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A general procedure for a one-pot oxidative cleavage/Wittig reaction of glycols

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Abstract—Oxidative cleavage of a series of glycols using $NaIO_4$ on silica gel in the presence of a series of stabilized ylides provides access to a number of synthetically useful alkenes. The ease and general utility of this reaction is demonstrated here using several carbohydrates and amino acid derived glycols. © 2002 Elsevier Science Ltd. All rights reserved.

In connection with the synthesis of several peptidomimetics of D-alanine–D-alanine, we needed to prepare an unsaturated ester as a common intermediate. Oxidative cleavage of amino acid-derived glycols similar to **1** have been utilized by Datta in the synthesis of azimic acid.[1] We found that in situ trapping of the intermediate aldehyde provided by cleavage of **1** with $NaIO_4$ on silica gel proceeded smoothly to afford the ester **2** (Fig. 1).[2]

We have found few references to conditions for this oxidative cleavage/Wittig reaction which involve an in situ sequence.[3] Other one-pot oxidation/Wittig sequences have been reported for the oxidation of primary alcohols using various oxidants including Swern oxidation, manganese-based oxidants, Dess–Martin reagent, *o*-iodoxybenzoic acid and lead tetraacetate.[4–8] Given the ease of utility of the sodium periodate/silica gel reagent as a non-aqueous oxidant, we felt that it would be worthwhile to investigate the general utility of the oxidative cleavage/Wittig sequence with some carbohydrate-derived glycols.

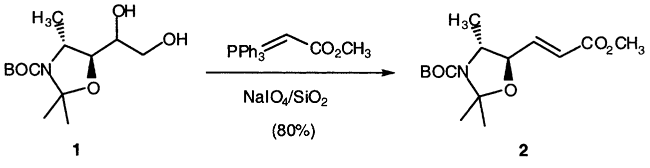

Figure 1.

The reactions of three different carbohydrate derivatives (**3**–**5**), as well as diol **1**, and phenylethane-1,2-diol were carried out in the presence of excess sodium periodate on silica and one of three ylides. The ylides chosen were the ethyl triphenylphosphoranylidene acetate, triphenylphosphoranylidene acetone and triphenylphosphoranylidene acetaldehyde (**6a**–**c**). Reaction conditions are non-aqueous, proceed readily at room temperature and involve no aqueous workup. The preparation of fifteen different alkenes is summarized in Table 1.

This sequence results in a comparable or improved yield in the preparation of several compounds that have previously demonstrated synthetic utility. For instance, **9a** has most often been prepared from the DIBAl-H reduction and Wittig olefination of the corresponding protected tartrate. This compound has been used in the syntheses of C_2-symmetric cyclic ureas, insecticides and antifungals as well as other useful structures.[9,10] Compounds **8a** and **10a** have been used in the synthesis of C_2-symmetric cyclic ureas, tetronomycin, and piperidine alkaloids.[11–13]

Typical conditions are described for the oxidation/Wittig of diol **1**: compound **1** (33 mg, 0.12 mmol) was dissolved in 1.0 ml of anhydrous CH_2Cl_2. Sodium periodate on silica gel (332 mg, 20% by weight) was added along with ylide **6d** (80 mg, 0.24 mmol). The mixture was stirred vigorously for 20 h, then filtered, washing twice with CH_2Cl_2. Evaporation and column chromatography afforded 29 mg (80%) of **5b**. ^1H NMR ($CDCl_3$) δ 1.40 (d, 3H, $J=6.2$ Hz), 1.48 (s, 9H), 1.56 (s, 3H), 1.63 (s, 3H), 3.74 (s, 3H), 5.33 (m, 1H, $C\underline{H}O$), 5.44 (m, 1H, $C\underline{H}N$), 5.92 (dd, 1H, $J=1.1$, 11.7 Hz), 6.32

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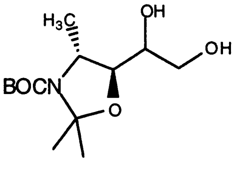
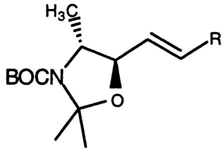
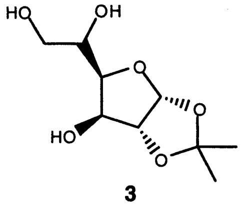
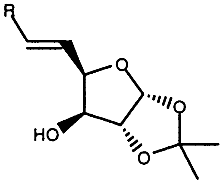
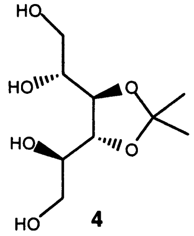
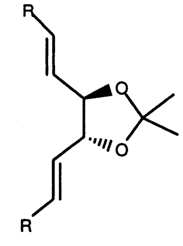
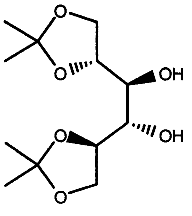
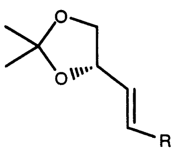
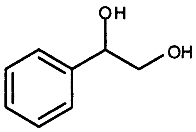
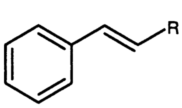
Table 1.

Glycol	Ylide	Product[2]	% yield: E/Z ratio[1]
 **1**	**6a-c** **(6a, R=CO_2Et)** **(6b, R=$COCH_3$** **(6c, R=COH)** **(6d, R=CO_2Me)**		**7a** (87 %) 2:1 **7b** (97 %) 4:1 **7c** (30 %) 2:1
 **3**	**6a-c**		**8a** (66 %) 2:1 **8b**[3] (78 %) 2:1 **8c**[3] (47 %) 2:1
 **4**	**6a-c**		**9a** (67 %) 2:1 **9b** (92 %) 2:1.5:1.0 E/E:Z/Z:E/Z **9c** (22 %) E/E only
 **5**	**6a-c**	(2 eq) 	**10a** (100 %) 2:1 **10b** (81%) 2:1 **10c** (54 %) 4:1
 **7**	**6a-c**		**11a** (85 %) 8:1 **11b** (65 %) E only **11c** (12 %) E only

[1] E/Z ratios were deternined by 1H-NMR. [2] Known compounds were identical by 1H-NMR to literature reports. New compounds (**7a-c, 8c and 9b**) were characterized by 1H-NMR, IR and MS. Typical Conditions: (2.6 eq $NaIO_4$ on silica and 2.0 eq of ylide; 0.25 M solution in dichloromethane; time = 20 hrs at room temp. [3]The Z isomers of **8b** and **8c** were isolated as the cyclic hemiacetals.

(dd, 1H, $J=8$, 11.7 Hz); IR ($CHCl_3$) 3037, 2940, 1723, 1689 cm^{-1}; HRMS (FAB) m/z calcd for $C_{15}H_{25}NO_5$ (M^++H): 300.1811, found 300.1838.

In conclusion, the general utility of a simultaneous, one-pot oxidative cleavage/Wittig reaction of glycols has been demonstrated. The reactions involve inexpensive reagents and should be amenable to large-scale preparations as there are no requirements for low temperatures or inert atmosphere and the workup requires only filtration.

References

1. Kumar, K. K.; Datta, A. *Tetrahedron* **1999**, *55*, 13899–13906.
2. Zhong, Y.-L.; Shing, T. K. M. *J. Org. Chem.* **1997**, *62*, 2622.
3. (a) Ray, P. C.; Roberts, S. M. *J. Chem. Soc., Perkin Trans. 1* **2001**, 149–153; (b) Terrell, L. R.; Ward, J. S.; Maleczka, R. E. *Tetrahedron Lett.* **1999**, *40*, 3097–3100.
4. Ireland, R. E.; Norbeck, D. W. *J. Org. Chem.* **1985**, *50*, 2198–2200.

5. (a) Shuto, S.; Niizuma, S.; Matsuda, A. *J. Org. Chem.* **1998**, *63*, 4489–4493; (b) Wei, Z.; Taylor, R. J. K. *Tetrahedron Lett.* **1998**, *39*, 3815–3818.
6. Barrett, A. G. M.; Hampricht, D.; Ohkubo, M. *J. Org. Chem.* **1997**, *62*, 9376–9378.
7. (a) Maiti, A.; Yadav, J. S. *Synth. Commun.* **2001**, *31* (10), 1499–1506; (b) Crich, D.; Mo, X.-S. *Synlett* **1999**, *1*, 67–68.
8. Leonard, J.; Mohialdin, S.; Swain, P. A. *Synth. Commun.* **1989**, *19* (20), 3529–3534.
9. Krief, A.; Dumont, W.; Pasau, P.; Lecomte, P. *Tetrahedron Lett.* **1989**, *45*, 3039–3052.
10. Barrett, A. G. M.; Doubleday, W. W.; Kasdorf, K.; Tustin, G. J. *J. Org. Chem.* **1996**, *61*, 3280–3286.
11. Schreiner, E. P.; Pruckner, A. *J. Org. Chem.* **1997**, *62*, 5380–5384.
12. Hori, K.; Hikage, N.; Inagaki, A.; Mori, S.; Nomura, K.; Yoshii, E. *J. Org. Chem.* **1992**, *57*, 2888–2902.
13. Patil, N. T.; Tilekar, J. N.; Dhavale, D. D. *J. Org. Chem.* **2001**, *66*, 1065–1074.