Action of Nitroalkanes on Benzofuroxan

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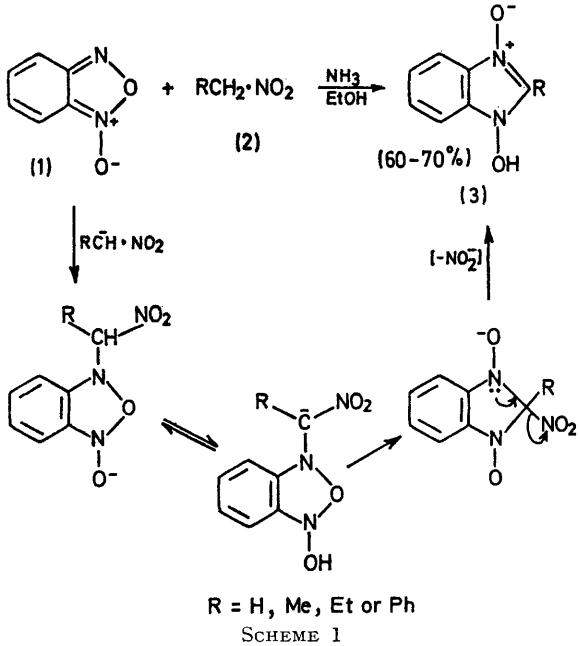
Summary Benzofuroxan reacts with primary nitroalkanes to give 2-substituted 1-hydroxybenzimidazole 3-oxides and with secondary nitroalkanes to yield 2,2-dialkyliso-benzimidazole 1,3-dioxides.

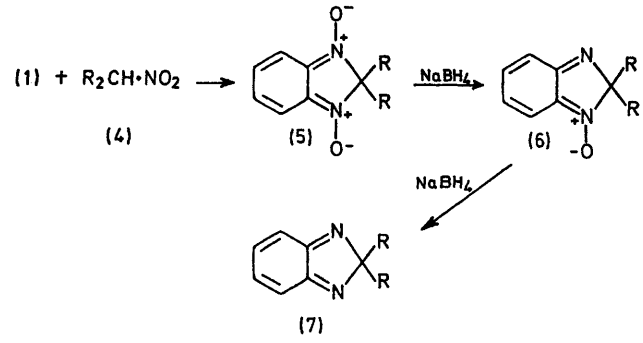
THE synthetic usefulness of benzofuroxan (**1**) has been demonstrated in its reactions with 1,3-dicarbonyl compounds,[1] malononitrile,[2] enamines,[3] and phenols[4] which give quinoxaline or phenazine *N*-oxides. We now report that benzimidazole and isobenzimidazole *N*-oxides can be made by the action of nitroalkanes.

Primary nitroalkanes (**2**) react readily in cold ethanolic solution with benzofuroxan (**1**) in the presence of ethanolic ammonia (which acts both as a catalyst and as a trap for the liberated nitrous acid) to give the known[5] 1-hydroxybenzimidazole 3-oxides (**3**) in 60—70% yield. The formation of these compounds is rationalised in Scheme 1, involving initial attack of the nitroalkane carbanion at the 3-position of benzofuroxan.



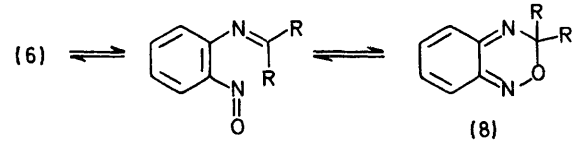
SCHEME 1

With secondary nitroalkanes (**4**) in cold chloroform and triethylamine as catalyst, benzofuroxan reacts rapidly to give an intense red solution.† A red, crystalline product is obtained in 80—90% yield to which we assign the novel structure (**5**). Thus the dimethyl compound (**5a**), readily soluble in both water and organic solvents, shows a methyl



a; R = Me b; RR = $[CH_2]_4$ c; RR = $[CH_2]_5$

singlet (τ 8·28) in the n.m.r. spectrum (carbon tetrachloride) and a symmetrical AA′BB′ aromatic multiplet. Similar absorptions are seen in the aromatic regions of the anlogues (**5b** and **c**), all of which collapse to singlets in D_2O solution. The 2,2-dimethyl compound (**5a**) gave acetone with hot mineral acid (but no *o*-nitroaniline), suffered reduction to *o*-phenylenediamine with hydrogen over palladium charcoal and slowly lost oxygen (1 atom equiv.) in warm, inert solvents. Removal of 1 atom equiv. of oxygen is virtually quantitative when 1 mol. equiv. of sodium borohydride in ethanol is used as the reducing agent for 30 min. The product is readily soluble in both water and organic solvents and we assign it the mono-*N*-oxide structure (**6a**). Its n.m.r. spectrum (deuteriochloroform) consists of a



SCHEME 2

† Commercial primary nitroalkanes give a red colour with benzofuroxan and a base owing to the presence of small amounts of secondary nitroalkanes. The sensitivity of this test is under investigation.

methyl singlet (τ 8·46) and an unsymmetrical aromatic multiplet, unchanged between -60 and $+60°$. However in D_2O solution an additional small singlet is discernible in the methyl region (*ca.* 8% of Me signal) which suggests the possibility of a valence tautomerism [(**6**) $\rightleftharpoons$ (**8**)] involving an intermediate ring-opened structure (Scheme 2). This is reminiscent of the analogous isomerism of benzofuroxans. Reduction of this *N*-oxide with an excess of sodium borohydride in ethanol yields the isobenzimidazole (**7a**) in high yield. We have previously reported[6] the synthesis of the related cyclohexyl compound (**7c**) by manganese dioxide-catalysed oxidation of its parent dihydrobenzimidazole; indeed, sodium borohydride reduction of (**6c**) yields the same isobenzimidazole. The dimethylisobenzimidazole (**7a**) showed a methyl singlet (τ 8·55) and a symmetrical AA'BB' aromatic multiplet in the n.m.r. spectrum (carbon tetrachloride).

A detailed study of the isobenzimidazoles (**5**)—(**7**) will be reported elsewhere.

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