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ENEPHOSPHINILATION

Dattatraya G. Mislankar[1], Ben Mugrage[2] and S. D. Darling*
Knight Chemical Laboratory
The University of Akron, Akron, OH 44325

A general method is described for the formation of vinylphosphines from arylsulfonylhydrazones. Oxidation of the resulting vinylphosphines yields phosphine oxides.

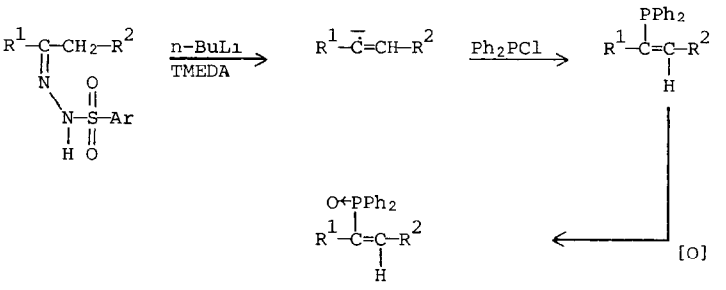
Recent publications from our laboratory have illustrated many alkylation reactions of unsaturated phosphorus compounds[3]. We describe here a new route to unsaturated phosphorus compounds beginning with readily available carbonyl compounds.

In the rush to impliment the "Umpolung"[4] of various synthons many elements have been selected beyond the second row of the periodic table. One element which has not received proper attention is phosphorus. Fulfillment of the potential for synthesis by phosphorus intermediates has been hampered by the absence of a general synthetic approach to vinylphosphorus compounds.

Only a limited number of methods have been available for the synthesis of vinylphosphines and phosphine oxides. Most of the earlier methods are considered to be generally laborious[5]. Most recent methods have included: 1) the cleavage of tertiary phosphines with lithium followed by alkylation with a vinyl halide[6], 2) treatment of an unsymmetrical methylenediphosphorus compound with an aldehyde in the presence of a strong base[7], 3) hydrolysis of cycloalkenylphosphonium salts, and 4) selenylation of the corresponding cycloalkylphosphine oxides and subsequent $PhSeO_2H$ elimination[8].

Vinyl carbanions generated by the action of an alkyllithium on p-toluenesulfonylhydrazones have been trapped with various electrophiles[9b]. The following, Scheme I, illustrates how this reaction may be used to obtain vinylphosphines and phosphine oxides.

SCHEME I



Maximum yields of the vinylphosphines were obtained when at least three equivalents of base were used with tosylhydrazones. This in turn necessitates the use of excess electrophile (Chlorodiphenylphosphine). A substantial amount of diphenylbutylphosphine was formed by the reaction of n-butyllithium with chlorodiphenylphosphine. This side product was difficult to separate from the vinylphosphine of interest.

To alleviate the problem of diphenylbutylphosphine formation, 2,4,6-triisopropylbenzenesulfonyl hydrazones[10] (trisylhydrazones) were used. In cases where dianion formation required the removal of a secondary hydrogen, we have used 2 equiv of the stronger base sec-butyllithium at -45°C for 1 hr. With the unsymmetrical trisylhydrazone the reaction proceeded to give regiospecifically the less substituted vinylphosphine oxide[9]. This has been substantiated by examination of the vinyl hydrogens by ^{1}H NMR spectroscopy. The results are summarized in Table 1.

General Procedure for the Synthesis of Vinylphosphines from Trisylhydrazones

A dry four-necked flask equipped with a magnetic stirring bar, an argon inlet, a rubber septum, thermometer and an Erlenmeyer flask containing the trisylhydrazone (ca. 8 g) connected by a short piece of Gooch tubing (with pinch clamp attached) was charged with dry TMEDA (ca. 75 ml) (freshly distilled over CaH_2). The solvent was cooled to -45°C and the alkyllithium (2 equiv) in hexane was introduced via a syringe. To this cold solution was added slowly in portions the trisylhydrazones over a 10-15 min period. The resulting orange solution was stirred for 1 hr at -45°C and was allowed to warm to 0°C. The mixture was held at 0°C for 30 min to ensure complete nitrogen evolution during which time the color of the solution changed to yellow. To the reaction mixture, again cooled to -45°C was added chlorodiphenylphosphine (1 equiv) via a syringe. The mixture was stirred at -45°C for 1 hr followed by stirring at room temperature overnight prior to being poured into water (200 ml) and dichloromethane (100 ml). The organic layer was separated and subsequently extracted with water (2x200 ml), saturated copper sulfate solution (2x200 ml) and brine (2x50 ml). The dried solution was concentrated using a flash evaporator and the residue distilled using a mercury diffusion pump to yield the vinylphosphine.

The following procedure for the preparation of (6-Methylcyclohexenyl)diphenylphosphine oxide is representative of the oxidation of vinylphosphines to phosphine oxides.

Procedure A:

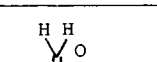
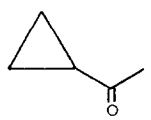
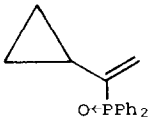
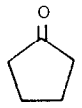
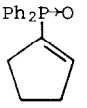
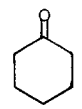
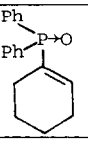
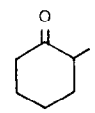
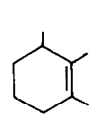
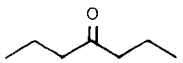
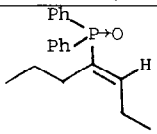
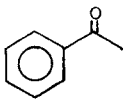
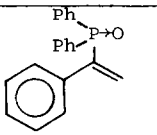
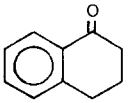
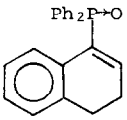
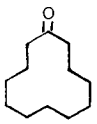
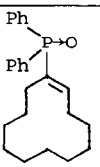
To a solution of 2.80 g (0.01 mol) of vinylphosphine in 20 ml of THF cooled to 0°C was added 1.45 ml (0.016 mol) of 30% H_2O_2. The reaction mixture was stirred for 2 hr at room temperature. Excess H_2O_2 was destroyed by adding solid $NaHSO_3$. The reaction mixture was saturated with sodium chloride and extracted with ether. Removal of the solvent gave a residual oil. The product was recrystallized from THF/ether to give the phosphine oxide (2.37 g, 80%).

Procedure B:

To a magnetically stirred ice cold mixture of 2.7 g (0.013 mol) vinylphosphine and 5 g of sodium carbonate in 300 ml of dichloromethane was added dropwise 3.0 ml of 40% peracetic acid which had been pretreated with a small amount of anhydrous sodium acetate. The resulting mixture was stirred until a negative starch-iodide test was obtained. The solids were removed by suction filtration and washed well with an additional amount of solvent. The dried solution was concentrated and the residual oil obtained was crystallized as above (3.38 g, 88%).

TABLE I

Enephosphinilations[a]

Ketone	% yield and M.P. of trisylhydrazone	vinylphosphine-oxide	% yield and M.P.	^{1}H NMR (δ) ($CDCl_3$)
	94 132-136°C		63 56-57°C lit[11] 55-56°C	7.7-7.00 (m, 10H, Ph_2P), 6.31-5.5 (m, 2H, C=CH), 2.0 (d, 3H).
	91 132-134°C		72 82-85°C	7.9-7.08 (m, 10H, Ph_2P), 5.95-5.15 (m, 2H, C=CH), 2.15-1.95 (m, 1H), 0.95-0.5 (m, 4H).
	82 159-160°C		75 111-113°C lit[5] 110-111°C	7.8-7.3 (m, 10H, Ph_2P), 6.35 (m, 1H, C=CH), 2.4-2.7 (m, 4H), 2.0 (pent, 2H).
	85 123-124°C		73 102-104°C lit[8] 118-120°C	8.0-7.4 (m, 10H, Ph_2P), 6.45 (m, 1H, C=CH), 2.5-1.2 (m, 8H).
	91 107-108°C		77 105-107°C	7.9-7.15 (m, 10H, Ph_2P), 6.3-5.7 (m, 1H, C=CH), 2.8-1.5 (m, 7H), 1.45 (d, 3H).
	69 96-99°C		68 87-89°C	7.9-7.1 (m, 10H, Ph_2P), 6.5-5.7 (m, 1H, C=CH), 2.4-1.9 (m, 6H), 1.35-0.65 (m, 6H).
	92 159-160°C		78 119-120° (dec)	8.0-7.0 (m, 15H, Ph_2P and aryl), 6.35 (m, 2H, C=CH).
	74 176-178°C		73 136-137°C	8.0-7.0 (m, 14H, Ph_2P and aryl, 6.35 (m, 1H, C=CH), 3.0-2.7 (m, 2H), 2.6-2.2 (m, 2H).
	90 143-144°C		77 95-96°C	7.8-7.3 (m, 10H, Ph_2P), 6.3-5.5 (m, 1H, C=CH), 2.7-1.9 (m, 4H), 1.65-0.9 (m, 16H).

[a]The term enephosphinilation signifies the conversion of a ketone to a vinylphosphine where the C-P bond replaces the original carbonyl group.

REFERENCES

1. Stauffer Chemical Foundation Research Fellow, 1980-81.

2. Undergraduate research participant supported The University of Akron Graduate Faculty Research Grant.

3. a) S. D. Darling and N. Subramanian, J. Org. Chem., 40, 2851 (1975).
   b) S. D. Darling, F. N. Muralidharan, and V. B. Muralidharan, Tetrahedron Lett., 2757-60 (1979).
   c) idem., ibid., 267-62 (1979).

4. D. Seebach, Angew. Chem. Internat. Ed., 18, 239 (1979).

5. T. E. Snider, D. L. Morris, W. R. Purdum, G. A. Dilbeck and K. D. Berlin, "Org. Prep. and Procedures, Int", 6, 221 (1974).

6. W. J. Bailey, S. A. Buckler and F. Marktscheffel, J. Org. Chem., 25, 1996 (1960).

7. D. Gloyna and H. G. Henning, Angew. Chem. Internat. Ed., 5, 847 (1966).

8. G. Saleh, T. Minami, Y. Ohshiro and T. Agawa, Chem. Ber., 112, 355 (1979).

9. a) R. H. Shapiro, M. F. Lipton, K. J. Kolonko, R. L. Buswell and L. A. Capuano, Tetrahedro Lett. 1811 (1975).
   b) J. E. Stemke and F. T. Bond, ibid., 1815 (1975).
   c) T. H. Chan, A. Baldassare and D. Massuda, Synthesis, 801 (1976).
   d) L. A. Paquette, W. E. Fristad, D. S. Dime and T. R. Bailey, J. Org. Chem., 45, 3017 (1980).

10. A. R. Chamberlin, J. E. Stemke and F. T. Bond, ibid., 43, 147 (1978).

11. F. J. Welch and H. J. Paxton, J. Polymer Sci., 3, 3439 (1965).

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