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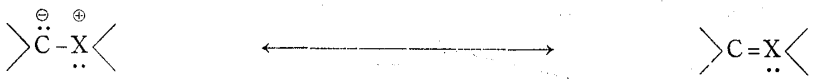
Formation of Thiabenzene 1-Oxide Derivatives

Recently increasing attention has been forcussed to a possible benzenoid conjugation in a heterocyclic ring system involving the sulfur or the phosphorous atom which possesses vacant "d" orbitals. Several thiabenzene derivatives[1] and 1,1-diphenylphosphabenzene derivatives[2] have been reported as such new aromatic heterocycles. These compounds have been estimated to possess an appreciable cyclic aromatic conjugation through the ylene-like structure.

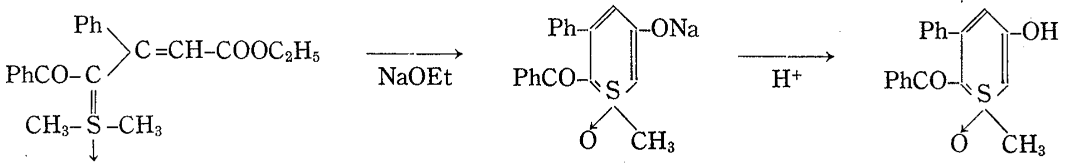


X=P or S

In contrast to the non-crystalline thiabenzenes so have been reported, a stable crystalline thiabenzene 1-oxide, 1-methyl-3,5-diphenylthiabenzene 1-oxide has been recently synthesized from 3-phenylpropiolophenone and dimethyloxosulfonium methylide[3] by Hortmann.[4]

In this communication we wish to report an ovel synthesis of such a stable crystalline heterocycle, 1-methyl-3-hydroxy-5-phenyl-6-benzoylthiabenzene 1-oxide (III) from dimethyloxosulfonium 1-benzoyl-2-phenyl-3-ethoxycarbonylallylide[5] (I).

Treatment of I, which was prepared from dimethyloxosulfonium 2-phenyl-3-ethoxycarbonylallylide[6] and benzoyl chloride in the presence of triethyl amine, with sodium ethoxide in a mixture of tetrahydrofuran and ethanol gave sodium salt of III. The salt, after acidifying with acetic acid, afforded the corresponding thiabenzene 1-oxide (III) in 60% yield as yellow prisms, m.p. 207~208° from methanol: *Anal.* Calcd. for $C_{19}H_{16}O_3S$: C, 70.34; H, 4.97; S, 9.91. Found: C, 70.16; H, 5.03; S, 9.72. UV λ_{max}^{EtOH} mμ (ε): 235 (17570), 298 (7380), and 383 (10630). Infrared spectrum: ν_{max}^{Nujol} cm^{-1}: 3300 (OH), NMR spectrum (in CD_3SOCD_3)*1: 6.9~7.3 (10H, multiplet) due to the aromatic protons, 6.16 (1H, doublet, J=2.0 c.p.s.), 5.64 (1H, doublet, J=2.0 c.p.s.), 3.88 (3H, singlet) and 10.90 (1H, broader singlet, due to the OH).



I II III

Chart 1.

Methylation of III with dimethylsulfate gave 1-methyl-3-methoxy-5-phenyl-6-benzoylthiabenzene 1-oxide (IV), m.p. 173~174°: *Anal.* Calcd. for $C_{20}H_{18}O_3S$: C, 70.98; H, 5.36:

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*1 Nuclear magnetic resonance spectra were obtained in a Varian A-60 spectrometer and the chemical shifts are given in p.p.m. unit (δ) from an internal reference of tetramethylsilane.

1) G. Sludand, C.C. Price: J. Am. Chem. Soc., **83**, 1770 (1960); *Idem*: *Ibid.*, **84**, 2090 (1962); *Idem*: *Ibid.*, **84**, 2094 (1962), C.C. Price, M. Hori, T. Parasaran, M. Polk: *Ibid.*, **85**, 2278 (1963).

2) G. Markl: Angew. Chem., **75**, 669 (1963), *Idem*: Z. Naturforsch., **18b**, 84 (1963), *Idem*: Angew. Chem., **75**, 168 (1963). C.C. Price: J. Am. Chem. Soc., **88**, 1034 (1966).

3) E.J. Corey, M. Chaykovsky: *Ibid.*, **87**, 1353 (1965), *Idem*: *Ibid.*, **84**, 4972 (1965).

4) A.G. Hortmann: *Ibid.*, **87**, 4972 (1965).

5) J. Ide, Y. Kishida: This Bulletin, in press.

6) C. Kaiser, B.M. Trost, J. Beeson, J. Weinstock: J. Org. Chem., **30**, 3972 (1965), J. Ide, Y. Kishida: Tetrahedron Letters: 1787 (1966).

S, 9.47. Found: C, 70.61; H, 5.36; S, 9.22. UV $\lambda_{\max}^{\mathrm{EtOH}}$ mμ (ε): 237 (18830), 291 (8040) and 384 (11980). Infrared spectrum $\nu_{\max}^{\mathrm{Nujol}}$ cm^{-1}: 1605, 1553, 1486, 1332, 1284, 1206, 1170, 1149, 775, 719, 699 and no exsistence of hydroxy group: NMR (in $CDCl_3$): 6.9~7.4 (10H, multiplet), 5.85 (1H, doublet, J=2.0 c.p.s.), 5.73 (1H, doublet, J=2.0 c.p.s.), 3.92 (3H, singlet) and 3.86 (3H, singlet) and (in CD_3SOCD_3): 6.93~7.3 (10H, multiplet), 6.59 (1H, doublet, J=2.5 c.p.s.), 5.63 (1H, doublet, J=2.5 c.p.s.), 3.92 (3H, singlet), and 3.84 (3H, singlet).

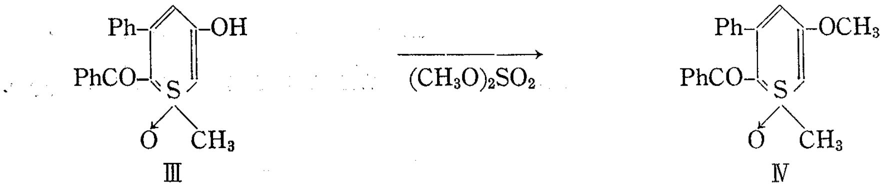

Chart 2.

The NMR spectral changes of Ⅲ and Ⅳ discussed below, if compared with such corresponding changes in the compound of 1-methyl-3,5-diphenylthiabenzene 1-oxide[*2] reported by Hortmann[4], would tell us that the signals at 6.16 and 6.59 p.p.m. in Ⅲ and Ⅳ (in CD_3SOCD_3) respectively were assigned to the protons at C-2 position. Therefore, the signals at 5.64 and 5.63 p.p.m. in Ⅲ and Ⅳ respectively were due to the protons at C-4 position.

The NMR spectrum taken in a solution of Ⅲ in CD_3SOCD_3 containing a few drops of D_2O almost lacks the signal at 6.16 p.p.m. which was observed in CD_3SOCD_3 alone, and the signal appeared as doublet at 5.64 p.p.m. (J=2.0 c.p.s.) in CD_3SOCD_3 changed into sharp singlet at 5.60 p.p.m. On the other hand, the NMR spectrum of the methylated thiabenzene 1-oxide (Ⅳ) in CD_3SOCD_3 containing a few drops of D_2O showed no change in comparison with that of Ⅲ in CD_3SOCD_3 (Fig. 1-4). From these results, Ⅲ would be more predominant in a ylide-like character than Ⅳ between sulfur and C-2. If deuterium-proton exchange would be promoted by the keto-enol tautomerization due to the hydroxy group at C-3 in Ⅲ, the proton at C-4 would disappear as well as C-2 position, but this hypothesis is excluded from the NMR spectra of Ⅲ in CD_3SOCD_3 (Fig. 1) and in CD_3SOCD_3 plus D_2O (Fig. 3). Confirming this, a solution of Ⅲ in CD_3COOD (Fig. 5) in the NMR spectrum showed disappearance of S-methyl protons and both C-2 and C-4 protons. On the other hand, a solution of Ⅳ in CD_3COOD (Fig. 6) in the NMR spectra also showed disappearance of S-ring protons but S-methyl and O-methyl protons

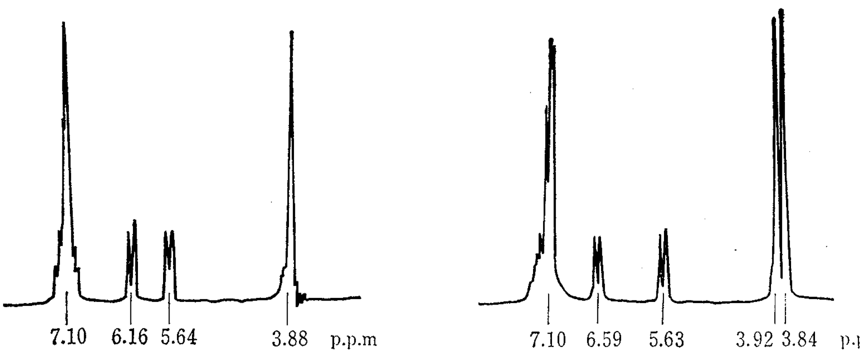

Fig. 1. Ⅲ　　Fig. 2. Ⅳ

Nuclear Magnetic Resonance Spectra of 1-Methyl-3-hydroxy-5-phenyl-6-benzoylthiabenzene 1-oxide (Ⅲ) and 1-Methyl-3-methoxy-5-phenyl-6-benzoylthiabenzene 1-oxide (Ⅳ) in CD_3SOCD_3.

[*2] NMR (in $CDCl_3$): 7.15~7.65 (10H, multiplet), 6.19 (1H, triplet, J=1.1 c.p.s.), 5.75 (2H, doublet, J=1.1 c.p.s.) and 3.50 (3H, singlet).

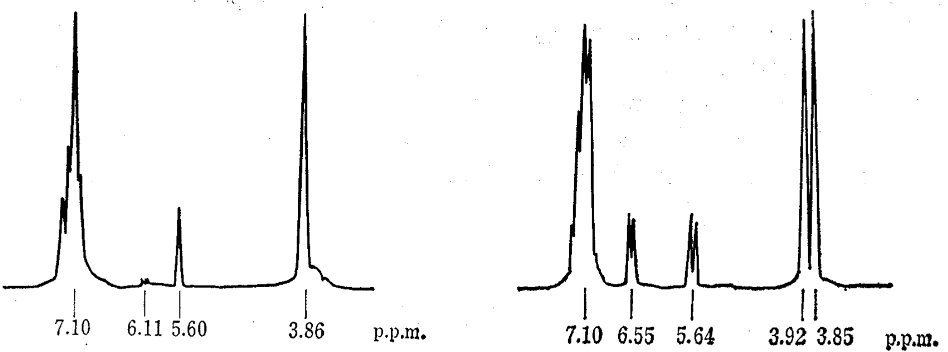

Fig. 3. III Fig. 4. IV

Nuclear Magnetic Resonance Spectra of 1-Methyl-3-hydroxy-5-phenyl-6-benzoylthiabenzene 1-oxide (III) and 1-Methyl-3-methoxy-5-phenyl-6-benzoylthiabenzene 1-oxide (IV) in $CD_3SOCD_3+D_2O$.

are remained unchanged. The behavior that S-methyl protons of IV showed no change in CD_3COOD but those of III almost lack the peak would again tell us that the sulfur atom of III has more sulfonium ion character than IV, consequently III has an appreciable ylide-like character.

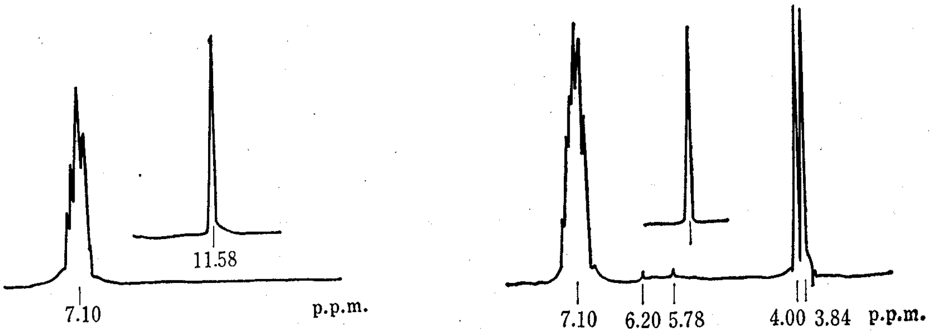

Fig. 5. III Fig. 6. IV

Nuclear Magnetic Resonance Spectra of 1-Methyl-3-hydroxy-5-phenyl-6-benzoylthiabenzene 1-oxide (III) and 1-Methyl-3-methoxy-5-phenyl-6-benzoylthiabenzene 1-oxide (IV) in CD_3COOD.

From these consideration, there seemed to be a possibility of more through-conjugated ylene-like structure for IV than III. These thiabenzene 1-oxide (III) and (IV) are remarkably stable as the thiabenzene 1-oxide prepared by Hortmann.[4] Further investigation in the synthesis of other thiabenzene 1-oxide derivatives and of chemical reactivity are undergoing.

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