Tetrahedron Letters, Vol. 34, No. 33, pp. 5281-5284, 1993
Printed in Great Britain

0040-4039/93 $6.00 + .00
Pergamon Press Ltd

# A New and Easy Route to (2E,4E)-Dienals by Four-Carbon Homologation of Aldehydes

**Moncef Bellassoued* and Malika Salemkour**

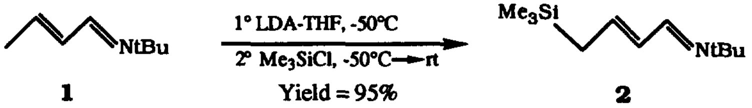
Laboratoire de Synthèse Organométallique associé au CNRS,
Université Pierre et Marie Curie, 4, Place Jussieu, 75252 Paris Cedex 05 (France).

**Abstract**: A new synthetic method of (2E,4E)-dienals by four-carbon homologation of aldehydes is described. γ-trimethylsilyl crotonaldimine **2**, easily generated from N-ter-butyl-crotonaldimine **1**, LDA and $ClSiMe_3$, reacts with aldehydes in the presence of catalytic CsF in DMSO at rt ⟶ 100°C to afford homologous aldehydes **3** in good yields and with excellent (E,E)-selectivities.

Polyethylenic aldehydes are well recognized as useful intermediates in organic synthesis, particularly for the preparation of polyunsaturated natural products. Several ways have been described in the literature to transform aldehydes into conjugated enals by chain extension.

To our knowledge, few reagents can be used efficiently for the direct conversion of an aldehyde into an elongated conjugated dienal by four-carbon unit introduction : 1-ethoxy 4-tributyltin butadiene[1], 4-(diethylphosphono) crotonylcyclohexylimine[2], 1-bromo 4-trimethylsiloxybutadiene[3], arsonium salt of crotonaldehyde[4] and more recently δ-alkoxy dienylzirconocene chloride[5]. Unfortunately, the preparation of these reagents requires, often, several steps and the arsonium salt suffers from a lack of stereoselectivity.

In extension of our previously reported olefinformylation work[6], we describe in this letter a simple method for one-pot synthesis of (2E,4E)-dienals using the organosilicon reagent **2** which is easily prepared by silylation of the ter-butyl crotonaldimine[7] **1**.



Addition of a mixture of reagent **2** and an aldehyde to a catalytic amount of CsF (5-10%) in the DMSO at rt→100°C followed by a very mild hydrolysis of the ter-butylimine function gave the four-carbon homologated starting aldehyde **3**.

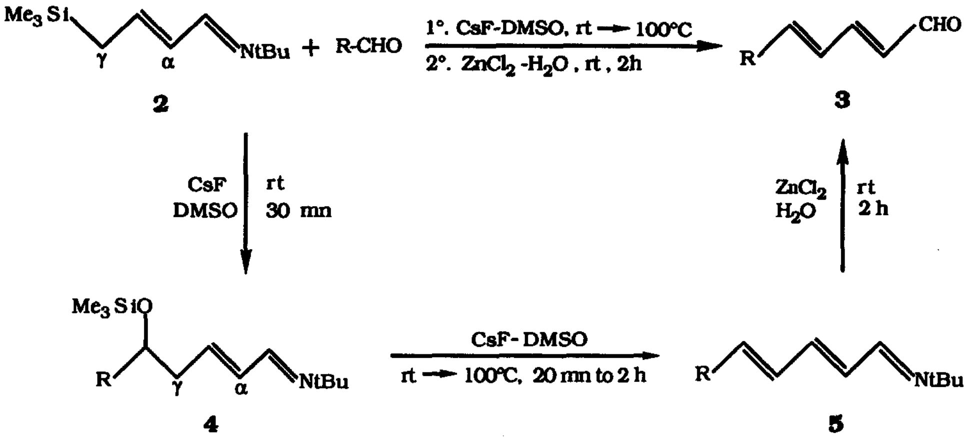


Table I shows the application of this four-carbon elongation procedure to some aldehydes. The reaction proceeded smoothly to give the corresponding dienals in good yields and with excellent (E, E)-selectivities.

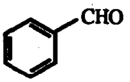
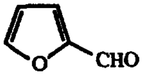
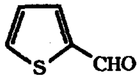
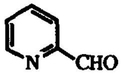
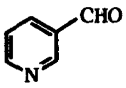
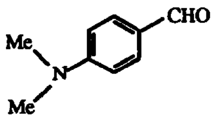
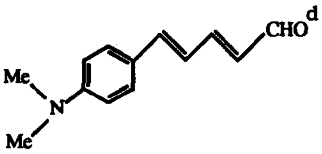
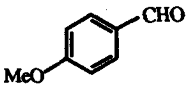
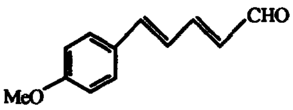
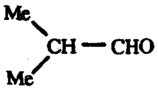
In order to gain insight into the reaction mechanism, this one-pot conversion was effected in three steps with isolating the different intermediates. When the reaction was carried out at room temperature (30mn), siloxyimines **4**, the single reaction products, were easily isolated. This result is of interest since it shows the exclusive γ-regioselective condensation of the silicon reagent **2** unlike the α-attack obtained from the lithium derivative of **1**[8].

When the reaction was performed at higher temperature, TLC-Monitoring revealed the gradual conversion of the adduct **4** to the dienimine **5** which was complete after 20 mn to 2h depending on the structure of the starting aldehyde. It is noteworthy that the nature of the solvent (DMSO or DMF) and the source of the fluoride (CsF or TBAF) were essentiel for this condensation-elimination process.

We are currently investigating the reaction of the silicon reagent **2** with other electrophiles and the application of this four-carbon homologation procedure to the total synthethis of some natural products.

TABLE I

Reaction of the Organosilicon Reagent **2** with some Aldehydes[9].

| Entry | Starting Aldehydes | Conjugated Dienals **3** Obtained[a] | Yield[b] (%) |
|---|---|---|---|
| **a** |  |  | 70 |
| **b** |  |  | 83 |
| **c** |  |  | 86 |
| **d** |  | [c] | 94 |
| **e** |  | [c] | 80 |
| **f** |  | [d] | 53 |
| **g** |  |  | 57 |
| **h** | t-Bu— CHO |  | 70 |
| **i** |  $\mathrm{Me_2CH{-}CHO}$ |  | 62 |

a - The isomeric purity (2E, 4E) for each product was confirmed to be > 98% by $^1$H-NMR at 200 MHz.
b - Isolated yield.
c - Sodium acetate buffer hydrolysis.
d - Wet silica gel hydrolysis.

## REFERENCES AND NOTES

1. Wollenberg, R. H. *Tetrahedron Lett.* **1978**, 717-720.

2. a) Rein, T. ; Akermark, B.; Helquist, P. *Acta. Chem. Scand. Vol B*, **1988**, *42*, 569-572. b) Kann, N.; Rein, T.; Akermark, B.; Helquist, P. *J. Org. Chem.* **1990**, *55*, 5312-5323.

3. Contreras, B.; Duhamel, L.; Ple, G. Synthetic Commun. **1990**, *20*, 2983-2990. See also Duhamel, L.; Guillemont, J.; Le Gallic, Y.; Poirier, J. M.; Ramondenc, Y.; Chabardes, P. *Tetrahedron Lett.* **1992**, *22*, 3129-3132.

4. a) Wang, Y.; Li, J.; Wu, Y.; Huang, Y.; Shi, L.; Yang, J. *Tetrahedron Lett.* **1986**, *27*, 4583-4584. b) Yang, J.; Shi, L.; Xiao, W.; Wen, X.; Huang, Y. *Heteroatom chem.* **1990**, *1*, 75-81.

5. Maeta, H.; Suzuki, K. *Tetrahedron Lett.* **1993**, *34*, 341-344.

6. a) Gaudemar, M.; Bellassoued, M. *Tetrahedron Lett.* **1990**, *31*, 349-352. b) Bellassoued, M.; Majidi, A. *J. Org. Chem.* **1993**, *9*, 2517-2522.

7. Takabe, K.; Katagiri, H.; Tanaka, J. *Tetrahedron Lett.* **1975**, 1237-1238. b) Bellassoued, M. ; Majidi, A. *J. Organomet. Chem.* **1993**, *444*, C7-C8 .

8. Vedejs, E.; Gapinski, D.M. *Tetrahedron Lett.* **1981**, *22*, 4913-4916.

9. A typical experiment is as follows : Reagent **2** (10 mmol) and 2-furaldehyde in deficient quantity (8.5 mmol) in DMSO (4 ml) were added dropwise to CsF cat. (10%) in DMSO (2 ml) under nitrogen at rt. The reaction was exothermic and the starting aldehyde desappeared within 30 mn. The dark red mixture was then heated at 100° C for 20 mn. The dienimine thus obtained was directly hydrolysed at rt with an aqueous solution of $ZnCl_2$ (2 g in 25 ml) for 2 h. The precipitate of $Zn(OH)_2$ was filtered off, the organic layer extracted with ether, washed by water and dried on $MgSO_4$. Flash chromatography on silica gel (230-400 mesh) with a mixture of cyclohexane/acetone(5/1) as eluant gave pure dienal **3 b**.

(Received in France 24 May 1993; accepted 18 June 1993)