

Figure 1. Liquid chromatographic resolution of 3,5-dinitrophenyl-carbamate of lactic acid ethyl ester (R = Methyl, R' = Ethyl) on CSP 1. All chromatographic conditions are given in Table 1.

Table I were determined by chromatographing samples prepared from optically pure α -hydroxycarboxylic acids. In every case, the optical resolution of α -hydroxycarboxylic acid derivatives on CSP 1 is excellent and it is shown that (S)-enantiomer eluted second. One interesting observation is that the separation factor, α values increase slightly as the ester alkyl groups increase in length. However, the size of R group of analytes 2 seems not to affect much the resolution behaviors.

In this communication, we do not rationalize these experimental results in mechanistic terms. We only assume from the resolution behaviors that the intercalation of the ester alkyl group of 2 between the two connecting arms of CSP may do important role in determining the resolution beha-

vior of 2 on CSP 1 and we want to mention that the efforts to rationalize the chromatographic resolution results are still in progress.

Acknowledgement. This work is supported by grants from the Korea Research Foundation and, in part, from GINSCO, Korea.

References

1. J. W. Scott, in "Asymmetric Synthesis", J. D. Morrison and J. W. Scott, Eds., Vol. 4, Chap. 1, Academic Press, New York, 1984.
2. For example see (a) W. H. Pearson and M.-C. Cheng, *J. Org. Chem.*, **51**, 3746 (1986); (b) H. C. Brown, B. T. Cho and W. S. Park, *J. Org. Chem.*, **51**, 3398 (1986) and references therein.
3. For example see M.-J. Kim and G. M. Whitesides, *J. Am. Chem. Soc.*, **110**, 2959 (1988) and references therein.
4. For example see J. P. Kamerling, G. J. Gerwig, J. F. G. Vliegthart, M. Duran, D. Ketting and S. K. Wadman, *J. Chromatogr.*, **143**, 117 (1977).
5. For example see (a) W. A. König and S. Sievers, *J. Chromatogr.*, **200**, 189 (1980); (b) W. A. König, S. Sievers and U. Schulze, *Angew. Chem. Int. Ed. Engl.*, **19**, 910 (1980); (c) N. Oi, H. Kitahara and T. Doi, *J. Chromatogr.*, **206**, 143 (1981).
6. Enantiomeric α -hydroxycarboxylic acids have been resolved by the ligand exchange liquid chromatography method. G. Gübitz and S. Mihellyes, *Chromatographia*, **19**, 257 (1984).
7. (a) W. H. Pirkle and M. H. Hyun, *J. Org. Chem.*, **49**, 3043 (1984); (b) W. H. Pirkle, M. H. Hyun and B. Bank, *J. Chromatogr.*, **316**, 585 (1984); (c) W. H. Pirkle, G. S. Mahler and M. H. Hyun, *J. Liq. Chromatogr.*, **9**, 443 (1986); (d) W. H. Pirkle, G. S. Mahler, T. C. Pochapsky and M. H. Hyun, *J. Chromatogr.*, **388**, 307 (1987); (e) W. H. Pirkle, D. M. Alessi, M. H. Hyun and T. C. Pochapsky, *J. Chromatogr.*, **398**, 203 (1987); (f) M. H. Hyun, I.-K. Baik and W. H. Pirkle, *J. Liq. Chromatogr.*, **11**, 1249 (1988); (g) M. H. Hyun, Y.-W. Park and I.-K. Baik, *Tetrahedron Lett.*, **29**, 4735 (1988); (h) M. H. Hyun and W. H. Pirkle, *Bull. Korean Chem. Soc.*, **8**, 45 (1987).
8. This is known as the "Three Point Interaction Model", C. Dalgleish, *J. Chem. Soc.*, **75**, 1072 (1953).

Reaction of O,S-Acetals and Phosphites in the Presence of Lewis Acids: Chemoselectivity in the Cleavage of the Acetals

Dong Il Han, Dae Young Kim, and Dong Young Oh*

Department of Chemistry, Korea Advanced Institute of Science and Technology
Seoul 130-650. Received March 16, 1989

The synthetic utility of α -heterosubstituted methanephosphonate carbanions in the Wittig-Horner reaction has been a

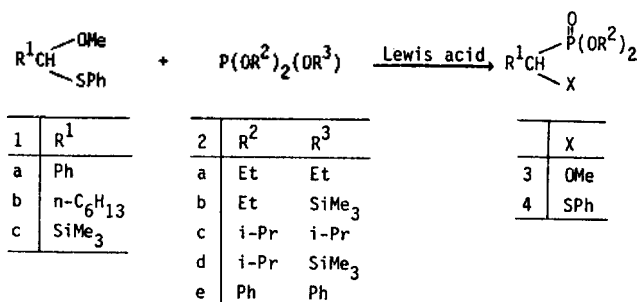
subject of interest in organic synthesis. 1-Alkoxy (or 1-aryltio) methanephosphonates are useful reagents for ke-

Table 1. Reaction of O,S-Acetals (1) with Various Phosphites (2)^a

Entry	O,S-Acetal	Phosphite	Lewis Acid	Product	
				Yield (%) ^b	3:4 ^c
1	1a	2a	SnCl ₄	73	100:0
2	1a	2a	TiCl ₄	81	2 :98
3	1a	2b	SnCl ₄	61	96 :4
4	1a	2b	TiCl ₄	75	3 :97
5	1a	2c	SnCl ₄	80	98 :2
6	1a	2c	TiCl ₄	92	10 :90
7	1a	2d	SnCl ₄	72	100:0
8	1a	2d	TiCl ₄	71	4 :96
9	1a	2e	SnCl ₄	90	5 :95
10	1a	2e	TiCl ₄	94	0 :100
11	1b	2a	SnCl ₄	77	60 :40
12	1b	2a	TiCl ₄	84	47 :53
13	1b	2b	SnCl ₄	57	89 :11
14	1b	2b	TiCl ₄	73	47 :53
15	1b	2e	TiCl ₄ ^d	87	5 :95
16	1c	2a	TiCl ₄ ^d	47	0 :100

^a Reactions were performed as described in the text unless otherwise noted. ^b Isolated yield by column chromatography. ^c Determined by GLC analysis. ^d The use of SnCl₄ afforded the same selectivity.

tone homologation.¹ Recently we reported some results for the preparation of this α -heterosubstituted methanephosphonate from the reaction of acetals or thioacetals with phosphites.² In an extension of this work we wish to report the highly selective preparation of either 1-methoxy-1-phenylmethanephosphonate (3) or 1-phenylthio-1-phenylmethanephosphonate (4) from reaction of O,S-acetals (1) with phosphites (2) in the presence of a Lewis acid.



The general experimental procedure is as follows: To a stirred solution of O,S-acetal (1) (1 mmol) in methylene chloride under nitrogen was slowly added Lewis acid (1

mmol) at -78°C. After being stirred for 10 min, phosphite (2) (1 mmol) was then added. The resulting solution was left to slowly return to ambient temperature over 1-4 h. Normal work-up gave the crude product, which was purified by column chromatography on silica gel (ether).

As shown in Table 1, 1a (R¹=Ph) shows the remarkable bias of the reaction products caused by alternation of the Lewis acid. Employment of stannic chloride (SnCl₄) leads to 3 whereas 4 are produced by use of titanium tetrachloride (TiCl₄).³ The difference in reactivity of the Lewis acid may rationalize the unique switching effect. The high affinity of TiCl₄ towards oxygen⁴ leaves the phenylthio group intact in this reaction. On the other hand, the predominant affinity of the tin atom to sulfur as well as the preferred stability of an intermediary α -methoxy carbocation governs the direction of the SnCl₄ promoted reaction. The chemoselectivity is highly dependent on the order of addition. The initial mixing of 1 and 2 followed by addition of Lewis acid led to the inconsistent results: for entry 1, 3:4 = 71:29, for entry 2, 3:4 = 60:40. Triphenyl phosphite shows the exclusive formation of 4. The reaction of dialkyl trimethylsilyl phosphite afforded the same reaction products as of trialkyl phosphite though the yields are somewhat lower. However 1b (R¹=n-C₆H₁₃) fails to give the remarkable selectivity in the carbon-phosphorus bond forming reaction. Regardless of Lewis acid employed, the product was obtained as a mixture of 3 and 4. And 1c (R¹=SiMe₃) also shows different results from 1a and 1b. In this case, only phenylthio(trimethylsilyl)methylphosphonate was isolated with both SnCl₄ and TiCl₄.⁵

The present process provides a highly selective preparation of α -heterosubstituted phosphonates. And an attempt to explain the influence of α -substituent of O,S-acetal (R¹ in 1) on the selectivity is under current study in our laboratory.

References

- (a) A. F. Kluge, *Tetrahedron Lett.*, 3629 (1978); (b) E. J. Corey and J. I. Shulman, *J. Org. Chem.*, **35**, 777 (1970).
- (a) D. Y. Kim and D. Y. Oh, *Synthetic Commun.*, 859 (1986); (b) D. Y. Kim, T. H. Kim, and D. Y. Oh, *Phosphorus and Sulfur*, **34**, 179 (1987).
- Chemoselective allylation or propargylation with BF₃OEt₂ and TiCl₄ has been observed in the reaction of O,S-acetal with allyl(or allenyl)tin compounds: T. Sato, S. Okura, J. Otera, and H. Nozaki, *Tetrahedron Lett.*, **28**, 6299 (1987).
- T. Mukaiyama, *Angew. Chem. Int. Ed. Engl.*, **16**, 817 (1977).
- The silylated O,S-acetal (1c) showed same selectivity in the reaction with aromatic compounds regardless of the Lewis acid employed; D. I. Han and D. Y. Oh, *Synthetic Commun.*, in press.