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# A NOVEL SYNTHESIS OF ALKYL VINYL KETONES AND DIVINYL KETONES FROM CARBONYL COMPOUNDS BY THREE-CARBON HOMOLOGATION[1]

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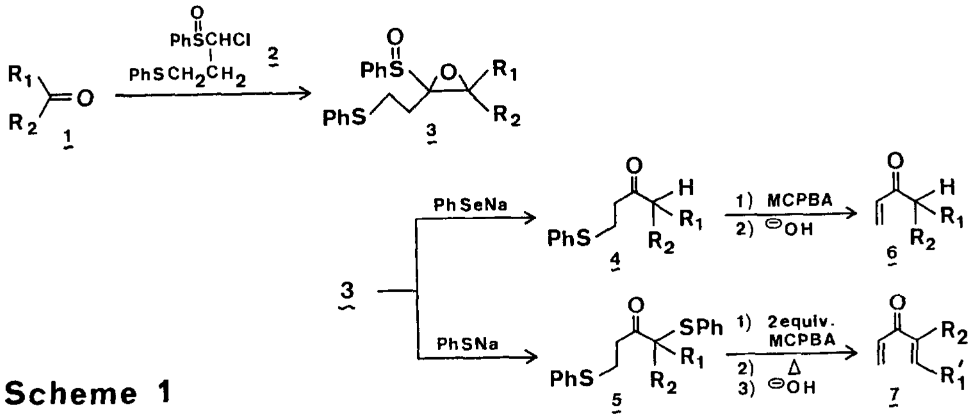
Summary Alkyl vinyl ketones and divinyl ketones are synthesized from carbonyl compounds and 1-chloro-3-phenylthiopropyl phenyl sulfoxide as a three-carbon homologating agent in good overall yields.

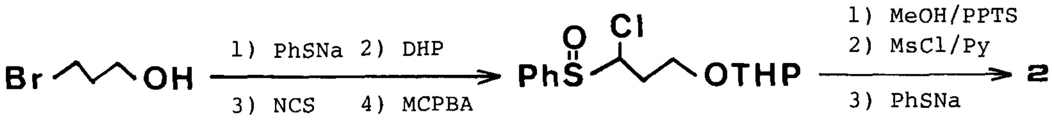
Alkyl vinyl ketones and divinyl ketones are extremely important compounds in synthetic organic chemistry. They are useful for the dienophiles in the Diels-Alder reaction,[2] and for the acceptors of Michael reaction, Robinson annulation[3] etc. Many methods have been reported for the synthesis of vinyl ketones. The most widely used one is two-carbon homologation method; one is the reaction of vinyllithium with carboxylic acids[4] or with aldehydes followed by oxidation,[5] and the other is the palladium-catalyzed acylation of alkenylzinc[6] or vinyltin.[7] Another method for the preparation of vinyl ketones is three-carbon homologation of alkyl halides or carbonyl compounds with vinyl ketone anion equivalents (acyl anion equivalents).[8]



Scheme 1

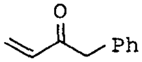
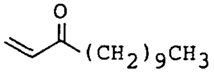
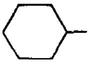
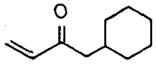
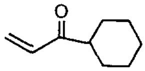
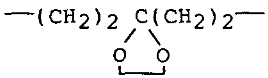
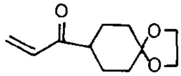
Recently, we have reported a new method for the synthesis of carbonyl compounds from lower carbonyl compounds via α,β-epoxy sulfoxides.[9] In this communication a novel and versatile method for the preparation of alkyl vinyl ketones and divinyl ketones from carbonyl compounds and 1-chloro-3-phenylthiopropyl phenyl sulfoxide (2) as a three-carbon homologating agent through α,β-epoxy sulfoxides (3) is described as shown in Scheme 1.

1-Chloro-3-phenylthiopropyl phenyl sulfoxide (2) is easily prepared from 3-bromo-1-propanol in about 80% overall yield as shown in the following equation.



According to the method described previously,[9,10] the α,β-epoxy sulfoxides (3) were prepared from carbonyl compounds (1) and 2 through chlorohydrins in good overall yields. The epoxides (3) were converted to ketones (4) on treatment with sodium benzeneselenolate[9a] in good yields. The sulfur of 4 was oxidized with MCPBA in $CH_2Cl_2$ at -70 °C for 5 min. Ether and 10% aq. NaOH were added to the reaction mixture and the whole (two phases) was stirred at room temperature. In this treatment the formed sulfoxide took place β-elimination to give the desired alkyl vinyl ketone (6) in excellent yield. Thermal elimination of the sulfoxides, of course, is possible but the alkaline treatment

Table 1. Preparation of vinyl ketones from α,β-epoxy sulfoxides

| α,β-Epoxy sulfoxide (3) $R_1$ | $R_2$ | Ketone (4) Yield[a] / % | Vinyl ketone (6) | Yield[a] % |
|---|---|---|---|---|
| Ph | H | 78 |  | 80 |
| $CH_3(CH_2)_8$ | H | 85 |  | 95 |
|  | H | 89 |  | 94 |
| $—(CH_2)_5—$ | | 94 |  | 74 |
|  $—(CH_2)_2C(CH_2)_2—$ | | 96 |  | 85 |

a) Isolated yields after silica gel column chromatography.

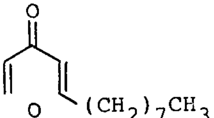
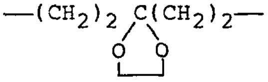
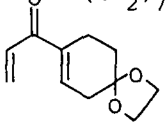
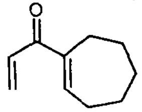
was much more convenient because of high yields and the one pot operation. The results are summarized in Table 1.

It is worthwhile noting that this reductive three-carbon homologation type reaction was once reported by Murai *et al.*[11] by using allylsilane chemistry. But their reaction was reported to be useful only when unhindered aldehydes, not ketones, were used. In contrast with their results the present method is quite useful for hindered aldehydes and ketones also.

The treatment of the α,β-epoxy sulfoxides (3) with sodium benzenethiolate (generated from diphenyl disulfide with sodium borohydride in EtOH at reflux for 30 min) in refluxing EtOH gave α-phenylthio ketones (5) in good yields.[9b] In this case, when sodium benzenethiolate prepared from thiophenol and sodium hydride in EtOH was used, only low yields of the α-phenylthio ketones were obtained. The reason of this difference is not clear now but a similar kind of difference was reported by Liotta *et al.*[12] in selenolate case.

The two sulfurs of the disulfenylated ketones (5) were oxidized with MCPBA in $CH_2Cl_2$ to afford disulfoxides. This was kept at room temperature for several hours or heated in refluxing toluene for 10 min to give mono desulfinated enones (sulfinate group at α position of the ketone (5) was eliminated). The enone was treated with alkaline as described above to give the desired divinyl ketone (7) in good yield. Representative results of the preparation of divinyl ketones from α,β-epoxy sulfoxides (3) are summarized in Table 2.

Table 2. Preparation of divinyl ketones from α,β-epoxy sulfoxides

| α,β-Epoxy sulfoxide (3)<br>$R_1$ | <br>$R_2$ | α-Phenylthio ketone (5) Yield[a)] / % | Divinyl ketone (7) | Yield[a)] % |
|---|---|---|---|---|
| $CH_3(CH_2)_8$ | H | 75 |  | 79 |
|  | | 97 |  | 76 |
| $—(CH_2)_6—$ | | 94 |  | 77 |

a) Isolated yields after silica gel column chromatography.

As divinyl ketones are good precursors for cyclopentenone derivatives by Nazarov type cyclization,[13] the present method contributes to the cyclopentanoid natural product chemistry as well.

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