Tetrahedron Letters No. 51, pp 4893 - 4894.
©Pergamon Press Ltd. 1979. Printed in Great Britain.
0040-4039/79/1215-4893$02.00/0

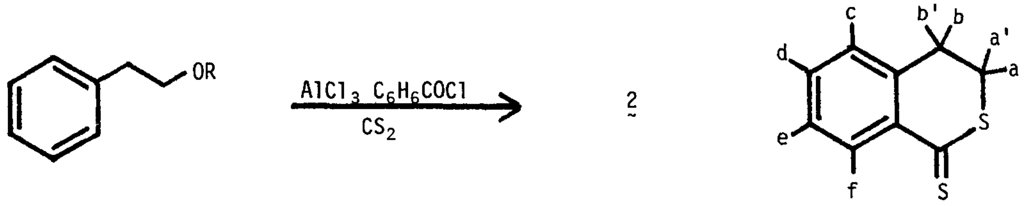
DIHYDRODITHIOISOCOUMARIN: NOVEL ELECTROPHILIC REACTION OF CARBON DISULFIDE WITH PHENETHYL ALCOHOL DERIVATIVES

Michael Czarniecki*
Department of Chemistry, University of Rochester, Rochester, New York 14627
Robert Q. Kluttz
Department of Chemistry, Columbia University, New York, New York 10027

ABSTRACT: The reaction of phenethyl alcohol and carbon disulfide promoted by aluminum chloride and benzoyl chloride yields dihydrodithioisocoumarin.

In the course of studies directed towards the synthesis of benzophenone derivatives for photochemical studies,[1] we have discovered a new class of sulfur heterocycles, the dihydrodithioisocoumarins,[2] which can be prepared in moderate yield in a simple one pot reaction. Benzoyl chloride, 1.0 g (7.1 mmole) was added to 2.0 gm (15.0 mmole) of aluminum chloride suspended in 50 ml of carbon disulfide and stirred for 15 minutes, then 0.40 gm (3.3 mmole) of phenethyl alcohol (1a) was added dropwise and the mixture refluxed, while stirring in a dry atmosphere, for 13 hours. The reaction was quenched with the addition of 50 ml of water, whereupon the mixture turned a deep red color. The organic layer was separated, washed with aqueous sodium bicarbonate, concentrated and chromatographed on 20 g of silica gel, eluting with hexane/methylene chloride (3/1). The major product (Scheme I), which elutes near the solvent front, was a non-polar, intensely red oil (b.p. 128°-130°, 0.2 mm), weight 0.27 g. NMR[3] and IR[3,4] indicated that the product was an aromatic dithioester; the strong downfield shift of the ortho hydrogen indicating that the thiocarbonyl was attached to the aromatic nucleus. Mass spectra and elemental analysis confirmed the structure as 2, dihydrodithioisocoumarin, isolated in 45% yield based on 1a.

SCHEME I



1a R = H

1b R = C_6H_6CO

1c R = CH_3CO

IR: 1600 cm^{-1} (—C=C—) 1225 cm^{-1} (—C=S)

NMR: a,a',b,b' δ 3.20 (4, m) c,d,e δ 7.40 (3, m) f δ 8.33 (1, dd, J = 8 Hz, 1 Hz)

CIMS: m + 1 = 181

ANAL:

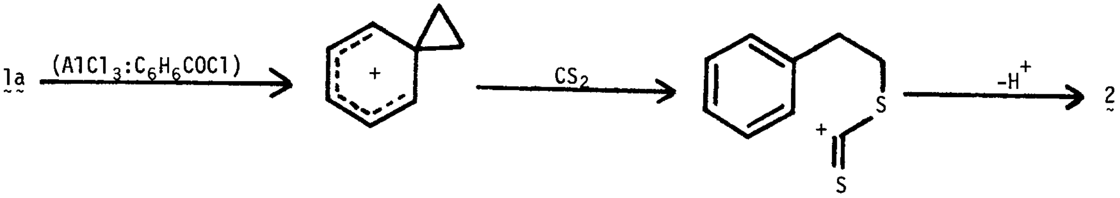
	Calc.	Found
C	59.96	60.25
S	35.57	35.18
H	4.47	4.63

Although dithioesters are a well characterized class of compounds,[4] their preparation usually involves nucleophilic attack on carbon disulfide. Thus, except in special cases,[5] the compounds previously prepared have been acyclic. The above reaction, accomplished under electrophilic conditions, produces a dithiolactone directly and thus represents a significant departure from previous chemistry. Therefore, further attention to the details of this unusual reaction seemed justified.

When phenethyl alcohol is treated directly with aluminum chloride in carbon disulfide, without added benzoyl chloride, the products are predominantly isoluble polymers with the yield of 2, after quenching, being less than 10%. The role played by benzoyl chloride in this reaction is, however, somewhat unusual. If the mixture of benzoyl chloride and aluminum chloride is quenched shortly after the addition of 1a, the isolated product is, as expected, phenethyl benzoate. Yet when phenethyl benzoate (1b) is treated with aluminum chloride in carbon disulfide without additional benzoyl chloride the yield of 2 drops to about 10%. Analogously, phenethyl acetate (1c) treated with aluminum chloride, benzoyl chloride, and carbon disulfide (same conditions as 1a) produced 2 in an isolated yield of 38%, yet in the absence of benzoyl chloride the products are insoluble polymers with 2 isolated in less than 10% yield.

Thus we believe that the primary role of the benzoyl chloride is to modulate the Lewis acidity of the aluminum chloride, and thus reduce the degradation of the starting materials or products. A plausible mechanism for this reaction (Scheme II) would involve initial generation of the stabilized phenonium ion by the Lewis acid, subsequent electrophilic reaction with the carbon disulfide, and ultimate ring closure through an intramolecular thioacylation, analogous to a Friedel-Crafts reaction, to give 2.

SCHEME II



Thus 2 represents the first member of a new family to sulfur heterocycles since alkyl and aryl substitution of 1a is clearly possible. Furthermore, the reaction products of 2 and related compounds will make available a variety of new organic structures with potentially interesting properties.[6] Therefore, further studies into the chemistry of the dihydrodithioisocoumarins are in progress.

Acknowledgements: We wish to thank the NSF for fellowship support and Professor R. Breslow for use of facilities.

References and Notes

1. M. F. Czarniecki, R. Breslow, J. Am. Chem. Soc., 101, 3675 (1979).
2. The dithiocoumarins, on the other hand, are well known, see: H. Simonis, A. Elias, Chem. Ber., 49, 765 (1916).
3. N. H. Leon, R. S. Asquith, Tetrahedron, 26, 1719 (1970).
4. For a recent and excellent review see: F. Duus in "Comprehensive Organic Chemistry," Vol. 3, D. N. Jones, Ed., Pergamon Press, 1979, Section 11.22.6.
5. R. Mayer, G. Lubon, M. Wirth, Ann. Chem., 703, 140 (1967).
6. For instance 2 is quantitatively converted to cyclic dithiohemiacetal at room temperature with lithium aluminum hydride.

(Received in USA 27 August 1979)