

*Short Note*

## 1,1,2,2,7,7,8,8-Octaethoxyocta-3,5-diyne

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**Abstract:** 1,1,2,2,7,7,8,8-Octaethoxyocta-3,5-diyne has been observed as a minor product in several syntheses utilizing 3,3,4,4-tetraethoxybut-1-yne (TEB) as starting material. In order to access this highly functionalized diyne, we have developed a procedure that provides the title compound in excellent yield.

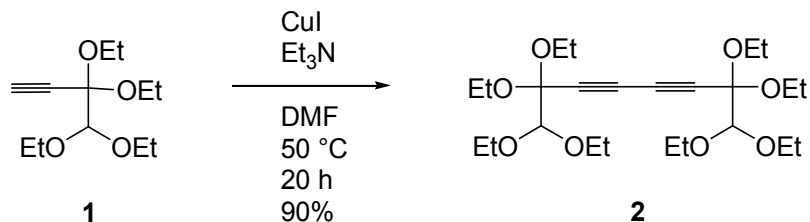
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Acetylenes have for decades been very valuable substrates in organic synthesis [1–4]. The terminal acetylenes are particularly attractive because they can serve two purposes: first to achieve elongation of carbon chain [5–7] and second, to utilize the chemical potential of the carbon-carbon triple bond to introduce other functional groups and a variety of cyclic motifs. We have been interested in this sort of application of terminal alkynes for some time and for that purpose we have investigated the reactivity of one highly functionalized acetylene in particular, *viz.* 3,3,4,4-tetraethoxybut-1-yne (TEB) (**1**) [8], toward a number of reagents under a variety of conditions. This has eventually led to the synthesis of a range of different products including functionalized allylic and homoallylic alcohols [9,10], highly substituted furans [11,12], amino-substituted furfurals [13], functionalized triazoles [14], deoxygenated carbohydrate analogues [9,15–17], various heterocycles [18–20], and functionalized 1,3-dithianes [17,21].

During these studies TEB has been exposed to many different reaction conditions, and formation of by-products has of course been impossible to avoid. One by-product that has been obtained in variable amounts every time a copper salt has been involved, is 1,1,2,2,7,7,8,8-octaethoxyocta-3,5-diyne (**2**) (Scheme 1), a dimer of TEB with no less than four protected carbonyl groups and a conjugated diyne moiety along an eight-carbon chain. The formation of **2** was first observed when attempts were made

to react TEB with sterically demanding 2-substituted aryl halides in Sonogashira-type reactions (cross-coupling by copper halides and organic-based Pd catalysts) [22]. Homocoupling of terminal acetylenes is a well-known side reaction under such conditions and the dimerization has been shown to involve oxidation of copper acetylides formed *in-situ* [5,7,23–30].



**Scheme 1.** Formation of 1,1,2,2,7,7,8,8-octaethoxyocta-3,5-diyne (**2**).

Further investigations aiming at obtaining **2** in high yield revealed that dimerization of TEB occurred in the absence of a palladium catalyst as well, and the reaction was particularly successful and furnished the dimer in high yield when TEB was reacted with an amine, e.g., triethylamine, in the presence of copper(I) iodide and air. If carried out under pure oxygen, the reaction is faster but the yield is not significantly better. These reaction conditions are similar to those prevailing in the classical Glaser reaction, which takes place facilitated by copper salts in presence of amines [24,25].

Diyne **2** is a fascinating molecule and considering the rich chemistry so far revealed by the TEB moiety itself [18], we feel **2** merits thorough studies under reaction conditions beyond those studied in our research group.

## Experimental Section

**1,1,2,2,7,7,8,8-Octaethoxyocta-3,5-diyne (2).** 3,3,4,4-Tetraethoxybut-1-yne (**1**) (0.23 g, 1.0 mmol) was dissolved in DMF (10 mL) at 50 °C in a round-bottom flask with access to air. CuI (3.8 mg, 2 mol %) and triethylamine (0.152 g, 1.5 mmol, ~0.18 mL) were added and the mixture was stirred at 50 °C for 20 h. The crude product mixture was then filtered and washed with a saturated aqueous solution of NaCl (25 mL). The phases were separated and the aqueous phase was extracted with diethyl ether (3 × 10 mL). The organic extracts were combined, washed with a saturated aqueous solution of NaHCO<sub>3</sub> (25 mL), dried over MgSO<sub>4</sub> (anhyd.), filtered, and concentrated under reduced pressure on rotary evaporator. Isolation by flash chromatography (SiO<sub>2</sub>, hexanes/ethyl acetate = 95:5) afforded the title compound as a colourless liquid (0.21 g, 90%).

FT-IR (film):  $\nu_{\max}$  2978 (m), 2931 (m), 2894 (s), 2188 (w), 1600 (w), 1635 (w), 1478 (w), 1447 (m), 1387 (m), 1334 (m), 1119 (s), 1080 (s), 932 (w), 885 (m), 771 (w) cm<sup>-1</sup>.

<sup>1</sup>H NMR (CDCl<sub>3</sub>, 300 MHz):  $\delta$  (ppm) 4.39 (s, 2H, CH(OCH<sub>2</sub>CH<sub>3</sub>)<sub>2</sub>), 3.86–3.61 (m, 16H, OCH<sub>2</sub>CH<sub>3</sub>), 1.29–1.18 (m, 24H, OCH<sub>2</sub>CH<sub>3</sub>).

<sup>13</sup>C NMR (CDCl<sub>3</sub>, 75 MHz):  $\delta$  (ppm) 103.5 (2 CH), 98.2 (2 C [sp<sup>3</sup>]), 78.1 (2 C [sp]), 74.9 (2 C [sp]), 64.7 (2 CH<sub>2</sub>), 64.5 (2 CH<sub>2</sub>), 59.4 (2 CH<sub>2</sub>), 59.2 (2 CH<sub>2</sub>), 15.1 (4 CH<sub>3</sub>), 15.0 (4 CH<sub>3</sub>).

MS (TOF EI<sup>+</sup>):  $m/z$  413 (20), 355 (10), 311 (10), 103 (100), 75 (50).

HRMS (TOF ESI<sup>+</sup>):  $m/z$  481.27788; HRMS Calcd for C<sub>24</sub>H<sub>42</sub>O<sub>8</sub>Na<sup>+</sup> [M + Na]<sup>+</sup>  $m/z$  481.27774, found  $m/z$  481.27788.

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## Author Contributions

The work reported here is a part of a project which has been going on in the research group of LKS for many years. It was planned by BH and LKS and carried out by BH. The manuscript has been written by both authors.

## Conflicts of Interest

The authors declare no conflict of interest.

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