A New One-step Synthesis of Sulphenamides from Alkyl and Aryl Disulphides

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Summary The reaction of an alkyl or aryl disulphide with silver(I) ion and alkyl or aryl amines gives good yields of the corresponding sulphenamides.

There are few general synthetic methods for the preparation of alkyl and aryl sulphenamides. The procedure most widely used involves the condensation of an alkyl[1] or aryl[2] sulphenyl chloride with an amine, less successful methods involve the reaction of metal mercaptides with chloroamines,[3] oxidative condensation of thiols with amines [4] and the displacement of amines on alkanesulphenylthiocyanates[5] and on alkyl esters of thiosulphinic *S*-acids [6]

We report a ready one-step synthesis of sulphenamides from alkyl or aryl disulphides according to equation (1)

$$R^1\ S{-}S{-}R^1 + AgX + 2R_2NH \rightarrow AgSR^1 + R^1SNR^2_2 + R^2_2NH_2X \qquad (1)$$

R^1 and R^2 = alkyl or aryl

$X = NO_3$ for aryl derivatives and AcO for alkyl derivatives

For the preparation of sulphenamides derived from aromatic disulphides the best procedure was the following To a solution of silver nitrate (1 equiv) in methanol the disulphide (1 equiv) and then the amine (2 equiv) were added The mixture was stirred at room temperature for 15 h and then filtered Evaporation gave a residue which was dissolved in ether, washed with water, and dried After removal of ether the sulphenamide was purified by chromatography, distillation or crystallization The yields of 3-nitrobenzenesulphenanilide[7] and 2-benzothiazolesulphenanilide[8] *via* the silver nitrate method were much better than those *via* the corrseponding sulphenyl chloride method (84 and 77% *vs* 40 and 59%, respectively)

The sulphenamides derived from aliphatic disulphides were unstable in the presence of silver nitrate–methanol, so the following procedure was devised To a solution of disulphide (1 equiv) in ethyl acetate was added silver acetate (2 equiv), and excess of amine (8 equiv), and the mixture was stirred at room temperature for 22 h The work-up procedure was identical to that for the aromatic systems The results are summarized in the Table

Recently, one of us reported[11] that disulphides are readily cleaved by methanesulphinate ion in the presence of silver nitrate to produce thiosulphonate *S*-esters in high yield We feel that both this reaction and the sulphenamide reaction are members of a mechanistic class, recently described by Kice,[12] in which co-operative assistance by an electrophile and a nucleophile results in sulphur–sulphur bond cleavage The present reaction would thus be initiated by formation of a complex between Ag^+ and a non-bonding electron pair on one sulphur atom of the R–S–S–R system, followed by nucleophilic displacement on the adjacent sulphur atom by amine

TABLE

Preparation of sulphenamides from aryl and alkyl disulphides

Disulphide	Amine	Reaction time (h)	Sulphanide	Properties
Bis (2 benzothiazolyl) disulphide	$PhNH_2$	15·0	2-Benzothiazolesulphenanilide (77%)	Ref 8
	Piperidine	15·0	*N*-Piperidyl-2-benzothiazolesulphenamide (90%)	Ref 9
	Pr^iNH_2	15·0	N-Isopropyl 2 benzothiazolesulphenamide (90%)	Ref 10
$(m\text{-}NO_2\ C_6H_4\ S\ )_2$	$PhNH_2$	15·0	*m*-Nitrobenzenesulphenanilide (82%)	Ref 7
	$EtNH_2$	15·0	*N* Ethyl *m* nitrobenzenesulphenamide (94%)	B p 111° at 0·05 mmHg
$(Ph\ CH_2\ S\ )_2$	Et_2NH	22·0	*NN*-Diethylbenzenesulphenamide (58%)	B p 79—82° at 0·6 mmHg
	Pr^i_2NH	22·0	*NN* Di isopropylbenzenesulphenamide (50%)	B p 88° at 0·7 mmHg
$(Ph{\cdot}S\ )_2$	Pr^iNH_2	22·0	*N* Isopropylbenzenesulphenamide (73) %	B p 61—61·5 at 0·4 mmHg
	Pr^i_2NH	22·0	*NN*-Di isopropylbenzenesulphenamide (76%)	B p 71·5—73° at 0·35 mmHg

Satisfactory elemental analyses i r spectra and ^1H n m r spectra were obtained for all new compounds

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[1] N E Heimer and L Field, *J Org Chem* 1970, **35**, 3012.

[2] N Kharasch, S J Potempa, and H L Wehrmeister, *Chem Rev* 1946, **39**, 267

[3] (a) T J Hurley and M A Robinson, *J Medicin Chem* 1965, **8**, 888 (b) E Zaucler, Ger P 586 351 (*Chem Abs* 1934, **38**, 687)

[4] (a) J J D'Amico, M W Harmon, and R H Cooper, *J Amer Chem Soc*, 1957, **79**, 5270 (b) E L Carr G E P Smith, jun, and G Allinger *J Org Chem*, 1949, **14**, 921

[5] R T Major and L H Peterson *J Amer Chem Soc*, 1956, **78**, 6181

[6] J E Dunbar and J H Rodger, *J Org Chem*, 1966, **31**, 2842

[7] F A Davis, R B Wetzel, T J Devon, and J F Stackhouse, *J Org Chem*, 1971, **36**, 799

[8] W E Messer, U S P 2,370,253 (*Chem Abs* 1945, **39**, 3967)

[9] F Tschunkur and H Kohler, Ger P 615,580 (*Chem Abs* 1935 **29**, 8408)

[10] J J D'Amico, *J Org Chem* 1961, **26**, 3436

[11] M D Bentley, I B Douglass, and J A Lacadie *J Org Chem* in the press

[12] J L Kice, *Accounts Chem Res*, 1968, **1**, 58