CHEMISTRY LETTERS, pp. 553-556, 1972. Published by the Chemical Society of Japan

A CONVENIENT SYNTHESIS OF 4-DIMETHYLSULFURANYLIDENE-2,3-DIOXO-TETRAHYDROFURAN DERIVATIVES; THE REACTIONS OF ETHYL (DIMETHYLSULFURANYLIDENE)-PYRUVATE WITH CARBONYL COMPOUNDS

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The cyclic ylides, 4-dimethylsulfuranylidene-2,3-dioxotetrahydrofuran derivatives, were synthesized by the reactions of ethyl (dimethylsulfuranylidene)pyruvate with carbonyl compounds in good yields. The structures of new sulfonium ylides were comfirmed by the spectral data and the elemental analyses.

Recently, a number of carbonyl-stabilized sulfonium ylides have been isolated and their reactions with electrophilic reagents have been reported.[2,3] In the present experiment, the preparation of ethyl (dimethylsulfuranylidene)pyruvate (II) and the synthesis of 4-dimethylsulfuranylidene-2,3-dioxotetrahydrofuran derivatives by the reactions of II with carbonyl compounds (III) were investigated.

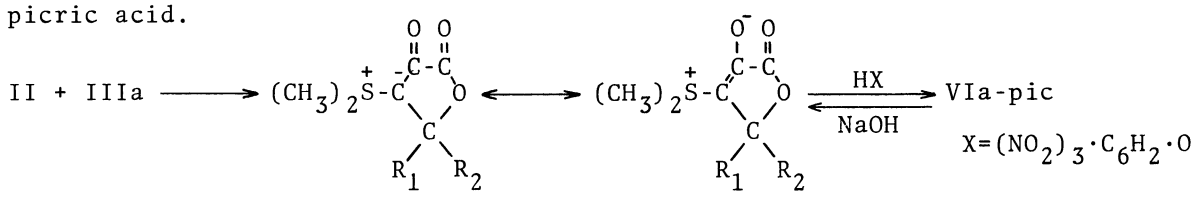
The ylide (II) was conveniently prepared by treating the corresponding sulfonium salt (I) with aqueous sodium hydroxide according to the procedure similar to those of ordinary carbonyl-stabilized sulfonium ylides.[3] For example, a treatment of dimethyl (ethoxalylmethyl)sulfonium picrate (I, X=$(NO_2)_3C_6H_2O$, 11.15 g, 0.0265 mole) in methylene chloride with 50% sodium hydroxide (2.15 g, 0.0265 mole) and 6.5 ml of saturated potassium carbonate under ice-cooling gave 3.69 g of II as hygroscopic yellow crystals (80%): IR spectrum (KBr) $\nu_{C=O}$ 1720, 1650 cm^{-1}; NMR spectrum ($CDCl_3$) at δ 4.68 (1H, s), 4.25 (2H, q), 3.00 (6H, s) and 1.34 (3H, t).

$$(CH_3)_2\overset{+}{S}\text{-}CH_2COCOOC_2H_5\ X^- \xrightarrow{NaOH} (CH_3)_2\overset{+}{S}\text{-}\overset{-}{C}HCOCOOC_2H_5 \qquad X=Br \text{ or } (NO_2)_3\cdot C_6H_2O$$

I II

The treatment of II with ethyl pyruvate (IIIa) in ethanol for two days at room temperature, followed by the addition of 2.3g of picric acid and removal of the solvent under reduced pressure gave a syrup, which was crystallized by the addition of ethyl acetate. It was recrystallized from ethanol to afford 3.37g of the picrate (VIa-pic) as yellow needles: mp 142-143°C (dec); $\nu_{C=O}$ 1790, 1775 cm^{-1} (KBr). Calcd for $C_{16}H_{17}N_3O_{12}S$: C, 40.43; H, 3.60; N, 9.40; S, 6.74%. Found: C, 40.70; H, 3.46; N, 8.95; S, 6.76%.

The picrate of VIa (1.80 g, 3.8 mmole) in methylene chloride was treated with 50% aq. sodium hydroxide (0.31 g, 3.8 mmole) and 3 ml of saturated potassium carbonate to give 0.71 g of the ylide (VIa) (76%): mp 132-134°C (dec). The structural assignment was made on the basis of spectral data [IR (KBr): 1765, 1750, 1625 cm^{-1}. NMR ($CDCl_3$): δ=4.23 (2H, q), 3.30 (3H, s), 3.14 (3H, s), 1.71 (3H, s), and 1.30 (3H, t)], and of the quantitative formation of the picrate (VIa-pic) with picric acid.



VIa

In a similar manner, the reactions of II with various carbonyl compounds (IIIb-d) such as biacetyl, butyraldehyde and benzaldehyde gave the corresponding new ylides. The ylides were isolated as their picrates or oxalate. In the case of the reaction of II with p-nitrobenzaldehyde (IIIe) or formaldehyde (IIIf), the ylide precipitated from the reaction mixture as stable crystals. The results and physical data of new ylides are shown in Tables 1 and 2, respectively. As shown in Table 1, the yields of VI were remarkably influenced by the solvent used. Among various solvents examined, methanol was proved to be the best solvent for this reaction.

It is reasonable to consider that the reaction of II with III proceeds through an intermediate betaine (IV), which is in turn cyclized to form V by an intramolecular nucleophilic attack of alkoxide anion to the ethoxycarbonyl group. The cyclization to form V would be a driving force of this reaction. The results are, therefore, different from those of carbonyl-stabilized sulfonium ylides such as dimethylsulfuranylideneacetophenone[4] and ethyl (dimethylsulfuranylidene)acetate[5] which are reported to be relatively unreactive toward ordinary carbonyl compounds.

Table 1. The Reactions of Ethyl (dimethylsulfuranylidene)pyruvate (II) with Carbonyl Compounds (III)

Compd III No	R_1	R_2	Solvent	Time(day)	No[2,3]	Product (VI) Yield(%)	mp (dec)(°C)[1]
IIIa	CH_3	$COOC_2H_5$	EtOH	2	VIa-pic	71	142-143
IIIa	CH_3	$COOC_2H_5$	THF	2	VIa-pic	41	
IIIb	CH_3	$COCH_3$	EtOH	2	VIb-pic	44	148-149
IIIb	CH_3	$COCH_3$	THF	2	VIb-pic	41	
IIIb	CH_3	$COCH_3$	MeOH	1	VIb-pic	61	
IIIc	H	C_3H_7	MeOH	1	VIc-oxal	45	124-125
IIId	H	C_6H_5	MeOH	1	VId-pic	52	145-146
IIIe	H	$C_6H_4\cdot NO_2\cdot P$	EtOH	2	VIe	41	170
IIIe	H	$C_6H_4\cdot NO_2\cdot P$	THF	2	VIe	0	
IIIe	H	$C_6H_4\cdot NO_2\cdot P$	MeOH	1	VIe	71	
IIIf	H	H	MeOH	1	VIf	80	139-140

1) All melting points are uncorrected.

2) All new compounds had satisfactory elemental analyses.

3) Abbreviations: Pic, picrate; oxal, oxalate.

Table 2. Physical Constants of New Sulfonium Ylides (VI)

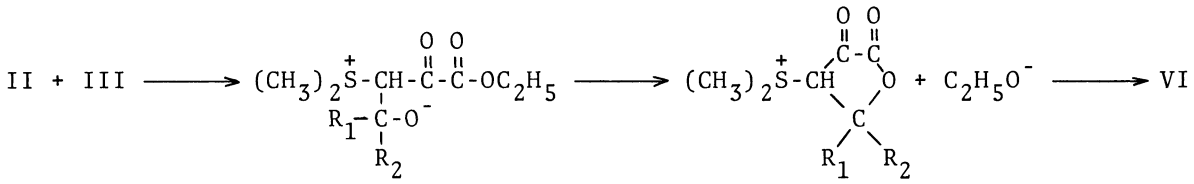
Compd (VI)[1] No	R_1	R_2	mp (dec)(°C)[2]	IR $\nu_{C=O}^{KBr}$ cm^{-1}	UV λ_{max}^{MeOH} mμ(ε)	NMR(δ)[4] $(CH_3)_2S^{+}$
a	CH_3	$CO_2C_2H_5$	132-134	1765,1750,1625	292(9490)	3.30(s,3H), 3.14(s,3H),A
b	CH_3	$COCH_3$	120-122	1765,1760,1715 1625	291(9070)	3.30(s,3H), 3.11(s,3H),A
c	H	C_3H_7	123-125	1760,1740,1620	292(9130)	3.16(s,3H), 3.12(s,3H),A
d	H	C_6H_5	162-163	1760(sh)[3],1745 1620	291(8000)	3.07(s,3H), 2.89(s,3H),A
e	H	$C_6H_4\cdot NO_2\cdot P$	170	1750,1620	286(10600)	2.92(s,6H),B
f	H	H	139-140	1750,1635	287(10890)	2.98(s,6H),B

1) Sulfonium ylides (VIa-d) were obtained from the corresponding sulfonium salts (picrate or oxalate) in about 80% yield.

2) All melting points are uncorrected.

3) Sh; shoulder absorption.

4) Solvent : A, $CDCl_3$; B, $(CD_3)_2SO$.



IVa-f Va-f

In conclusion, it was established that the cyclic ylides (VI), 4-dimethylsulfuranylidene-2,3-dioxotetrahydrofuran derivatives[6], were successfully synthesized in good yields by the reactions of II with various carbonyl compounds.

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(Received April 24, 1972)