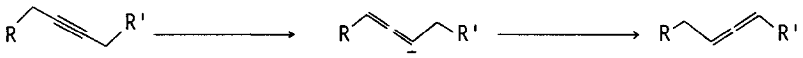
Tetrahedron Letters,Vol.27,No.38,pp 4599-4600,1986 0040-4039/86 $3.00 + .00
Printed in Great Britain Pergamon Journals Ltd.

HIGHLY REGIOSELECTIVE ISOMERIZATION OF ACETYLENES TO ALLENES

Masayuki ENOMOTO, Tsutomu KATSUKI,* and Masaru YAMAGUCHI
Department of Chemistry, Faculty of Science, Kyushu University 33, Hakozaki, Higashi-ku,
Fukuoka 812, Japan

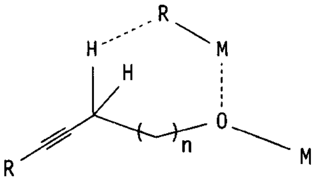
Summary: Internal acetylenes bearing a hydroxyl group at the appropriate position of an alkyl chain, isomerized regioselectively to allenes by the treatment with alkyl lithium in the presence of N,N,N',N'-tetramethylethylenediamine.

Transformation of acetylenic derivatives to allenes is one of the useful methods for the synthesis of allenic compounds. Especially, the replacement reaction of α-heterosubstituted acetylenes with various nucleophiles provides a highly regioselective route to allenes.[1)] In contrast to this, the direct isomerization of acetylenes to allenes by a deprotonation-protonation sequence (Scheme 1) has not been used often for synthetic purposes though it is a long-known and simple process, since the isomerization usually gives a mixture of regioisomers. As it has been known that the protonation of ambident lithio allenyl anions (**2**) proceeded with high regioselectivity to give allenic products (**3**) exclusively,[2)] the remaining problem is the regioselective α-deprotonation of disubstituted acetylenes (**1**).



Scheme 1

As one of the solutions to the problem, we examined a scheme of anchoring a base to the pendent alkoxide oxygen atom attached to one of the alkyl groups of acetylenes at an appropriate remoteness, such that the deprotonation occurs in an intramolecular fashion favoring a proximal site (Scheme 2).



Scheme 2

We describe here the regioselective transformation of internal alkynes bearing an ω-hydroxyl group into the corresponding allenes with alkyl lithium, and factors connected with the effectiveness of the method.

Typical experiment is exemplified below.

BuLi (1.6 mol dm^{-3}, 319 μl, 2.2 eq) and N,N,N',N'-tetramethylethylenediamine (71 μl, 2.2 eq) were added successively to a solution of 4-nonyn-1-ol (32.1 mg) in THF (2 ml) at -70 °C. After kept standing for 18 h at -20 °C, the mixture was quenched with 2 mol dm^{-3} phosphoric acid. After usual workup, the allenic product was separated from the starting acetylene by silica gel chromatography, acetylated, chromatographed on a short silica gel column, and analyzed by ^{1}H NMR.

Results obtained are shown in Table 1.

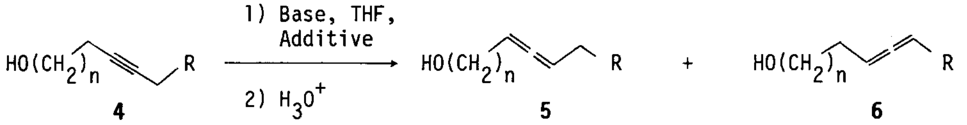


Table 1. Isomerization of Acetylenes Bearing a Hydroxyl Group at Terminal Position to Allenic Compounds by Treatment with Alkyl Lithium .

Entry	n	R in **4**[a]	Base	Additive	Reaction Time (h)	Temp. (°C)	Yield[b] (%)	**5** : **6**[c]
1	1	C_4H_9	n-BuLi	TMEDA[d]	3	-78	39	>20 : 1
2		C_7H_{15}	n-BuLi	TMEDA	100	-78	45	>20 : 1
3	2	C_4H_9	n-BuLi	-	21	-78	0	
4		C_3H_7	n-BuLi	-	24	0	62	5 : 1
5		C_3H_7	n-BuLi	TMEDA	24	-20	74	20 : 1
6		C_3H_7	n-BuLi	t-BuOK	1	-78	74	1 : 1
7		C_5H_{11}	t-BuLi	TMEDA	24	-20	76	11 : 1
8	3	C_3H_7	t-BuLi	TMEDA	24	-20	60	1 : 1
9		C_3H_7	n-BuLi	TMEDA	24	-78	51	5 : 1
10	4	C_3H_7	t-BuLi	TMEDA	24	-78	46	1 : 1

a) Compounds (**4**) were prepared according to Ames's procedure (reference 4). b) Yield of a mixture of allenic products. Each product gave a satisfactory NMR analysis. c) Isomeric ratio was determined by ^{1}H NMR (90 MHz) after conversion of the allenic product to the corresponding acetate. d) TMEDA= N,N,N',N'-tetramethylethylenediamine.

The addition of N,N,N',N'-tetramethylethylenediamine (2.2 eq) enhanced the rate of deprotonation and improved the regioselectivity (entries 3, 4, and 5). As shown in the Table 1, high and moderate regioselectivities were realized when n≤3 (entries 1, 2, 5, 7, and 9), but no selectivity was observed when n=4, even under the presence of N,N,N',N'-tetramethylethylenediamine. This suggests that the reaction proceeds via the cyclic transition state shown in Scheme 2. The reaction of 3-dodecyn-1-ol did not complete even after a prolonged reaction time because of the low deprotonation rate at -78 °C (entry 2).[3] At the higher temperature (-20 °C), elimination of the hydroxyl group took place preferentially. Isomerization in the presence of added potassium butoxide showed no regioselectivity. The poor chelating ability of the potassium ion could be the reason (entry 6).

References and note

1) a) L. Brandsma and H. D. Verkruijsse, Synthesis of Acetylenes, Allenes, and Cumulenes, Studies in Organic Chemistry 8, Elsevier, Amsterdam (1981). b) R. Epsztein, "The Formation and Transformation of Allenic-α-Acetylenic Carbanion," in "Comprehensive Carbanion Chemistry," ed by E. Buncel and T. Durst, Elsevier, Amsterdam (1984).

2) A. A. Petrov, V. A. Kormer, and I. G. Savich, Zh. Obshch. Khim., **30**, 3845 (1960); Chem, Abstr., **55**, 20923 (1961).

3) It was found that deuterium was not incorporated into the recovered acetylene but the allenic product, when dilithiated 3-dodecyn-1-ol was quenched with methanol-d_4.

4) D. E. Ames, A. N. Covell, and T. G. Goodburn, J. Chem. Soc., **1963**, 5889.

(Received in Japan 19 June 1986)