

## Oxidation of Alcohols to Carbonyl Compounds *via aci*-Nitroesters

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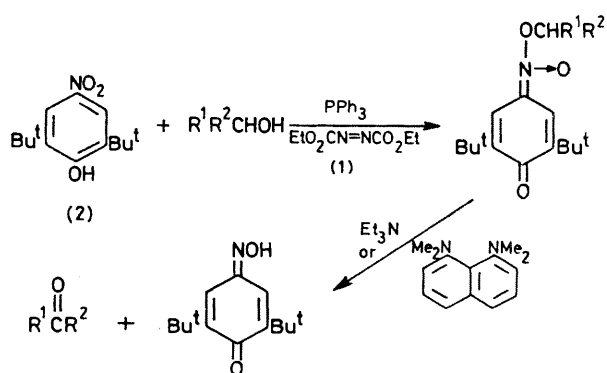
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**Summary** The reaction of various alcohols with triphenylphosphine, diethyl azodicarboxylate (**1**), and 2,6-di-*t*-butyl-4-nitrophenol (**2**) afforded the corresponding *aci*-nitroesters in good yields which were decomposed to carbonyl compounds.

OXIDISING reagents which can oxidise a specific hydroxy group in polyols would be useful for the chemical synthesis and transformation of natural products.<sup>1</sup> We report here

the oxidation of alcohols to carbonyl compounds *via aci*-nitroesters.

It is known that *aci*-nitroesters can be transformed into the corresponding carbonyl compounds by treatment with a base,<sup>2</sup> but a major drawback is that no method is available for the direct conversion of alcohols into *aci*-nitroesters. We have reported that regioselective esterification of diols can be accomplished by the use of triphenylphosphine and diethyl azodicarboxylate (**1**).<sup>3</sup> The reaction is assumed to



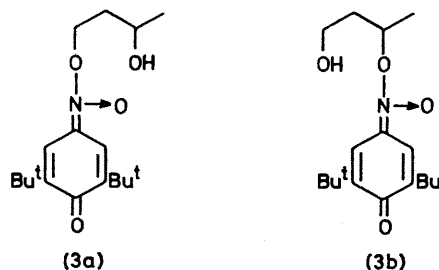
proceed through initial activation of the alcoholic hydroxy group. It would therefore be reasonable to expect that 2,6-di-*t*-butyl-4-nitrophenol (2) would react with an alcohol in the presence of these reagents to give the corresponding *aci*-nitroester rather than the nitrophenyl alkyl ether<sup>4</sup> because of steric hindrance of the two bulky *t*-butyl groups.

In fact, the reaction of 2-phenylethanol with (1), (2), and PPh<sub>3</sub> at room temperature for 1 day gave the 2-phenylethyl *aci*-nitroester in 83% yield following t.l.c. A 10% solution of this *aci*-nitroester in tetrahydrofuran containing 1% of Et<sub>3</sub>N (v/v) or 10% of 1,8-bis(*NN*-dimethylamino)naphthalene was refluxed for 8–10 h to give phenylacetaldehyde

in 82 or 86% yields. Similarly, other alcohols were oxidized to aldehydes or ketones *via aci*-nitroesters, and the results are in the Table.

It is noteworthy that pentane-2,4-diol reacted smoothly with (2) in the presence of (1) and PPh<sub>3</sub> to afford the mono- and di-*aci*-nitroesters of the diol in 68 and 7% yields, respectively. Treatment of the mono-*aci*-nitroester with base as above gave the expected 4-hydroxybutan-2-one in 64% yield. Similarly, hexane-1,6-diol afforded 6-hydroxyhexanal in 43% overall yield.

When butane-1,3-diol was allowed to react with (1), (2), and PPh<sub>3</sub>, a mixture of monoesterified products (3a) and (3b) was isolated in 69% yield. The ratio of products containing secondary (3a) and primary (3b) hydroxy groups was determined to be 2.5:1 by n.m.r. spectroscopy.



On keeping the mixture at room temperature for 1 day, followed by t.l.c. separation, the ratio of (3a):(3b) became 1.5:1. This result suggests that the esterification of the primary hydroxy group is a kinetically controlled process. Studies on the equilibrium of the mono-*aci*-nitroesters of unsymmetrical diols will be reported elsewhere.

5-*O*-Monomethoxytrityl-2,3-isopropylideneribose and 2,3,4,6-tetra-*O*-benzylglucose gave the corresponding lactones in good yields without treatment with base.

Yoneda *et al.* have reported that (1) oxidizes alcohols to aldehydes or ketones under neutral conditions. Application of this reaction to diols, however, has not yet been studied in detail; the only example reported is the oxidation of propane-1,2-diol to lactaldehyde in 23% yield.<sup>6</sup>

The method described here makes *aci*-nitroesters readily available and indicates their potential usefulness in the selective oxidation of alcohols.

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TABLE. Oxidation of alcohols *via aci*-nitroesters.

Alcohol	<i>aci</i> -Nitroester	Isolated % yields of products <sup>a</sup> Aldehyde, ketone, or lactone
2-Phenylethanol	83	86 [82 <sup>b</sup> ]
Propan-2-ol	79	—
Octan-2-ol	76	63
$\beta$ -Citronellol	66	55
Pentane-2,4-diol	68 (7 <sup>c</sup> )	64
Hexane-1,6-diol	68 (7 <sup>c</sup> )	63
Butane-1,3-diol	69 (8 <sup>c</sup> )	—
5- <i>O</i> -Monomethoxy-2,3- <i>O</i> -isopropylideneribose	—	68
2,3,4,6-Tetra- <i>O</i> -benzylglucose	—	Quant. <sup>d</sup>

<sup>a</sup> Yields have not been optimized. <sup>b</sup> Yield of isolated 1,3-diphenylimidazolidine derivative. <sup>c</sup> Yield of di-*aci*-nitroester. <sup>d</sup> Isolated as 2,3,4,6-tetra-*O*-benzyl-*NN*-dimethyl-D-glucosamide (see ref. 5).

<sup>1</sup> In the selective oxidation of primary-secondary diols, the reaction generally takes place at the secondary position in preference to the primary one. For the selective oxidation of diols and polyols, see for example W. M. Hoehn and J. Linsk, *J. Amer. Chem. Soc.*, 1945, **67**, 312; E. M. Jung and L. M. Speltz, *ibid.*, 1976, **98**, 7882; M. Fétizon, M. Golfier, and J.-M. Louis, *Chem. Comm.*, 1969, 1102; J. Wicha and A. Zarecki, *Tetrahedron Letters*, 1974, 3059; E. J. Corey and L. S. Melvin, Jr., *ibid.*, 1975, 929; G. H. Posner, R. B. Perfetti, and A. W. Runquist, *ibid.*, 1976, 3499; Y. Ueno and M. Okawara, *ibid.*, p. 4597; M. E. Jung and R. W. Brown, *ibid.*, 1978, 2771; J. Defaye and A. Gdelle, *Carbohydrate Res.*, 1975, **42**, 373; M. A. Neirabeyeh, J.-C. Ziegler, B. Cross, and P. Caubère, *Synthesis*, 1976, 811, and refs. therein.

<sup>2</sup> J. S. Meek and J. S. Fowler, *J. Org. Chem.*, 1968, **33**, 226.

<sup>3</sup> O. Mitsunobu, J. Kimura, K. Iizumi, and N. Yanagida, *Bull. Chem. Soc. Japan*, 1976, **49**, 510.

<sup>4</sup> Bittner *et al.* reported that the reaction of *p*-nitrophenol with alcohols, PPh<sub>3</sub>, and (1) gave *p*-nitrophenyl alkyl ethers (S. Bittner and Y. Assaf, *Chem. and Ind.*, 1975, 281).

<sup>5</sup> H. Kuzuhara and H. G. Fletcher, Jr., *J. Org. Chem.*, 1967, **32**, 2531.

<sup>6</sup> F. Yoneda, K. Suzuki, and Y. Nitta, *J. Org. Chem.*, 1967, **32**, 727.