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Synthesis of 6′*H*-spiro(indene-2,2′-[1,3]oxathiane)-1,3,5′-triones

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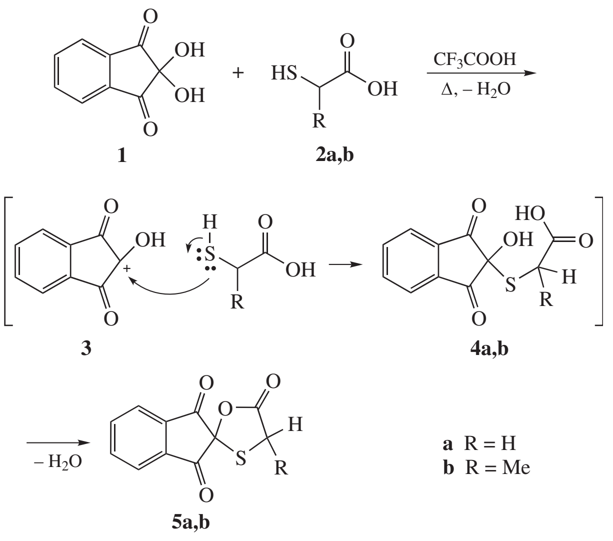
Reaction of ninhydrin with α-mercapto carboxylic acids or the corresponding Bunte salts affords 6′*H*-spiro(indene-2,2′-[1,3]oxathiane)-1,3,5′-triones.

Ninhydrin (indanetrione monohydrate) is a reactive electrophile that can undergo successive substitution of both hydroxy groups in reactions with nucleophiles.[1,2] This property makes it promising in the syntheses of spiro structures, involving lactonization of intermediate γ-hydroxy acids. The latter can be generated by addition of carboxylic acids bearing an α-positioned nucleophilic group to ninhydrin. Herein, α-mercapto-substituted carboxylic acids were used for this purpose.

We found that short heating of ninhydrin **1** with thioglycolic acid **2a** or thiolactic acid **2b** in trifluoroacetic acid gave hitherto unknown 6′*H*-spiro(indene-2,2′-[1,3]oxathiane)-1,3,5′-triones **5a**,**b**, respectively (Scheme 1). Probably, carbocation **3** generated from ninhydrin is attacked by the sulfanyl moieties of compounds **2a**,**b** to form intermediates **4a**,**b**, which are finally cyclized to produce spiro derivatives **5a**,**b**.[†]

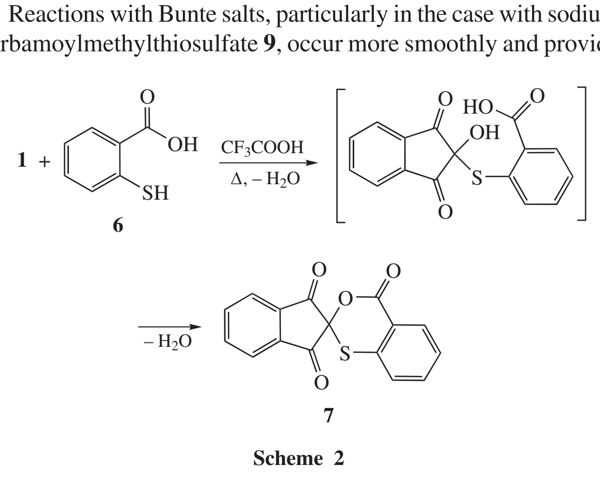


Scheme 1

The reaction of ninhydrin with thiosalicylic acid **6** proceeded similarly to result in 4*H*-spiro(3,1-benzoxathion-2,2′-indene)-1′,3′,4-trione **7** (Scheme 2).[‡]

Instead of thioglycolic acid, the corresponding Bunte salt, *viz*., sodium carboxymethylthiosulfate **8**, can be used as the equivalent of the carboxymethylsulfide residue[3] (Scheme 3). Interestingly that other Bunte salt, sodium carbamoylmethylthiosulfate **9**, during the reaction gave the same spirane **5a** rather than the expected analogue with a nitrogen atom in the ring. Hence, this cyclization involves elimination of ammonia (Scheme 3).

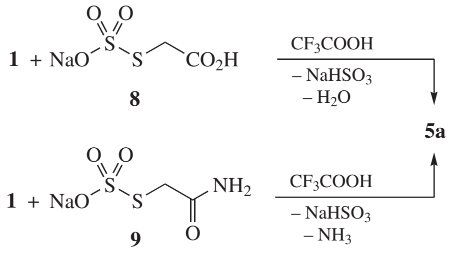
Reactions with Bunte salts, particularly in the case with sodium carbamoylmethylthiosulfate **9**, occur more smoothly and provide



Scheme 2

[†] *6′*H*-Spiro(indene-2,2′-[1,3]oxathiane)-1,3,5′-trione* **5a**. (*a*) A mixture of ninhydrin **1** (0.72 g, 4.1 mmol), thioglycolic acid (0.4 ml, 5.6 mmol) and CF_3COOH (1 ml) was triturated with a glass rod until complete dissolution, heated to boiling, poured into ice water (20 ml) and kept on ice with trituration with glass rod until the precipitate solidified completely. The precipitate was filtered off, washed with water and dried. The yield of the crude product was 0.2 g (20%). A colourless pure compound was obtained by crystallization from EtOH, mp 134–136 °C. IR (ν/cm^{-1}): 1800, 1788, 1763, 1718 (CO), 1588 (arom.). ^{1}H NMR ($CDCl_3$) δ: 4.04 (s, 2H, CH_2), 7.99 (m, 2H, CH_{arom}), 8.07 (m, 2H, CH_{arom}). MS, *m/z*: 234 [M]$^+$. Found (%): C, 56.10; H, 2.95; S, 13.72. Calc. for $C_{11}H_6O_4S$ (%): C, 56.40; H, 2.58; S, 13.69. (*b*) A mixture of compound **1** (0.36 g, 2 mmol), compound **8** (0.4 g, 2 mmol) and CF_3COOH (1 ml) was refluxed for 3 min and then cooled. Ice water (10 ml) was added and the mixture was triturated with a glass rod on cooling with ice. The resulting precipitate was filtered off, washed with water and dried. The yield of the crude product was 0.25 g (53%). (*c*) A mixture of compounds **1** (0.18 g, 1 mmol), **9** (0.2 g, 1 mmol) and CF_3COOH (0.5 ml) was heated to boiling and then cooled. Water was added to give a sticky precipitate that solidified completely upon addition of ice and trituration. The precipitate was filtered off, washed with water and dried. The yield of the crude product was 0.17 g (72%).

*4-Methyl-6′*H*-spiro(indene-2,2′-[1,3]oxathiane)-1,3,5′-trione* **5b**. A mixture of compounds **1** (0.36 g, 2 mmol) and **2b** (0.25 ml, 2.8 mmol) was heated until dissolution, then two drops of CF_3COOH were added. The mixture was heated to boiling, cooled, and water was added. The aqueous layer was decanted from the oil that formed. The oil was dissolved in a small amount of EtOH and poured into the decanted water cooled on ice, with trituration by a rod. The resulting precipitate was filtered off, washed with water and dried. The yield of the crude product was 0.2 g (40%). The product was recrystallized from Pr^{i}OH (3 ml) to afford a colourless compound, mp 88–92 °C. IR (ν/cm^{-1}): 1783, 1760, 1746, 1720 (CO), 1587 (arom.). ^{1}H NMR ($CDCl_3$) δ: 1.72 (d, 3H, Me, *J* 7.0 Hz), 4.47 (q, 1H, CH, *J* 7.0 Hz), 7.97 (m, 2H, CH_{arom}), 8.02 (m, 2H, CH_{arom}). MS, *m/z*: 248 [M]$^+$. Found (%): C, 58.11; H, 3.48; S, 12.32. Calc. for $C_{12}H_8O_4S$ (%): C, 58.05; H, 3.25; S, 12.92.



Scheme 3

higher yields of **5a** than that with thioglycolic acid. The literature[4,5] analogues of the compounds synthesized usually contain methylene group instead of carbonyl ones and were obtained differently.

References

1 M. Cugnon de Sevricourt, C. Dacquet, M. Finet, F. Le Marquer, M. Robba, N. O. Tembo, S. Yannic-Arnoult and J. L. Torregrosa, *EP Patent 0566446 (A1)*, 1993 (*Chem. Abstr*., 1994, **120**, 217010).

2 E. N. Shepelenko, L. Yu. Ukhin, L. V. Belousova and O. I. Dmitrieva, *Abstracts of VI International Conference 'High-Spin Molecular Magnets'*, Rostov-on-Don, September 8–13, 2012, p. 136.

3 L. Yu. Ukhin, A. R. Akopova, A. V. Bicherov, L. G. Kuzmina, A. S. Morkovnik and G. S. Borodkin, *Tetrahedron Lett*., 2011, **52**, 5444.

4 K. Gleiter, H. Hoffmann, H. Irngartinger and M. Nixdorf, *Chem. Ber*., 1994, **127**, 2215.

5 M. Schmidt, H. Meier, H.-P. Niedermann and R. Mengel, *Chem. Ber*., 1990, **123**, 1143.

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‡ *4*H-*Spiro(3,1-benzoxathion-2,2'-indene)-1',3',4-trione* **7**. A mixture of compounds **1** (0.36 g, 2 mmol) and **6** (0.31 g, 2 mmol) was ground in a mortar and transferred to a conic 10 ml flask, then CF_3COOH (1 ml) was added and the mixture was refluxed for 5 min followed by addition of Pr^iOH (3 ml). The mixture containing an abundant precipitate was heated to boiling and cooled on ice. The precipitate was filtered off, washed with cold Pr^iOH and with light petroleum and then dried. A slightly yellowish compound was recrystallized from propanol. Yield 0.46 g (78%), mp 185–188 °C. IR (ν/cm^{-1}): 1768, 1750, 1737, 1717 (CO), 1589 (arom.). ^{1}H NMR (DMSO-d_6) δ: 7.50 (m, 2H, CH_{arom}), 7.67 (m, 1H, CH_{arom}), 7.90–8.20 (m, 5H, CH_{arom}). MS, *m/z*: 296 [M]$^+$. Found (%): C, 64.86; H, 3.23; S, 10.05. Calc. for $C_{16}H_8O_4S$ (%): C, 64.86; H, 2.72; S, 10.82.