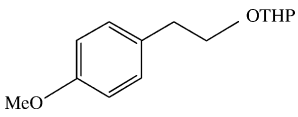
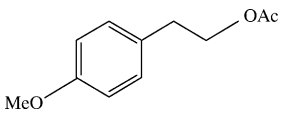
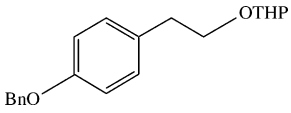
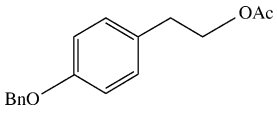
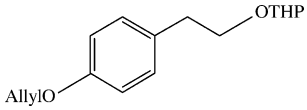
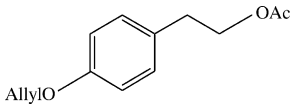
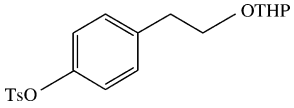
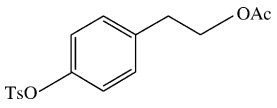
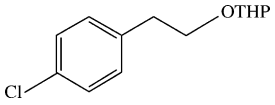
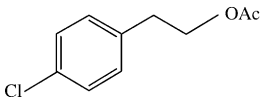
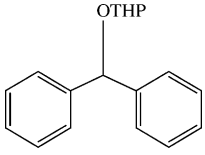
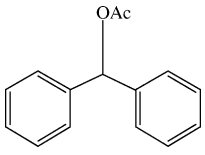
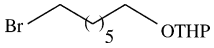
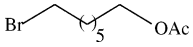
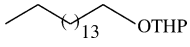
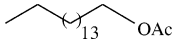
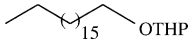
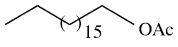
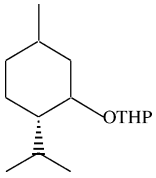
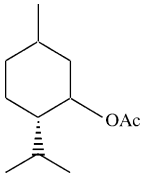
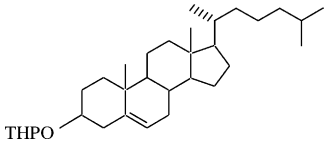
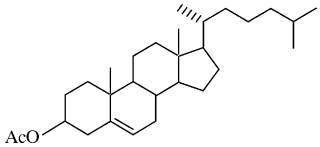
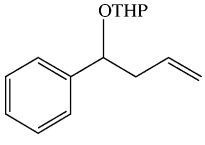
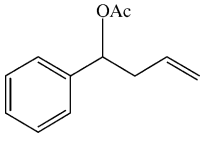
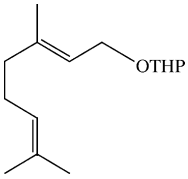
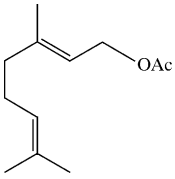
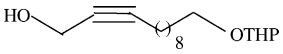
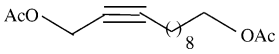
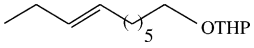
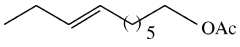
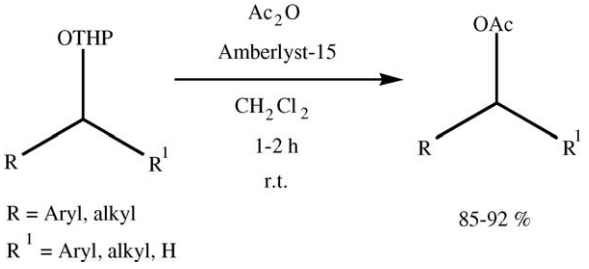
Entry	Substrate (a)	Product (b)	Time (h)	Yield (%)[b]
1			1.0	90
2			1.0	89
3			1.5	92
4			1.5	90
5			1.5	91
6			1.5	88
7			1.5	91
8			2.0	86
9			1.0	87
10			1.5	89
11			2.0	85
12			2.0	88
13			2.0	85
14			1.5	91

Table 1 (*Continued*)

Entry	Substrate (a)	Product (b)	Time (h)	Yield (%)[b]
15			2	89
16			1.5	86
17			2	87

[a] The structures of the products were determined from their spectroscopic (^{1}H NMR and MS) data.
[b] Yield refers to isolated yield.



Scheme 1.

with the acetates prepared by acetylation of the parent alcohols with Ac_2O and pyridine.

The catalyst, Amberlyst-15 works under heterogeneous conditions. It can easily be handled and removed from the reaction mixture. The catalyst can be recovered, activated and reused. It was used for consecutive three times with a small variation of the yields of the products.

In conclusion, we have developed an efficient one-pot method for interconversion of THP ethers into the corresponding acetates by treatment with Ac_2O in the presence of Amberlyst-15 as a catalyst. The mild reaction conditions, high yields and reusability of the heterogeneous catalyst are advantages of the present conversion.

Table 2
Optimization of reaction conditions using compound **3a** (1 mmol)

Entry	Amount of catalyst (mg)	Solvent	Time (h)	Yield[a] (%)
a	50	CH_2Cl_2	2.0	67
b	100	CH_2Cl_2	1.5	92
c	150	CH_2Cl_2	1.5	92
d	100	THF	2.0	65
e	100	CH_3CN	2.0	51
f	100	Et_2O	2.0	12
g	100	Hexane	2.0	0

[a] Yield refers to isolated yield.

1. Experimental

1.1. General procedure for conversion of THP ethers into acetates

To a stirred solution of a THP ether (1 mmol) in CH_2Cl_2 (10 ml), Ac_2O (1 mmol) followed by Amberlyst-15 (100 mg) was added and the reaction mixture was stirred at room temperature for the given time (Table 1). The reaction was monitored by TLC. After completion, the mixture was filtered and the catalyst was recovered from the residue. The filtrate was concentrated and the viscous mass was subjected to column chromatography over silica gel. The column was eluted with hexane-EtOAc (20:1) to obtain corresponding acetate. The spectral (^{1}H NMR and MS) data of some representative compounds are given below.

2b: ^{1}H NMR (200 MHz, $CDCl_3$): δ 7.30–7.10 (5H, m), 4.10 (2H, t, J = 7.0 Hz), 2.70 (2H, t, J = 7.0 Hz), 2.05 (3H, s), 2.0–1.90 (2H, m); EIMS: m/z 178 (M^+).

9b: ^{1}H NMR (200 MHz, $CDCl_3$): δ 4.05 (2H, t, J = 7.0 Hz), 3.40 (2H, t, J = 7.0 Hz), 2.05 (3H, s), 1.70–1.20 (10H, m)); EIMS: m/z 238, 236 (M^+).

12b: ^{1}H NMR (200 MHz, $CDCl_3$): δ 4.64 (1H, dt, J = 12.0, 5.0 Hz), 2.02 (3H, s), 1.94 (1H, m), 1.86 (1H, m), 1.72–1.63 (2H, m), 1.48 (1H, m), 1.36–1.26 (2H, m), 1.12–0.98 (2H, m), 0.90 (3H, d, J = 7.0 Hz), 0.74 (6H, d, J = 7.0 Hz); EIMS: m/z 198 (M^+).

14b: ^{1}H NMR (200 MHz, $CDCl_3$): δ 7.51–7.21 (5H, m), 5.67 (1H, t, J = 7.0 Hz), 5.76 (1H, m), 5.21–5.15 (2H, m), 2.51–2.45 (2H, m), 2.05 (3H, s); EIMS: m/z 190 (M^+).

15b: ^{1}H NMR (200 MHz, $CDCl_3$): δ 5.30 (1H, bt, J = 7.0 Hz), 5.05 (1H, bt, J = 7.0 Hz), 4.55 (2H, d, J = 7.0 Hz), 2.10–2.0 (4H, m), 2.0 (3H, s), 1.70 (3H, s), 1.65 (3H, s), 1.60 (3H, s); EIMS: m/z 196 (M^+).

16b: ^{1}H NMR (200 MHz, $CDCl_3$): δ 4.65 (2H, s), 4.05 (2H, t, J = 7.0 Hz), 2.20 (2H, t, J = 7.0 Hz), 2.08 (3H, s), 2.02 (3H, s), 1.70–1.20 (14H, m); EIMS: m/z 282 (M^+).

17b: ^{1}H NMR (200 MHz, $CDCl_3$): δ 5.40–5.35 (2H, m), 4.05 (2H, t, J = 7.0 Hz), 2.10 (3H, s), 2.0–1.95 (4H, m), 1.35–1.25 (8H, m), 1.20 (3H, t, J = 7.0 Hz); EIMS: m/z 198 (M^+).

Acknowledgements

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References

[1] (a) T. Oriyama, K. Yatabe, S. Sugauttra, Y. Machiguchi, G. Koga, Synlett (1996) 523–525;
(b) G. Yang, X. Ding, F. Kong, Tetrahedron Lett. 38 (1997) 6725–6728.

[2] (a) M. Schwarz, R.M. Waters, Synthesis (1972) 567;
(b) S. Chandrasekhar, T. Ramachander, M.V. Reddy, M. Takhi, J. Org. Chem. 65 (2000) 4729–4731;
(c) B.C. Ranu, A. Hajra, J. Chem. Soc., Perkin Trans I (2001) 355–357;
(d) T. Mineno, Tetrahedron Lett. 43 (2002) 7975–7978;
(e) C.S. Reddy, G. Smitha, S. Chandrasekhar, Tetrahedron Lett. 44 (2003) 4693–4695.

[3] (a) C. Rene, A. Niesen, G. Tschuch, G. Moritz, Tetrahedron 60 (2004) 6001;
(b) V. Srivastava, A. Tandon, S. Ray, Synth. Commun. 22 (1992) 2703.