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REGIO- AND STEREOSELECTIVE VINYLIC SUBSTITUTION REACTIONS OF α-HALOENYNE SULFONES

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Abstract: The nucleophilic vinylic substitution reaction of *(E)*-α-haloenyne sulfones **2**, **5-8** with sodium alkoxides proceeded regioselectively to give *(E)*-α-alkoxyenyne sulfones **9-17** in high yields with exclusive retention of their configuration. Copyright © 1996 Elsevier Science Ltd

Recently, we reported the dehydrosulfonylation reaction of 1-phenylsulfonyl-1-buten-3-yne.[1] These conjugate enyne sulfones are a potentially versatile intermediate in synthetic organic chemistry; however, these conjugate enyne sulfones have received little attention so far. There are no reports on the syntheses and reactivities of enyne sulfones except for our previous results[1] and that of Krause.[2] In order to characterize the enyne sulfones, we attempted the addition reaction of an alkoxide anion to the enyne sulfone. The reaction of 5,5-dimethyl-1-phenylsulfonyl-1-hexen-3-yne (**1**) with sodium methoxide did not proceed and the enyne sulfone was recovered. We then performed the reaction of α-haloenyne sulfones with a few nucleophiles such as PhSNa, PhSeNa, $PhSO_2Na$, and RONa. The addition of PhSNa to the α-chloroenyne sulfone **2** occurred at the α-position of the sulfonyl group to give *(E)*-5,5-dimethyl-1-phenylthio-1-phenylsulfonyl-1-buten-3-yne (**3**) in 71% yield; however, the addition reaction of PhSeNa (generated *in situ* from $(PhSe)_2$ and $NaBH_4$ in EtOH) to the enyne sulfone **2** occurred at the δ-position of the sulfonyl group to give 1-chloro-5,5-dimethyl-4-phenylseleno-1-phenylsulfonyl-1,3-butadiene (**4**) in quantitative yield. The addition reaction of $PhSO_2Na$ gave a complex mixture. On the other hand, sodium alkoxides regioselectively gave α-alkoxyenyne sulfones with retention of their stereochemistry. We report herein the synthesis of new α-alkoxyenyne sulfones as a versatile intermediate.

α-Haloenyne sulfones are prepared by almost the same procedure as described in our previous report.[1,3] α-Chloroenyne sulfone **2** reacted with sodium methoxide (2 equiv.) to give α-methoxyenyne sulfone **9** in 72% yield (Table 1, entry 1). The stereochemistry of the product **9** was established by a nuclear Overhauser effect (NOE) enhancement between the olefinic proton and the aromatic *ortho*-protons of the sulfonyl group. The reaction of other α-halo derivatives **5**(X=Br), **6**(X=I) with sodium methoxide also gave α-methoxyenyne sulfone **9**. Next, we examined the addition reaction of various alkoxides to α-chloroenyne sulfones **2**, **7**, **8**. The reactions of *t*-butyl-substituted enyne sulfone **2** with sodium ethoxide, *t*-BuOK, and sodium *i*-propoxide gave α-ethoxy **10** (86%), α-*t*-butoxy **11** (81%), and α-*i*-propoxyenyne sulfone **13** (71%), respectively. Sodium allyloxide and propynyloxide also afforded *(E)*-α-allyloxy **14** and α-propynyloxyenyne sulfones **15** and **16** in high yields. The α-phenoxyenyne sulfone **12** was obtained as an *E,Z*-isomeric mixture (*E:Z*=16:1) (entry 6). The *n*-butyl-substituted enyne sulfone **7** gave α-methoxyenyne sulfone **17** in 42% yield. The Ph-substituted enyne sulfone **8** gave the adduct **18** in low yield; however, the dehydrosulfonylation reaction of the adduct **18** proceeded smoothly and methyl 4-phenyl-3-butynoate (20%) and *(E)*- and *(Z)*-1-methoxy-4-phenylbut-1-en-3-yne (40%) were also obtained.[1,4]

The plausible mechanism for the formation of the products can be explained as follows. Alkoxides attack an α-carbon to the sulfonyl group of the α-haloenyne sulfones and produce **19a**.[5] The high stereoselectivity could be compatible with Rappoport's addition-elimination mechanism.[6] An alkynyl group of the enyne sulfones enables the perpendicular attack of alkoxy anions to the π orbital, which produces a propargyl anion **19a**. The internal 60° rotation of **19a**, followed by reductive elimination of halides would give the (*E*)-α-alkoxyenyne sulfone. Negative hyperconjugation between the halides and the carbanionic electron pair **19a** accounts for the preference of the 60° rotation over the 120° rotation of **19a**.[6]

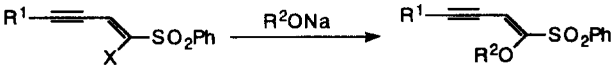


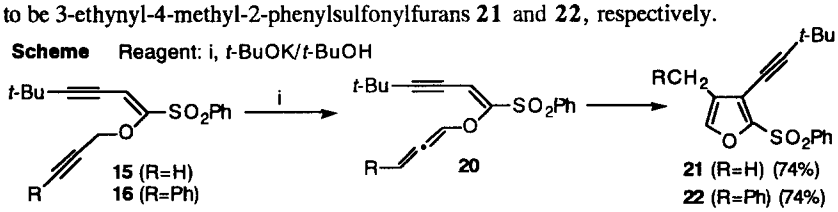
Table 1 Reaction of α-Haloenyne Sulfone with Alkoxide

Entry	Enyne sulfone	R^1	X	Alkoxide R^2	Product (% yield)
1	**2**	*t*-Bu	Cl	Me	**9** (72)
2	**5**	*t*-Bu	Br	Me	**9** (71)
3	**6**	*t*-Bu	I	Me	**9** (68)
4	**2**	*t*-Bu	Cl	Et	**10** (86)
5	**2**	*t*-Bu	Cl	*t*-Bu	**11** (81)
6	**2**	*t*-Bu	Cl	Ph	**12** (100)[*1]
7	**2**	*t*-Bu	Cl	*i*-Pr	**13** (71)
8	**2**	*t*-Bu	Cl	allyl	**14** (66)
9	**2**	*t*-Bu	Cl	propynyl	**15** (97)
10	**2**	*t*-Bu	Cl	3-phenylpropynyl	**16** (85)
11	**7**	*n*-Bu	Cl	Me	**17** (42)
12	**8**	Ph	Cl	Me	**18** (11)[*2]

[*1] *E*:*Z*-Isomer ratio was 16:1. [*2] Methyl 4-phenyl-3-butynoate (20%) and (*E*)- and (*Z*)-1-methoxy-4-phenylbut-1-en-3-yne (40%) were also obtained.

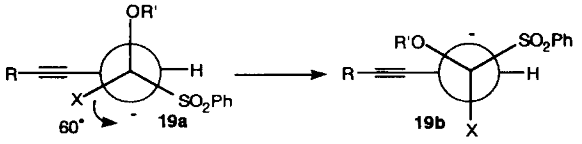
The α-alkoxyenyne sulfones are potential versatile intermediates. We examined the isomerization of the 2-propynyl ethers **15** and **16** to the corresponding allenyl derivatives **20** with *t*-BuOK/*t*-BuOH.[7] The products were found to be 3-ethynyl-4-methyl-2-phenylsulfonylfurans **21** and **22**, respectively.

Scheme Reagent: i, *t*-BuOK/*t*-BuOH



REFERENCES AND NOTES

1. Yoshimatsu, M.; Kawahigashi, M.; Shimizu, H.; Kataoka, T. *J. Chem. Soc., Chem. Commun.*, **1995**, 583-584. Yoshimatsu, M.; Hayashi, M. *Tetrahedron Lett.*, **1996**, 37, 4161-4164.
2. Hohmann, M.; Krause, N. *Chem. Ber.*, **1995**, 128, 851-860.
3. α-Haloenyne sulfones are prepared from the reaction of α-halomethyl phenyl sulfones/LDA and the alkynyl aldehydes followed by elimination using MsCl/Et_3N.
4. Zweifel, G.; Rajagopalan, S. *J. Am. Chem. Soc.*, **1985**, 107, 700-701. Kwon, J. H.; Lee, S. T.; Shim, S. C.; Hoshino, M. *J. Org. Chem.*, **1994**, 59, 1108-1114.
5. Marshall, D. R.; Stirling, C. J. M. *J. Chem. Soc., Perkin II*, **1977**, 1920-1927. Oftedahl, M. L.; Baker, J. W.; Dietrich, M. W. *J. Org. Chem.*, **1965**, 30, 296-298.
6. Apeloig, Y.; Rappoport, Z. *J. Am. Chem. Soc.*, **1979**, 101, 5095-5098.



7. Yamaguchi, Y.; Tatsuta, N.; Hyakawa, K. Kanematsu, K. *J. Chem. Soc., Chem. Commun.*, **1989**, 470-471. Marshall, J. A.; Bartley, G. S. *J. Org. Chem.*, **1994**, 59, 7169-7171.

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