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STEREOSELECTIVITY IN THE HOMOLYTIC REACTION OF EPIMERIC t-BUTYL 2,4,6-TRIMETHYL-1,3,5-TRITHIANE-2-PEROXYCARBOXYLATES

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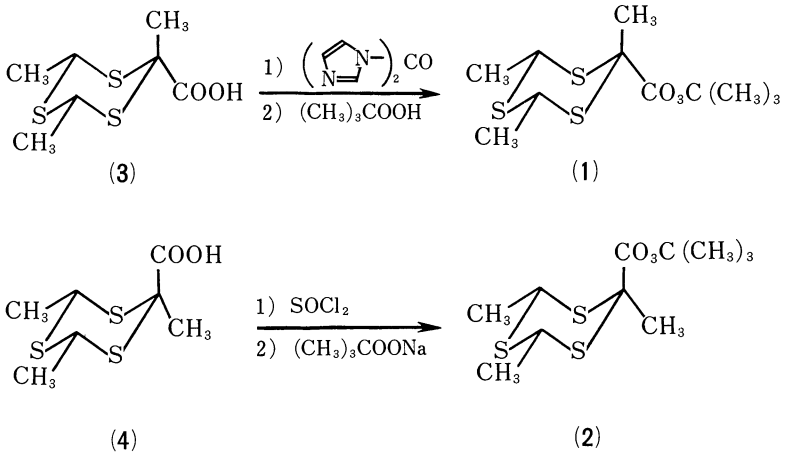
Isomeric t-butyl 2,4,6-trimethyl-1,3,5-trithiane-2-peroxycarboxylates are found to show large difference in decomposition rates, the axial peroxycarboxylate decomposing much faster. Preferential formation of products by axial-attack of the intermediate radical is also observed when the peroxycarboxylates are decomposed in toluene.

1,3,5-Trithiane derivatives were found to show remarkable stereoselectivity in polar reactions. 2-Lithio-1,3,5-trithianes preferred to give products with an equatorial substituent,[1] when treated with electrophiles, whereas 2-benzoyloxy-1,3,5-trithianes afforded products by axial attack of entering nucleophiles.[2] As a natural extention of the study on chemistry of 1,3,5-trithianes, radical reactions of a pair of peroxycarboxylates are investigated. Stereoselectivity is also found, although less extensive in its extent. This paper describes the results of such investigations.

A typical method of preparation of t-butyl 2,c-4,c-6-trimethyl-1,3,5-trithiane-r-2-peroxycarboxylate (1) is as follows. 2,c-4,c-6-Trimethyl-1,3,5-trithiane-r-2-carboxylic acid[3] (3) (0.55 g or 2.5 mmol) was added to a solution of 0.41 g (2.5 mmol) of N,N'-carbonyldiimidazole[4] in 8 ml of tetrahydrofuran. The resulting mixture was stirred at 50°C for 5 min and then at room temperature for further 25 min. After the end of the period, a solution resulted. The solution was treated with 0.25 ml (2.5 mmol) of t-butyl hydrogen peroxide which had been dried over Molecular Sieve. The mixture was allowed to stand at 15°C for 1 hr and treated with 5 % aq. sodium hydrogen carbonate and benzene. The benzene layer afforded 1, mp 37.5-39°C, in ca. 60 % yield after removal of the solvent at ca. 5°C and triturating with isopentane at -20°C. ^{1}H NMR (δ, CCl_4): 1.35 (9H, s), 1.56 (6H, d), 2.00 (3H, s), 4.33 (2H, q).

Preparation of isomeric t-butyl 2,t-4,t-6-trimethyl-1,3,5-trithiane-r-2-peroxycarboxylate (2) was not possible by the similar procedure because of the instability of 2. 2,t-4,t-6-Trimethyl-1,3,5-trithiane-r-2-carboxylic acid (4) (0.2 g or 0.9 mmol) was treated with 0.3 ml of thionyl chloride in 3 ml of carbon tetrachloride-chloroform (9:1) at reflux temperature for 6-8 hr. The completion of the reaction was checked by ^{1}H NMR: δ (CCl_4); 1.56 (6H, d), 1.87 (3H, s), 4.38 (2H, q). The solvent was evaporated in vacuo and the residue was taken up in 2 ml of dichloromethane. The solution was added at -30°C with stirring to a suspension

of sodium t-butyl peroxide, freshly prepared from 0.05 g of sodium hydride and 0.15 ml of t-butyl hydrogen peroxide, in 25 ml of dichloromethane. After 40 min, the mixture was filtered through a short column of Florisil below -30°C under dry nitrogen atmosphere. The purity (90-95%) and the yield (ca. 60%) based on the acid chloride were determined by ^{1}H NMR spectra at -40°C: δ ($CDCl_3$); 1.36 (9H, s), 1.57 (6H, d), 1.85 (3H, s), 4.82 (2H, q).



(3) (1) (4) (2)

Rate constants of decomposition of 1 and 2 in dichloromethane were measured by ^{1}H NMR and were obtained as 3.1×10^{-4} s^{-1} at 30°C and 2.9×10^{-4} s^{-1} at 2.5°C, respectively. These values are remarkably greater than that of t-butyl 1-methylcyclohexaneperoxycarboxylate which gives a rate constant of 9.2×10^{-4} s^{-1} at 80°C in ethylbenzene.[4] This enhanced reactivity of the trithiane series must be attributed to participation of the neighboring sulfur atoms to stabilizing the radical produced.[5] It is worthy of note that the axial peroxycarboxylate (2) decomposes much faster than the equatorial counterpart (1).

Product analyses were carried out after running the decomposition in toluene at 50°C by vapor phase chromatography. This decomposition gives much cleaner product than that obtained in dichloromethane. The concentrations were 6 mmol/l and 9 mmol/l for 1 and 2, respectively. For reference, authentic samples were prepared and a pair of 2-benzyl 2,4,6-trimethyl-1,3,5-trithianes were synthesized by the following sequence of reactions. 2,4,6-Trimethyl-1,3,5-trithianes were lithiated with butyllithium in hexane and treated with benzyl chloride. The product, mp 124.5°C, must be r-2-benzyl-2,c-4,c-6-trimethyl-1,3,5-trithiane (8), since the reaction of lithio derivatives of trithianes is known to proceed from the equatorial side.[1] The expectation was confirmed by the measurement of nuclear Overhauser effect. 8 was treated with boron trifluoride etherate to give a mixture of products. Chromatography on silica gel afforded pure r-2-benzyl-2,t-4,t-6-trimethyl-1,3,5-trithiane (7), oil.[6]

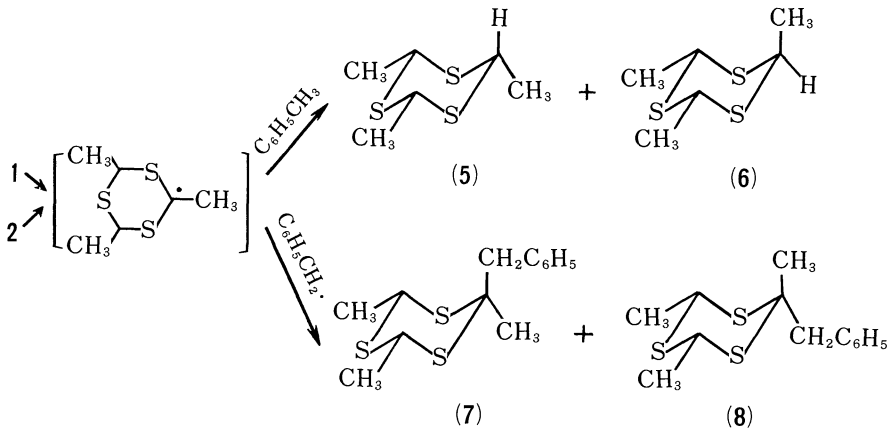


Table 1. Yields of Decomposition Products of Isomeric t-Butyl 2,4,6-Trimethyl-1,3,5-trithiane-2-peroxycarboxylates

	Trimethyltrithianes (5 + 6)	5/(5 + 6)	Benzyltrimethyl-trithianes (7 + 8)	7/(7 + 8)
1	16	0.95 ± 0.02	24	0.79 ± 0.02
2	15	0.98 ± 0.02	9	0.80 ± 0.03

The results of analyses are given in Table 1. Apparently, the product ratios were identical within the experimental error, although yields vary to a small extent according to the starting material. The ratios of the products deviate from that thermodynamically controlled: equilibration of a mixture of trimethyl-trithianes with boron trifluoride etherate in toluene at 50°C gave a ratio 5/(5 + 6) of 0.90-0.91 and the ratio 7/(7 + 8) must be <0.5, because benzyl group is larger than the methyl. Thus, although the material balance is not good,[7] we may at least draw a conclusion that the conformations of intermediary 2,4,6-trimethyl-1,3,5-trithian-2-yl radical are equilibrated under the conditions, and abstraction of hydrogen and combination with benzyl radical proceed preferentially at the axial side.

The results presented here suggest that the 1,3,5-trithian-2-yl radical is preferentially generated when an unpaired electron is formed in the axial direction and the radical thus generated reacts preferentially at the axial side. The origin of the preference is still to be explored.

References and Notes

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6) Both the new compounds gave satisfactory results of analyses.
7) Some high-boiling materials are produced to make the material balance poor. The best balance was obtained in decomposition of 1 at 70°C: 30% trimethyltrithianes, 40% benzyltrimethyltrithianes, 5% bibenzyl, and ca. 80% carbon dioxide.

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