Functionalization of the Methyl Group of 1,4-Dimethyl-1,4-dihydronaphthalene-1,4-endoperoxide

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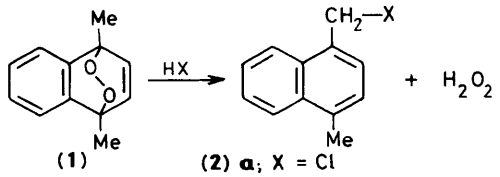
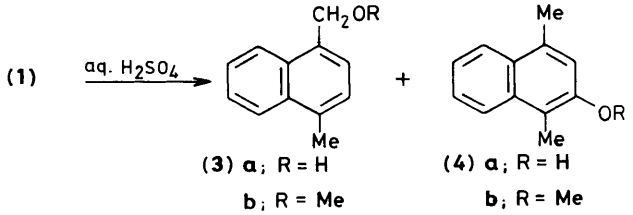
The acid-catalysed cleavage of 1,4-dimethyl-1,4-dihydronaphthalene-1,4-endoperoxide gives the 4-hydroxy, methoxy, trifluoroacetoxy, formyloxy, bromo, and chloro methyl derivatives of 1-methylnaphthalene in yields of 36, 38, 52, 76, 77, and 100% respectively when water, methanol, trifluoroacetic, formic, hydrobromic, or hydrochloric acids are used as reagents.

1,4-Dimethyl-1,4-dihydronaphthalene-1,4-endoperoxide, (**1**), is often employed as a chemical source of singlet oxygen.[1] Apart from this use and certain thermal and photochemical rearrangements of the endoperoxide group,[2] the chemistry of endoperoxides remains largely unexplored. Recently we reported that acid catalysis of (**1**) in the presence of aldehydes and ketones is a useful procedure for preparing 1,2,4-trioxanes.[3] We now describe another new reaction of (**1**) in which one of the methyl groups undergoes monosubstitution in high yield at the expense of the peroxide bridge.

Examples are provided by the acid treatment of (**1**). When an aqueous 5M solution of hydrochloric acid (5 ml) in tetrahydrofuran (THF) (5 ml) is treated with (**1**) (4.5 mmol), with vigorous stirring for 2 h, 1-chloromethyl-4-methylnaphthalene (**2a**)[4] was formed in quantitative yield. Under similar conditions, an identical regiochemical result was obtained when aqueous hydrobromic, formic,† or triflu-

† Formic acid alone was ineffective, catalysis by Amberlyst-15 being necessary to produce (**2c**).





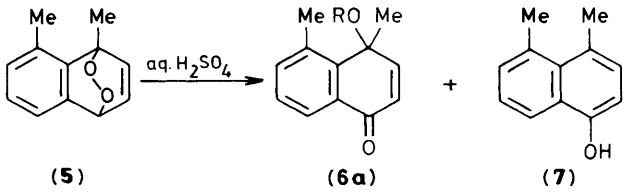
oroacetic acid in methylene chloride was used. Yields of 77, 76, and 52% were obtained for the corresponding bromo,[5] formyloxy, and trifluoroacetoxy methyl derivatives (**2b**, **c**, and **d**) respectively. In all cases, hydrogen peroxide was eliminated, thereby converting an unactivated methyl group into the corresponding substituted methyl derivative.‡

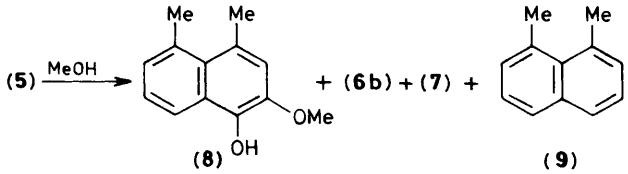
Other acids behaved similarly, giving mainly the substituted methyl derivatives, but also substantial quantities of ring-substituted products. Treatment of (**1**) (4.5 mmol) in THF (10 ml) with 10% aqueous sulphuric acid for 3 h at 25 °C, followed by addition of water and chromatography over silica gel (eluant CH_2Cl_2) gave the methanol derivative (**3a**) (38% yield) and the phenol (**4a**) (21%).[5–7] Methanolysis of (**1**) catalysed by Amberlyst-15 afforded the analogous methyl ethers (**3b**)[5] and (**4b**)[6] in 36 and 31% yields, respectively.§

This regiochemical reaction course, *i.e.* formation of the substituted methyl derivative, requires that the two methyl groups be in a 1,4 relation. Trial experiments with 1,8-dimethyl-1,4-dihydronaphthalene-1,4-endoperoxide (**5**)[1] gave products expected from simple hydrolysis. Aqueous sulphuric acid converted (**5**) into the naphthaquinone (**6a**) (58%) and the phenol (**7**) (20%). Methanol had a similar effect on (**5**). Analogous products [(**6b**), 43% (**7**) 11%] and the allylically rearranged product from (**6b**), namely (**8**) (14%), were formed. Some parasitic retro-Diels–Alder reaction to 1,8-dimethylnaphthalene [(**9**) 20%] also occurred.

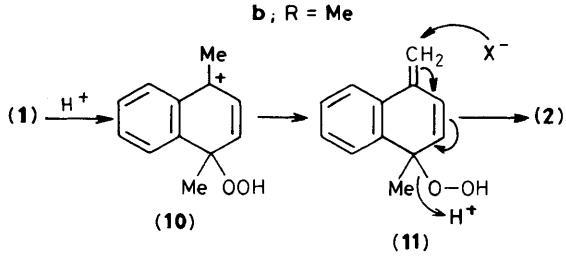
Formation of the substituted methyl derivatives is best rationalized in terms of the hydroperoxy cation (**10**) which arises from (**1**) by protonation. We have already proposed (**10**) as the entity[3] which can be captured by aldehydes to form 1,2,4-trioxanes. Although (**10**) may be attacked by the counterion of the acid at the benzylic or the allylic position, elimination to the conjugated diene (**11**) is favoured. Aromatization of (**11**) can then occur by attack of the counterion at the methylene carbon atom, expelling hydroperoxide as a protonated species to give the product (**2**).

The difference in behaviour of (**1**) and (**5**) is attributed





(**6**) **a**; R = H
b; R = Me



either to the C-8 methyl substituent impeding methylene group formation at C1, or to the ease of deprotonation at C-4 in intermediates arising from analogues of (**10**). Deprotonation and functionalization of a methyl group finds precedent in the acid-catalysed methanolysis of 1,4-epoxy-1,2,3,4-tetramethyl-1,4-dihydronaphthalene[7] and its 1,4-(*N*-benzylimino) analogue.[8] In both cases, 1-(methoxymethyl)-2,3,4-trimethylnaphthalene was formed in 78 and 50% yields. However, 1,4-epoxy-1,4-dimethyl-1,4-dihydronaphthalene, unlike (**1**), under the same conditions gave mainly 2-methoxy-1,4-dimethylnaphthalene (**4b**).[7]

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References

1 H. H. Wasserman and D. L. Larsen, *J. Chem. Soc., Chem. Commun.*, 1972, 253.
2 K. H. Schulte-Elte, B. Willhalm, and G. Ohloff, *Angew. Chem., Int. Ed. Engl.*, 1969, **8**, 985; K. K. Maheshwari, P. de Mayo, and D. Wiegand, *Can. J. Chem.*, 1970, **48**, 3265; J. P. Hagenbuch and P. Vogel, *J. Chem. Soc., Chem. Commun.*, 1980, 1062; M. Suzuki, R. Noyori, and N. Hamanaka, *J. Am. Chem. Soc.*, 1981, **103**, 5606; J. Rigaudy, P. Scribe, and C. Brelière, *Tetrahedron*, 1981, **37**, 2585; W. Adam and M. Balcı, *Tetrahedron*, 1980, **36**, 833; M. Balcı, *Chem. Rev.*, 1981, **81**, 91; M. Balcı and Y. Sütbeyaz, *Tetrahedron Lett.*, 1983, **24**, 311; A. Defoin, J. Baranne-Lafont, and J. Rigaudy, *Bull. Soc. Chim. Fr.*, 1984, 145.
3 C. W. Jefford, D. Jaggi, J. Boukouvalas, and S. Kohmoto, *J. Am. Chem. Soc.*, 1983, **105**, 6497; C. W. Jefford, J. Boukouvalas, S. Kohmoto, and H. G. Grant, *Anal. Chim. Acta*, 1984, **157**, 199; C. W. Jefford, J. Boukouvalas, and S. Kohmoto, *J. Chem. Soc., Chem. Commun.*, 1984, 523.
4 G. Darzens and A. Lévy, *C. R. Acad. Sci.*, 1936, **202**, 73.
5 G. Lock and R. Schneider, *Chem. Ber.*, 1958, **91**, 1770.
6 M. Fétizon and Nguyên Trong Anh, *Bull. Soc. Chim. Fr.*, 1965, 3208.
7 E. Wolthuis, B. Bossenbroek, G. DeWall, E. Geels, and A. Leegwater, *J. Org. Chem.*, 1963, **28**, 148.
8 E. Wolthuis and A. De Boer, *J. Org. Chem.*, 1965, **30**, 3225.

‡ All new compounds [(**2c**), (**2d**), (**6a**), (**6b**), (**7**), and (**8**)] were fully characterized (m.p. and i.r., mass, and ^{1}H-n.m.r. spectra) and gave acceptable elemental analyses.

§ In addition to the major products (**3**) and (**4**) minor quantities of several other, as yet unidentified products were obtained.