Tetrahedron Letters, Vol.32, No.36, pp 4679-4682, 1991
Printed in Great Britain

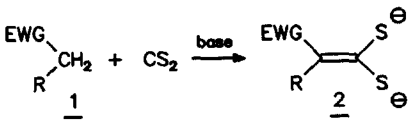
0040-4039/91 $3.00 + .00
Pergamon Press plc

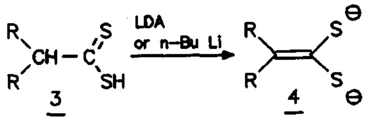
TETRATHIOMALONIC ACID AND ITS ANIONS [1]

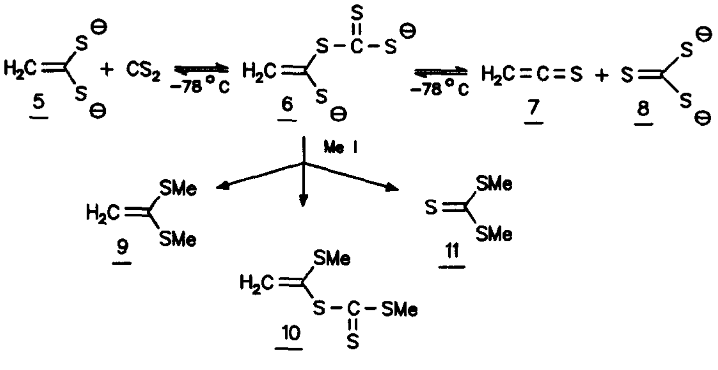
Klaus Hartke* and Nobert Rettberg
Institut für Pharmazeutische Chemie der Universität Marburg,
Marbacher Weg 6, D-3550 Marburg/Lahn, Germany

Summary: Condensation of ethanedithioic acid with CS_2 and 3 Li[HMDS] leads to the trianion 13 which is protonated to give the dimer 17 of tetrathiomalonic acid. Further deprotonation of 13 leads to the tetraanion 19 which is alkylated to form the tetrakis(alkylthio)allenes 20.

The base catalyzed addition of CH-acidic compounds 1 to carbon disulfide has been studied extensively[2]. It gives rise to the dianions 2 of dithioic acids, stabilized by at least one electron withdrawing group (EWG). In contrast to these stabilized dianions the chemistry of the nonstabilized dianions 4 of simple aliphatic dithioic acids 3 has been largely neglected. Some years ago Ziegler and Chan[3] prepared such dianions by deprotonation of aliphatic dithioic acids 3 with lithium diisopropylamide (LDA) or n-butyl lithium (n-BuLi) and transformed them into ketene dithioacetals by alkylation. Recently Beslin and Houtteville[4] studied the diastereoselective addition of propanedithioic acid dianion to achiral aldehydes. We report here on the reaction of ethanedithioic acid dianion 5 with carbon disulfide.

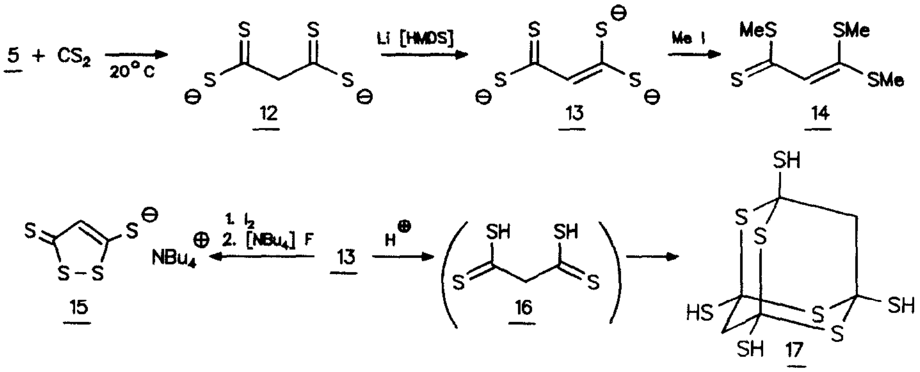


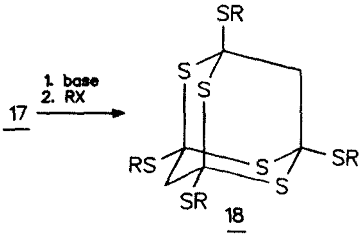




The ambident dianion 5 of ethanedithioic acid, formed with 2 equivalents of lithium hexamethyldisilazide (Li[HMDS]), reacts with carbon disulfide at -78°C mainly by S-addition leading to an equilibrium between the starting material, the S-addition product 6 and the elimination products 7 and 8. This can be shown by alkylation with methyl iodide at -78°C giving rise to a mixture of the vinyl trithiocarbonate 10, 1,1-bis(methylthio)ethene (9) and dimethyl trithiocarbonate (11) in a molar ratio 2:2:1.

By allowing the reaction mixture of 5 and carbon disulfide to warm up to room temperature, the S-addition product 6 rearranges to the thermodynamically more stable C-addition product 12 which gives the trianion 13 by loss of a proton. Therefore one more equivalent of Li[HMDS] is needed to complete this transformation. Subsequent methylation yields the methyl 3,3-bis(methylthio)-2-propenedithioate (14)[5].



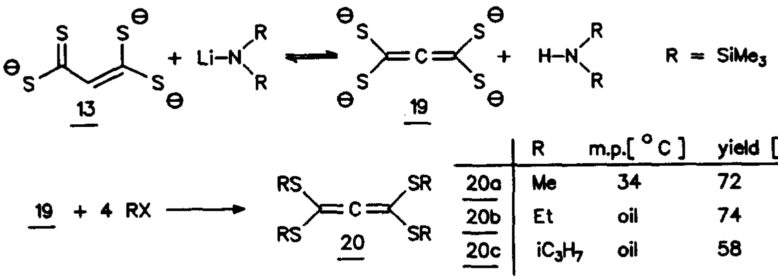


	R	m.p.[°C]	yield [%]
15	–	90	63
17	–	170 dec.	45
18a	Me	171	72
18b	Ph–CO	170 dec.	69

Oxidation of 13 with iodine at -50°C gives rise to the 3,5-dithioxo-1,2-dithiolate 15 isolated as its tetrabutylammonium salt. Protonation of 13 should lead to the unknown tetrathiomalonic acid (16). Instead of 16 a dimer, prone to oxidation, is isolated. This dimer was assigned the tetrathiaadamantane structure 17 due to its spectral data reflecting the high symmetry of the compound [e.g. ^1H-NMR([D_8]THF): δ = 4.24ppm (s, 4H, SH),2.38

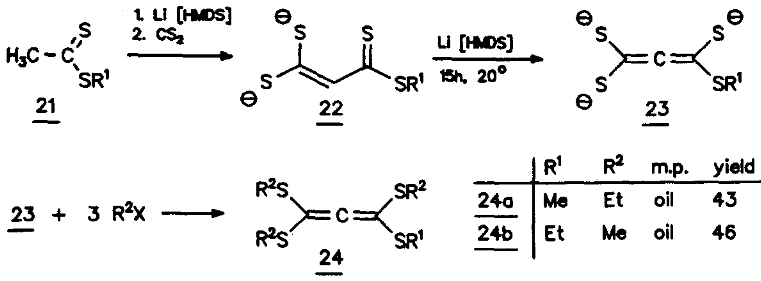
(s, 4H, CH$_2$); ^{13}C-NMR([D$_8$]THF): δ = 57.8ppm (C-1, -3, -5, -7), 48.8 (CH$_2$)][6]. 17 is rather acidic; deprotonation already occurs in an aequeous hydrogen carbonate solution. By alkylation or acylation the more stable derivatives 18 are formed.

The hydrogen atom left in the trianion 13 can be abstracted with another mol of Li[HMDS] leading to an equilibrium between 13 and the tetraanion 19. Alkylation of 19 with alkyl iodides gives rise to the tetrakis(alkylthio)-allenes 20[7]. The methyl derivative 20a was first obtained by Brandsma and coworkers[8] reacting 1-methylthio-propyne with dimethyl disulfide. Gompper and Jersak[9] observed the formation of 20a and 20b as byproducts in the condensation of tetrachloro cyclopropene with thiols. The pure products 20 are stable at room temperature for a few days. Attempts to alkylate 19 with α,ω-dihalogenides or with benzyl bromide lead to extensive decomposition.



	R	m.p.[°C]	yield [%]
20a	Me	34	72
20b	Et	oil	74
20c	iC$_3$H$_7$	oil	58

An attempted twofold deprotonation of dialkyl tetrathiomalonates or O,O-dialkyl dithiomalonates with 2 moles of Li[HMDS] gave only the monoanions. The dianions 22, however, obtained from alkyl dithioacetates 21 with carbon disulfide, reacted with another mol of Li[HMSD] to form the trianions 23. This deprotonation step in rather slow and requires about 15 h at room temperature. Subsequent alkylation leads to the mixed tetrakis(alkylthio)allenes 24 in moderate yields.



	R^1	R^2	m.p.	yield [%]
24a	Me	Et	oil	43
24b	Et	Me	oil	46

ACKNOWLEDGEMENTS: The authors gratefully acknowledge financial support from the "Fonds der Chemischen Industrie".

REFERENCES AND NOTES

1. Dithio and Thiono Esters, 51. Dithio and Thiono Esters, 50: K.Hartke, H.-D.Gerber and U.Roesrath, Liebigs Ann.Chem. 1991, in print.

2. Reviews: M.Kolb, Synthesis 1990, 171. R.K.Dieter, Tetrahedron 42, 3029 (1986). R.Mayer and S.Scheithauer in Methoden der Organischen Chemie (Houben-Weyl), Vol.E5, p.894, Thieme, Stuttgart 1985.

3. F.E.Ziegler and C.M.Chan, J.Org.Chem. 43, 3065 (1978).

4. P.Beslin and M.-C.Houtteville, Tetrahedron 45, 4445 (1989).

5. For an independent preparation see K.Hartke and R.Hoffmann, Liebigs Ann.Chem. 1980, 483. K.Hartke and A.Afrashteh, Arch.Pharm.(Weinheim) 321, 903 (1988).

6. Preparation of 17: To a mixture of THF (30mL) and n-BuLi (18.75mL of a 1.6 M solution in hexane, 30mmol) at -78°C is added with stirring hexamethyldisilazane (6.12g, 33mmol) in THF (5mL). After warming to room temperature and cooling again to -78°C ethanedithioic acid (0.92g, 10mmol) in THF (5mL) is added dropwise during 30 min followed by a solution of carbon disulfide (0.80g, 10.5mmol) in 5mL of THF. The reaction mixture is stirred for another 3 h at room temperature, diluted with 20ml of hexane and then treated with an excess of aqueous hydrogen chloride (5%). The yellow precipitate of 17 is filtered off, dissolved in THF and reprecipitated by addition of hexane (yield 45%). Recrystallization from acetonitrile, accompanied by heavy loss of product, leads to an analytically pure sample: m.p. 165-175°C (decomp.).

7. Preparation of 20: To a mixture of THF (30mL) and n-BuLi (14.0mL, 22.4 mmol) at -78°C is added with stirring hexamethyldisilazane (4.64g, 25mmol). After warming to room temperature and cooling again to -78°C the reaction mixture is treated with n-BuLi (12.5mL, 20mmol), ethanedithioic acid (0.92g, 10mmol) in 5mL of THF and carbon disulfide (0.80g, 10.5mmol) in 5ml of THF. After stirring at room temperature for 30 min methyl iodide (8.52g, 60mmol) is added at -30°C. After 3 more h at room temperature the reaction mixture is poured on ice and 20a extracted with hexane. For purification 20a is dissolved in 50mL of ether/THF (1:1) and treated dropwise at -10°C with perchloric acid 70%. The crystalline precipitate is filtered off and dissolved in 20mL of acetonitrile/triethylamine (9:1). The solution is diluted with 50mL of water and 20a is extracted with hexane. ^{13}C-NMR ($CDCl_3$) of 20a: δ = 187.9ppm (C-2), 118.1 (C-1 and -3), 17.3 (CH_3).

8. G.A.Wildschut, L.Brandsma and J.F.Arens, Rec.Trav.Chim.Pays-Bas 88, 1132 (1969).

9. R.Gompper and U.Jersak, Tetrahedron Lett. 1973, 3409.

(Received in Germany 28 May 1991)