

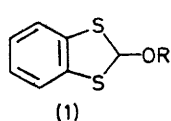
Introduction of Cyclic Dithioacetal Functions into Activated Methylene Compounds by Treatment with 2-Alkoxy-1,3-benzodithioles

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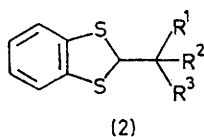
2-Alkoxy-1,3-benzodithioles reacted with a wide variety of active methylene compounds in acetic acid to give products in which the 1,3-benzodithiol-2-yl group had been introduced at the activated carbon atom. In the reactions with malononitrile, methyl cyanoacetate, cyanoacetamide, and rhodanine, products with two 1,3-benzodithiol-2-yl substituents at the activated carbon atom were obtained in excellent yields.

2-ALKOXY-1,3-BENZODITHIOLES (1) have been obtained by one-step synthesis on a preparative scale which involved addition of alcohols to the carbene (1,3-benzodithiol-2-ylidene) produced from benzyne and carbon disulphide.¹ We have already shown that the dithioles (1) can serve as convenient starting materials for preparing 2-substituted 1,3-benzodithioles and related compounds.²⁻⁴ We now report the introduction of a cyclic dithioacetal function (the 1,3-benzodithiol-2-yl group) into active methylene compounds by reactions with the benzodithioles (1).

2-(3-Methylbutoxy)-1,3-benzodithiole (1d) reacted with acetylacetone in the presence of pyridine in acetic



- a; R = Me
 b; R = Prⁿ
 c; R = Buⁿ
 d; R = [CH₂]₂ Prⁱ



	R ¹	R ²	R ³
a;	H	MeCO	COMe
b;	Me	MeCO	COMe
c;	H	CO-[CH ₂] ₃ -CO	
d;	H	CO-CH ₂ -CMe ₂ -CH ₂ -CO	
e;	CHO	CO-[CH ₂] ₃	
f;	CHO	CO-[CH ₂] ₄	
g;	H	MeCO	CO ₂ Et
h;	H	PhCO	CN
i;	H	MeCO	SPh
j;	H	PhCH ₂ -CO	Ph
k;	H	CO-[CH ₂] ₄	
l;	H	CO-[CH ₂] ₃	

acid at room temperature to give 3-(1,3-benzodithiol-2-

1,3-benzodithioles (1a—c) also reacted with acetylacetone to give (2a) in 80—92% yield. The presence of pyridine was not essential to the reaction: compound (1d) reacted with acetylacetone in the absence of pyridine to give (2a) in 85% yield. Similarly, 3-methylpentane-2,4-dione, cyclohexane-1,3-dione, dimedone, 2-oxocyclopentane-carbaldehyde, 2-oxocyclohexane-carbaldehyde, ethyl acetoacetate, phenacyl cyanide, and acetonyl phenyl sulphide, reacted with compound (1d) to give the dithioles (2b—i) in good yields. Heating facilitated the reaction; the reaction of (1d) with phenacyl cyanide in acetic acid at 65 °C for 3 h gave (2h) in 72% yield, although the reaction at room temperature needed 2 days to give an 86% yield. The reaction of (1d) with ethyl acetoacetate at 65 °C for 5 h gave (2g) in 74% yield. Carbon atoms activated by only one electron-withdrawing group resisted reaction with compound (1d). Dibenzyl ketone with (1d) at room temperature gave (2j) in low yield (34%), and cyclopentanone, cyclohexanone, acetophenone, nitromethane, and phenylacetonitrile did not react with (1d) at room temperature. Heating compound (1d), cyclohexanone, and pyridine in boiling acetic acid for 1 h gave the expected dithiole (2k) (33%) and an unidentified product, m.p. 241—243°, scarcely soluble in organic solvents. Under the same conditions, the reaction of cyclopentanone with (1d) gave (2l) (29%), 2,2-bis-(1,3-benzodithiol-2-yl)cyclopentanone (3a) (5%), and the same unidentified product. The structure (3a) was supported by the n.m.r. spectrum. Heating acetophenone (2 mol. equiv.) with (1d) and pyridine in boiling acetic acid for 2 h gave dibenzotetrathiafulvalene² (4) (15%), a small amount of 2,2'-spirobi-(1,3-benzodithiole)² (5), and a yellow crystalline compound, m.p. 243—246°. The formation of compounds (4) and (5) by thermal decomposition of (1d) has been reported.²

The reaction of (1d) with malononitrile, in striking contrast to the foregoing results, afforded bis-(1,3-benzodithiol-2-yl)malononitrile (3b) exclusively in 93% yield (a slight excess of malononitrile was employed). Methyl cyanoacetate, cyanoacetamide, and rhodanine reacted with (1d) in a similar manner to give compounds (3c—e) in high yields.

Reaction conditions, yields, and properties of compounds (2) and (3) are summarised in Tables 1 and 2.

The reaction probably involves the 1,3-benzodithiol-

TABLE 1
Reaction of 2-alkoxy-1,3-benzodithioles (1) with active methylene compounds

Pro- ducts	Conditions ^a	Yield (%)	M.p. (°C) (solvent)	Found (%)				Formula	Required (%)			
				C	H	N	S		C	H	N	S
(2a)	r.t., overnight ^b	90	128—129 (EtOH)	57.25	4.55		25.4	C ₁₂ H ₁₂ O ₂ S ₂	57.15	4.83		25.35
	r.t., overnight	85										
	r.t., overnight ^{b,c}	86										
	r.t., overnight ^{b,d}	80										
	r.t., overnight ^{b,e}	92										
(2b)	r.t., overnight ^b	73	63—64 (n-C ₈ H ₁₄)	58.7	5.15		24.05	C ₁₂ H ₁₄ O ₂ S ₂	58.65	5.3		24.05
(2c)	r.t., 2 days	79	192.5—193 (PhH-EtOH)	59.05	4.55		23.9	C ₁₂ H ₁₂ O ₂ S ₂	59.1	4.6		24.2
(2d)	r.t., overnight	74	171—173 ^f	61.6	5.5		21.55	C ₁₅ H ₁₆ O ₂ S ₂	61.65	5.5		21.9
(2e)	r.t., 2 days	55	104—105 (EtOH)	59.0	4.55		24.25	C ₁₂ H ₁₂ O ₂ S ₂	59.1	4.6		24.2
(2f)	r.t., 2 days	50	94—95 (MeOH)	60.45	4.95		23.1	C ₁₄ H ₁₄ O ₂ S ₂	60.45	5.05		23.0
(2g)	65 °C, 5 h ^b	74	61—62 (EtOH-H ₂ O)	55.6	4.95		22.4	C ₁₃ H ₁₄ O ₂ S ₂	55.3	5.0		22.65
(2h)	r.t., 2 days	86	102—105 (MeOH)	64.85	3.85	4.85	21.45	C ₁₄ H ₁₁ NOS ₂	64.65	3.75	4.7	21.55
	65 °C, 3 h	72										
(2i)	r.t., 4 days	54	113—114 (MeOH)	60.4	4.4		30.25	C ₁₆ H ₁₄ OS ₂	60.4	4.45		30.15
(2j)	r.t., 2 days	34	98—99 (MeOH)	72.7	4.9		17.7	C ₂₂ H ₁₈ OS ₂	72.9	5.0		17.65
(2k)	refl., 1 h ^{b,g}	33	85—86 (MeOH)	62.45	5.45		25.5	C ₁₃ H ₁₄ OS ₂	62.4	5.65		25.6
(2l)	refl., 1 h ^{b,g}	29	85—86 (n-C ₈ H ₁₄)	60.95	4.85		27.2	C ₁₂ H ₁₂ OS ₂	61.0	5.1		27.1
(3a)		5	147—149 (cyclo-C ₆ H ₁₂)	58.8	4.0		33.05	C ₁₅ H ₁₆ OS ₂	58.75	4.15		32.95
(3b)	r.t., overnight	96	219—220 (decomp.) ^f	54.75	2.75	7.6	34.25	C ₁₇ H ₁₆ N ₂ S ₄	55.15	2.7	7.55	34.55
(3c)	65 °C, 7 h	82	161.5—162.5 ^f	53.5	3.3	3.45	31.45	C ₁₈ H ₁₃ N ₂ O ₂ S ₄	53.6	3.25	3.45	31.75
(3d)	r.t., 2 days	66	201—202 (decomp.) (PhH)	52.5	3.15	7.25	32.9	C ₁₇ H ₁₂ N ₂ OS ₄	52.55	3.1	7.2	33.0
(3e)	r.t., overnight	93	245 (decomp.) (THF ^h -n-C ₆ H ₁₄)	46.7	2.75	3.25	43.1	C ₁₇ H ₁₁ NOS ₈	46.7	2.55	3.2	43.9

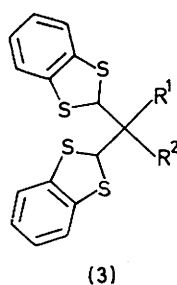
^aAll the reactions were carried out with 5 mmol of the dithiole (1d) and 6 mmol of active methylene compound in 15 ml of acetic acid, unless otherwise stated; r.t. = room temperature; refl. = heated under reflux. ^b Pyridine (0.5 ml) was added. ^c The dithiole (1a) was used instead of (1d). ^d The dithiole (1b) was used. ^e The dithiole (1c) was used. ^f The products, which precipitated from the reaction mixtures, were submitted to elemental analysis without further purification. ^g Two equiv. of the ketone were employed. ^h THF = tetrahydrofuran.

TABLE 2
N.m.r. and i.r. data for compounds (2) and (3)

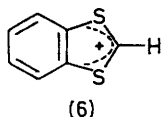
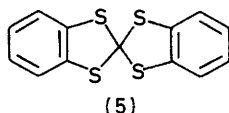
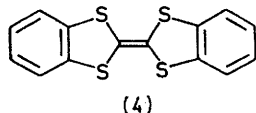
Compd.	N.m.r. (δ values; J in Hz) ^a				I.r. (ν_{\max} /cm ⁻¹) ^b	
	Aromatic	Methine	Methylene	Methyl	Carbonyl	Other
(2a)	7.0—7.3 (4 H, m)	5.37 (1 H, d, J 11) 4.46 (1 H, d, J 11)		2.25 (6 H, s)	1 724, 1 700sh	
(2b)	6.9—7.2 (4 H, m)	5.92 (1 H, s)		2.15 (6 H, s) 1.58 (3 H, s)	1 720, 1 712sh, 1 680	
(2c) ^{c,d}	6.9—7.3 (4 H, m)	6.48 (1 H, s)	2.36 (4 H, t, J 6) 1.83 (2 H, quint, J , θ)		1 592	2 520br (OH)
(2d) ^{c,d}	6.9—7.3 (4 H, m)	6.44 (1 H, s)	2.26 (4 H, s)	0.96 (6 H, s)	1 630w, 1 570br	2 550br (OH)
(2e) ^e	6.9—7.3 (4 H, m)	5.68 (1 H, s)	1.7—2.7 (6 H, m)		1 742, 1 702	
(2f) ^e	6.9—7.3 (4 H, m)	5.62 (1 H, s)	1.6—2.8 (8 H, m)		1 722, 1 692	
(2g)	7.0—7.3 (4 H, m)	5.35 (1 H, d, J 11) 4.25 (1 H, d, J 11)	4.28 (2 H, q, J 7)	1.30 (3 H, t, J 7) 2.30 (3 H, s)	1 740, 1 712	
(2h)	7.0—8.1 (9 H, m)	5.43 (1 H, d, J 9) 4.77 (1 H, d, J 9)			1 680	2 250 (CN)
(2i)	6.9—7.6 (9 H, m)	4.92 (1 H, d, J 12) 3.94 (1 H, d, J 12)		2.34 (3 H, s)	1 710	
(2j)	6.9—7.4 (14 H, m)	5.38 (1 H, d, J 11) 4.30 (1 H, d, J 11)	3.64 (2 H, s)		1 712	
(2k)	6.9—7.2 (4 H, m)	5.20 (1 H, d, J 6) 2.8 (1 H, m)	1.5—2.6 (8 H, m)		1 708	
(2l)	6.9—7.2 (4 H, m)	5.26 (1 H, d, J 5) 2.6 (1 H, m)	1.6—2.3 (6 H, m)		1 728	
(3a)	6.9—7.3 (8 H, m)	5.45 (2 H, s)	1.8—2.5 (6 H, m)		1 730	
(3b) ^c	7.1—7.6 (8 H, m)	6.04 (2 H, s)				2 250vw (CN)
(3c) ^c	7.0—7.4 (8 H, m)	5.62 (2 H, s)		3.30 (3 H, s)	1 740	
(3d) ^{c,f}	7.0—7.5 (8 H, m)	8.85 (2 H, s)			1 700	3 450, 3 300, 3 230, 3 170 (NH ₂), 2 240 (CN)
(3e) ^c	7.0—7.4 (8 H, m)	6.04 (2 H, s)			1 780, 1 695	3 280, 3 180 (NH)

^a Determined at 100 MHz for solutions in deuteriochloroform with tetramethylsilane as internal reference unless otherwise stated. ^b For Nujol mulls. ^c (CD₃)₂SO as solvent. ^d These compounds exist in the enol form: a broad signal ascribable to OH appeared at 11.50 in both cases; see also i.r. data. ^e The formyl proton signal of (2e) appeared at 9.40 and that of (2f) at 9.66. ^f The amide proton signal appeared at 7.76 and 8.06 as two singlets.

ylum ion (6) as intermediate. Acetic acid may facilitate the formation of this ion by protonation of the ether



- | | | |
|----|--|-----------------------------|
| | R^1 | R^2 |
| a: | $\text{CO}[\text{CH}_2]_3$ | |
| b: | CN | CN |
| c: | CN | CO_2Me |
| d: | CN | $\text{CO}\cdot\text{NH}_2$ |
| e: | $\text{S}\cdot\text{CS}\cdot\text{NH}\cdot\text{CO}$ | |



linkage; supporting evidence is found in the formation of 1,3-benzodithiolylium tetrafluoroborate from (1) by

* Acetic acid was distilled from phosphorus pentoxide. A solution of (1d) in acetic acid contaminated with water gives 2,2'-(*o*-phenylenedithio)bi-1,3-benzodithiole, by hydrolysis.³

treatment with tetrafluoroboric acid.⁵ The reactions of 1,3-dithiolylium salts with active methylene compounds are well known.⁶

The 1,3-benzodithiol-2-yl group can be converted into a formyl group by hydrolysis with mercury(II) chloride and mercury(II) oxide.³ Thus derivatives of type (2) would be expected to serve as useful starting materials for preparing various aldehydes.

EXPERIMENTAL

Reaction of 2-Alkoxy-1,3-benzodithioles (1) with Active Methylene Compounds.—The dithiole (1) (5 mmol) and the active methylene compound (6 mmol) were dissolved in anhydrous acetic acid* (15 ml) [in some cases pyridine (0.5 ml) was added]. The mixture was left at room temperature or was heated (see Table 1). In the reactions with cyclohexane-1,3-dione, dimedone, malononitrile, methyl cyanoacetate, cyanoacetamide, and rhodanine, the products which precipitated were filtered off. Addition of water (*ca.* 5 ml) to the filtrates gave more product. In other cases iced water (*ca.* 15 ml) was added to the mixture and the resulting crystalline precipitate was filtered off. In cases where oily materials separated, they were extracted with ether and purified by column chromatography on silica gel.

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⁵ J. Nakayama, K. Fujiwara, and M. Hoshino, *Chem. Letters*, 1975, 1099.

⁶ H. Prinzbach and E. Futterer, *Adv. Heterocyclic Chem.*, 1966, 7, 39; E. Campaigne and R. D. Hamilton, *Quart. Reports Sulphur Chem.*, 1970, 5, 275.