Preparation and Rearrangement of Some Conjugated Phenylsulphinylacetate Derivatives

By QUEZIA B. CASS, ALBERT A. JAXA-CHAMIEC, and PETER G. SAMMES*
(*Department of Organic Chemistry, University of Leeds, Leeds* LS2 9JT)

Summary The direct condensation of saturated or unsaturated aldehydes with methyl phenylsulphinylacetate can be effected with the products undergoing base-catalysed rearrangements, those from saturated aldehydes yielding γ-hydroxy-$\alpha\beta$-unsaturated esters, whilst crotonaldehyde gives rise to methyl 6-phenylsulphinylhexa-2,4-dienoate.

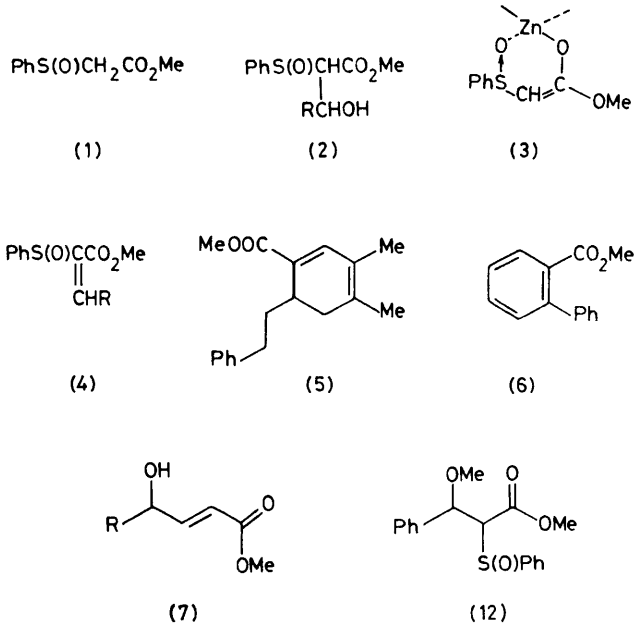
ESTERS of phenylsulphinylacetic acid, *e.g.* (**1**), like malonic acid derivatives, have potential in organic synthesis but have been largely ignored by chemists despite their ready availability. Herein we describe some chemical transformations which extend the usefulness of this group of compounds.

Condensation of the ester (**1**) with aldehydes generally proceeds only as far as the adducts (**2**);[1] subsequent attempts to dehydrate these, by treatment with acid, cause multiple reactions. It has now been found that further reaction can be effected by use of the zinc enolate (**3**), produced for example by successive treatment of the ester (**1**) with sodium hydride and zinc chloride. The resulting products are the conjugated sulphoxides (**4**) formed in moderate yields (Table). The *E*-configuration of the products was

TABLE

Aldehyde	Condensation product [a]	Isolated yield/%	Rearranged product	Isolated yield/% Direct [b]	Indirect [c]
$PhCH_2CH_2CHO$	(**4a**), R = $PhCH_2CH_2$	50	(**7a**), R = $PhCH_2$	26	36
$Me[CH_2]_3CHO$	(**4b**), R = $Me[CH_2]_3$	35	—	—	—
$Me[CH_2]_4CHO$	(**4c**), R = $Me[CH_2]_4$	38	(**7c**), R = $Me(CH_2)_3$	58	52
MeCHO	(**4d**), R = Me	34	—	—	—
PhCHO	(**4e**), R = Ph	20	(**12**)	63	—
PhCH=CHCHO	(**4f**), R = PhCH=CH	40	—	—	—
MeCH=CHCHO	(**4g**), R = MeCH=CH	39	(**10**)	40	[15 [b]]

[a] 1—2 mmol scale; reactions were carried out in tetrahydrofuran by adding the aldehyde to a preformed solution of the zinc enolate (**3**) at 0 °C, stirring the mixture at room temperature for 18—24 h, and finally heating to reflux for 0·5—3 h. Reactions were quenched with dilute HCl before extraction into ethyl acetate and purification by preparative t.l.c. (Yields are not optimised.) [b] From the aldehyde by reaction with magnesium methoxide in methanol at room temperature overnight, working-up as described in footnote [a]. [c] From the sulphoxides (**4**), by treatment with pyridine or triethylamine at room temperature overnight, working-up as described in footnote [a].

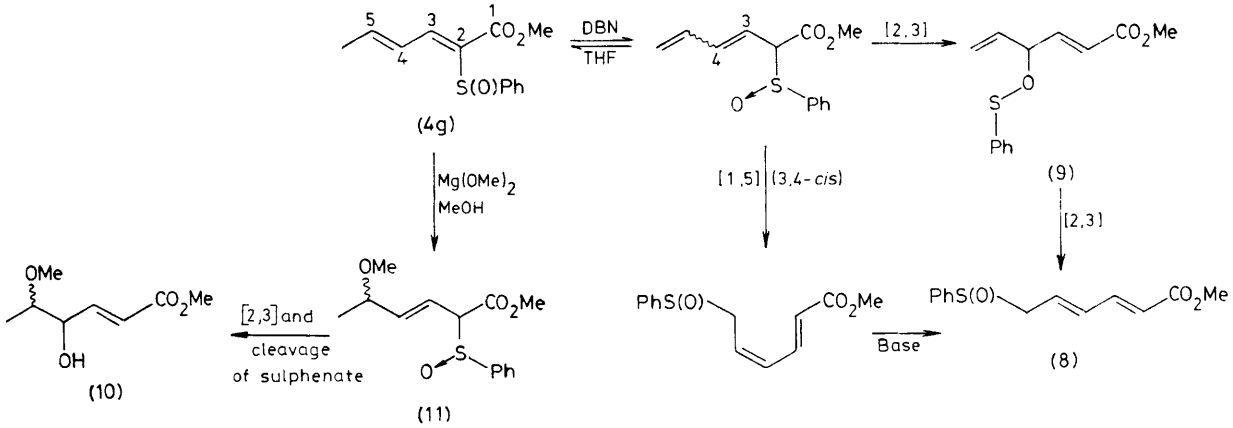


readily shown by ^1H n.m.r. experiments using lanthanide induced shifts [$Eu(fod)_3$, fod = $CF_3CF_2C(:O)CH_2C(:O)CMe_3$] in which the vinylic proton resonance is rapidly shifted downfield owing to preferential complexing of the reagent with the sulphoxide group.[2]

The conjugated sulphoxides, previously obtained by a multistep route,[3] exhibit a variety of chemical behaviour. They are potent dienophiles; thus the ester (**4a**) reacts with 2,3-dimethylbutadiene to form, after elimination of benzenesulphenic acid, the cyclohexadiene derivative (**5**) (60%), whilst reaction of the benzaldehyde derivative (**4e**) with 1-acetoxybutadiene leads directly to 2-methoxycarbonylbiphenyl (**6**) (54%).

Treatment of the vinylic sulphoxides with tertiary amine bases catalyses a rapid rearrangement to the corresponding γ-hydroxy-$\alpha\beta$-unsaturated ester. Thus with pyridine the sulphoxide (**4c**) produces the alcohol (**7c**) (Table); the *trans*-configuration of the product follows both from its failure to cyclise to a lactone under the reaction conditions and from the observed coupling constant between the two vinylic protons of 16 Hz. Presumably initial $\alpha\beta$- to $\beta\gamma$-isomerisation of the double bond occurs before [2,3]-sigmatropic rearrangement of the sulphoxide group and collapse of the sulphenate species to the product alcohol. A related base-catalysed transformation has been observed by Uda *et al.*[4]

The adduct from crotonaldehyde (**4d**) is unaffected by pyridine. However, treatment of this ester with catalytic quantities of diazabicyclononene (DBN) in tetrahydrofuran (THF) produces the isomeric sulphoxide (**8**) (76%), m.p. 74—75 °C. ^1H N.m.r. studies revealed an all-*trans* configuration. Compound (**8**) can arise either by two consecutive [2,3]-shifts of the sulphoxide moiety, or by one [1,5]-transposition (see Scheme). The latter process would involve a new example of this class of reaction. Attempts



SCHEME

to trap the intermediate sulphenate ester (**9**), by the addition of thiophiles, have so far failed but this could be because the second rearrangement occurs rapidly. Further efforts to distinguish between the possible reaction paths are in hand.

When the ester (**4g**) was treated with magnesium methoxide in methanol a new product was obtained, identified as a mixture of stereoisomers of the type (**10**). These presumably form by conjugate addition of methanol at position 5, to produce the intermediate $\beta\gamma$-unsaturated ether (**11**) which is then set up to undergo the [2,3]-rearrangement (see Scheme).

Finally it has been shown that condensation of the ester (**1**) with aldehydes can also be effected by the use of magnesium methoxide in methanol. In this case the isolated products are not the conjugated sulphoxides (**4**) but, instead the rearranged alcohols (**7**), formed directly. Under these conditions benzaldehyde gives the methoxy adducts (**12**), since the [2,3]-rearrangement is blocked.

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