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THE VINYLOGATION OF ALDEHYDES: AN IMPROVED METHOD FOR THE PREPARATION OF ALPHA FORMYLETHYLIDENETRIPHENYLPHOSPHORANE, AND AN IMPROVED ALPHA SILYL IMINE REAGENT OF PROPIONALDEHYDE

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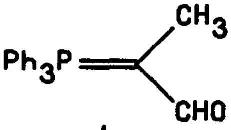
Abstract A high yield preparation of α-formylethylidenetriphenylphosphorane from the ethyltriphenylphosphonium iodide and ethyl formate is reported. The α-triethylsilyl *t*-butylimine of propionaldehyde is a thermally stable and easily purified reagent that smoothly olefinates aldehydes and ketones.

The conversion of an aldehyde into its α,β-unsaturated vinylogue has been a tactically useful but often vexing necessity within the context of synthesis.[3] Two reagents that have been used in this regard are α-formylethylidenetriphenylphosphorane (**1**), and the α-trimethylsilyl *t*-butylimine of propionaldehyde **2**.



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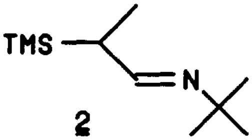

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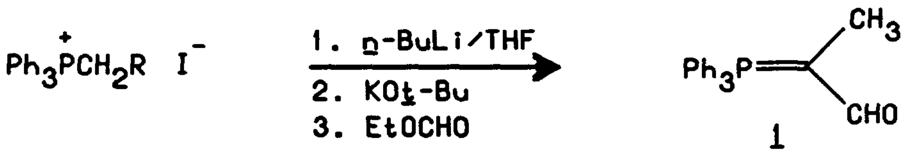
However, the known methods of preparing **1** either gave low yields[4] or proved cumbersome to carry out.[5] This circumstance, coupled with our inability to obtain the α-trimethylsilyl *t*-butylimine of propionaldehyde **2**[6] uncontaminated by its N-trimethylsilyl enamine analogue, seriously eroded the practical viability of these reagents. Since alternatives to both of these reagents were not readily forthcoming, we set out to improve the preparation of phosphorane **1** and to derive a purely C-silyl analogue of **2**.

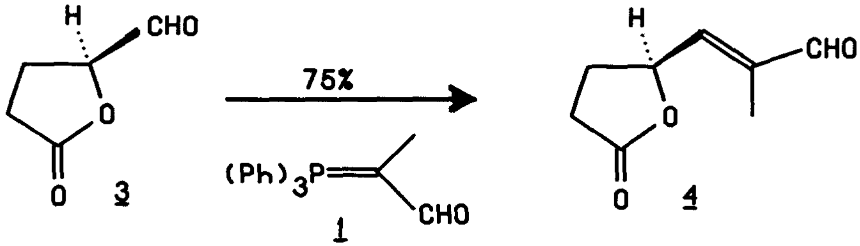
With respect to the preparation of phosphorane **1**, we describe a simple modification of the original Trippett procedure[4] that allows conversion of the starting ethyltriphenylphosphonium iodide into its corresponding formyl derivative in good yield. This modification, which consists of adding slightly more than one equivalent of potassium *t*-butoxide to the ylide solution before admixture of ethyl formate, increases the yield of **1** to 84% from Trippett's value of 37%.[4] Other alkyltriphenylphosphonium iodides also may be used in this manner to form their corresponding formyl derivatives in good yields (80%).



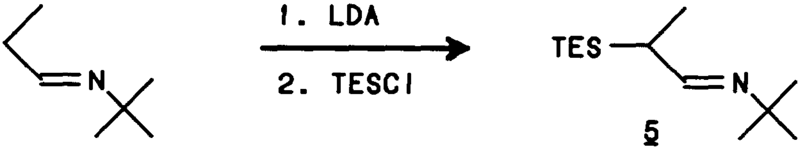
PREPARATION OF 1

Butyllithium in hexane (1.1eq) was added dropwise to a mechanically stirred suspension of ethyltriphenylphosphonium iodide (10.0mmol) in THF (33ml) at 22°C under a nitrogen atmosphere. The resulting red solution was stirred for 1 hr, then cooled to 0°C. Freshly sublimed potassium *t*-butoxide (1.1eq) was added followed by the rapid addition of ethyl formate (2.5eq, neat, dried over P_2O_5). The buff colored reaction mixture was kept at OC for 15min and then quenched with 1M HCl (12.5ml). Dichloromethane (75ml) was added and the pH of the aqueous layer adjusted to pH=8 (pH paper) by adding 10% aqueous sodium hydroxide, followed by stirring at 0°C for 0.5hrs. The aqueous layer was separated and extracted further with CH_2Cl_2 (50ml). The combined organic extracts were dried ($MgSO_4$) and evaporated *in vacuo* to give an oil that was crystallized from CH_2Cl_2/Et_2O to afford a white solid mp 180-182°C in 84% yield. Recrystallization from benzene/hexane afforded material mp 213-217°C, lit.[5] 214-218°C.

Ylide with the melting point of 180-182°C was used for aldehyde vinylogations carried out in these laboratories; for example, the conversion of **3** into **4** in 75% yield.



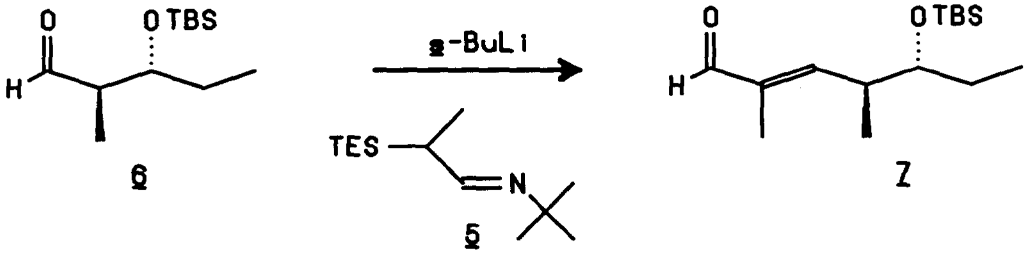
In response to the frustration induced by our inability to prepare the α-silyl aldimine **2** in pure form, we set out to formulate the α-triethylsilyl *t*-butylimine of propionaldehyde **5**. Compound **5**, formed without any detectable N-silyl contamination, was easily distilled to purity in good yield.



PREPARATION OF 5

To a solution of lithium diisopropylamide (1.05eq, 1M in THF/-78°C) was added the *t*-butylimine of propionaldehyde (1.0eq, 4M in THF). The resulting yellow-colored solution was stirred (30min at -78°C) whereupon triethylsilyl chloride (1.01eq, neat) was added and the resulting mixture stirred with gradual warming (0°C) over a period of 3.5hrs. The reaction was quenched with water and extracted with ether. The combined ether extracts were washed with saturated brine and then dried over K_2CO_3. Removal of the ether followed by distillation gave **5** as a clear oil in 73% yield (bp 54-55°C/ 0.22 torr). The ^1H, ^{13}C, and mass spectra of **5** were in complete agreement with its assigned structure.[7]

The lithioimine derived from **5** undergoes smooth olefination with aldehydes and ketones, although somewhat longer reaction times are required than those reported for its trimethylsilyl analogue **2**.[6] As an example of the utility of **5**, the very difficult vinylogation of aldehyde **6** into the α,β-unsaturated aldehyde **7** was readily achieved in 77% yield using the lithioimine of



5; whereas, no other reagent proved useful for this conversion. The complementary nature of reagents **1** and **5** is illustrated by the observation that **1**, a neutral ylide, does not successfully react with the aldehyde **6**, and further, **5** as its enolate does not successfully react with the aldehyde-lactone **3**.

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REFERENCES

1. Hooker Corp. Fellow, Sherman Clarke Fellow, ACS Graduate Fellow in Organic Chemistry.
2. Sherman Clarke Fellow.
3. For some examples, see Green, R. H.; Lambeth, P. F.; Tetrahedron, 1983, 39, 1687.
4. Trippett, S.; Walker, D. M. J. Chem. Soc. 1961, 1266.
5. Bestmann, H. J.; Schmid, G.; Oechsner, H.; Ermann, P. Chem. Ber. 1984, 117, 1561.
6. Corey, E. J.; Enders, D.; Bock, M. G. Tetrahedron Lett. 1976, 7, and references cited therein.
7. ^{1}H and ^{13}C spectra were recorded either on a G.E. QE-300 or a Brucker WH-400 instrument. Mass spectra were determined on a VG-7035. The ^{1}H spectrum of **5** ($CHCl_3$) at 400 MHz exhibited resonances at (ppm) 7.533 (1H, d), 2.052 (1H, q), 1.153 (3H, d), 1.130 (9H, s), 0.929 (9H, m), and 0.563 (6H, m); q = quintet.

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