Reaction of Benzoxazolone with 2,4-Dinitrochlorobenzene: Formation of 10-(2,4-Dinitro)phenyl-3-nitrophenoxazine

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Arylation of benzoxazolone **1** by 2,4-dinitrochlorobenzene **2** under solid-liquid phase transfer catalysis (PTC) gave 3-(2,4-dinitro)phenylbenzoxazolone **3** and 10-(2,4-dinitro)phenyl-3-nitrophenoxazine **4**. Neither PTC nor copper catalysis achieved arylation of **1** by less activated aryl halides.

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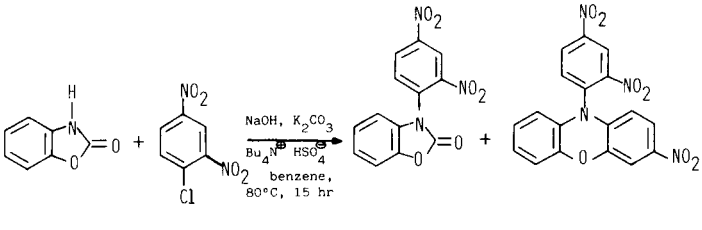
N-Alkylation of benzoxazolone **1** in alkaline media is a well established method which has been in use for many years [1]. However, no *N*-arylations of **1** have been described. We were interested in a general method for the *N*-arylation of benzoxazolone **1**, and recently there have been many reports on the phase-transfer-catalyzed (PTC) *N*-alkylation of *N*-substituted carboxamides [2], sulfonamides [3] and formamides [4]. On the other hand, classical copper-mediated chemistry (the Goldberg reaction) which allows *N*-arylation of acetanilides, has been found to present certain limitations [5], while the method has been extended to *N*-arylsulfonamides [6]. We therefore undertook the study of the reaction of **1** with a variety of aryl halides under alkaline PTC or copper catalysis. The present note reports the unexpected isolation of a phenoxazine in one such reaction.

Benzoxazolone **1**, prepared from urea and 2-aminophenol [7], did not give *N*-arylated products when treated with several aryl halides (bromobenzene, 3-bromonitrobenzene, 2-chloronitrobenzene and 4-chloronitrobenzene) under PTC or copper catalysis. However, reaction of **1** with 2,4-dinitrochlorobenzene **2** under solid-liquid PTC conditions gave two products which could be separated by column chromatography (Scheme 1). The expected product, 3-(2,4-dinitro)phenylbenzoxazolone **3**, was readily identified, but a more abundant, deeply red second product was finally identified as 10-(2,4-dinitro)phenyl-3-nitrophenoxazine **4** by a combination of spectroscopic evidence and mechanistic reasoning.

Scheme 1



1 2 3 4

The mass spectrum of **4** showed the molecular ion at m/e 394 (100%) and the ir spectrum displayed no carbonyl absorption. The molecular formula $C_{18}H_{10}N_4O_7$, confirmed by elemental analysis, suggested the presence of three nitro groups. The pmr spectrum of **4** (Figure 1a) showed the presence of a single dinitrophenyl group (absorptions at δ 8.1-9.1) and two protons at δ 5.97-6.25, a rather shielded position for aromatic protons. All this evidence could be accomodated by structure **4**, in which the perpendicular position of the aromatic substituent on N-10 would place H-1 and H-9 above and below the dinitrophenyl ring, *i.e.*, in the shielding regions. The same effect has been found in a number of substituted 10-phenylphenoxazines [8]. Finally, the 3-position for the remaining nitro group was confirmed by a decoupling experiment (Figure 1b) in which irradiation of the multiplet at δ 7.5-7.7 (undoubtedly corresponding to protons *ortho* to a nitro group) resulted in collapse of part of the high field signals to a sharp singlet, thus indicating that a proton *meta* to the nitro group was in a *peri* relationship to the dinitrophenyl substituent on N-10. A second decoupling experiment shown in Figure 1c, confirmed the coupling between the multiplet appearing at δ 5.95-6.15 (H-9) and part of the multiplet at δ 6.7-7.0 (H-8).

A mechanism of formation of **4** is proposed in Scheme 2. Several arguments support this mechanism. 3-Arylbenzoxazolones are known to split into carbon dioxide and 2-hydroxydiarylamines under prolonged heating [1]. Reaction of *N*-substituted 2-aminophenols with **2** or picryl chloride in strongly basic media is known to give the *O*-arylated derivative rather than the *N*-arylated one, due to the ionization of the phenol [9]. Spirocyclic Meisenheimer intermediates of type **7** have recently been observed [10] in phenoxazine-forming Turpin reactions [11]. The Smiles rearrangement from **6** to **8** is required to accomodate the final position of the nitro substituent at C-3 (the alternative would be direct formation of **8** by reaction between **5** and **2**; this would require preferential nucleophilic attack from the very delocalized nitrogen lone pair rather than from the phenoxide ion, a much unlikely possibility). There is

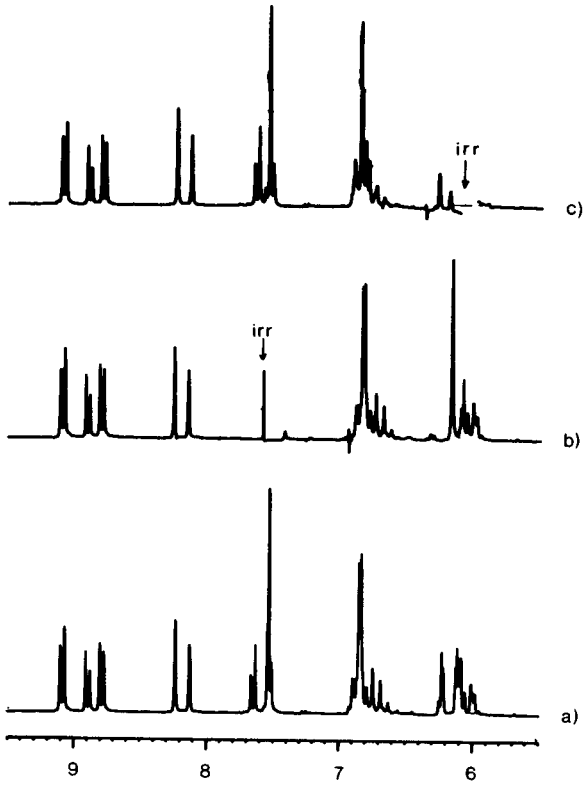
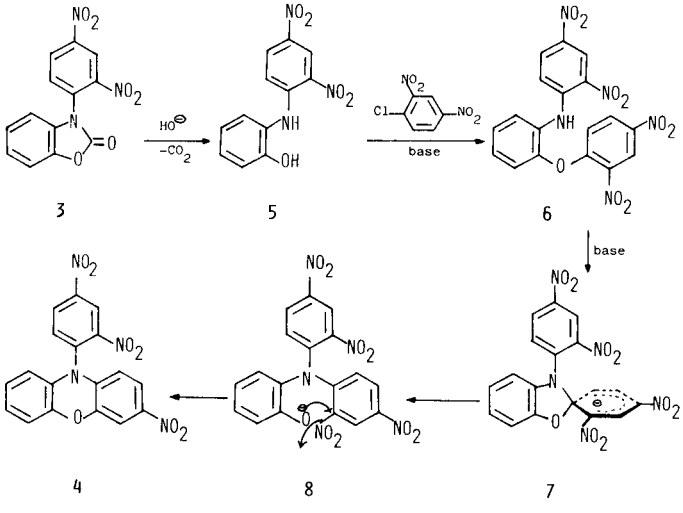


Fig. 1

also precedent for the formation of phenoxazines from benzoxazolones: thus, reaction of 3-diethylaminoethylbenzoxazolone with picryl chloride and sodium hydroxide in refluxing ethanol has been reported to yield 1,3-dinitro-10-diethylaminoethylphenoxazine [12]. Finally, half a century ago, there was a report [13] stating that treatment of 2-(2,4-dinitro)phenoxy-2',4'-dinitrodiphenylamine **6** with caustic soda in aqueous pyridine gave "3(?)-nitro-6-(*sic*)-dinitrophenylphenoxazine, a deep red substance which melted at 230-233° dec". Since our compound **4** is a deep red substance melting at 234-235° dec, we think that both are one and the same compound.

Scheme 2



EXPERIMENTAL

Melting points were determined on a Kofler block (Reichert, Wien). The ir spectra were recorded on a Perkin-Elmer 1310 spectrophotometer. Mass spectra were taken under electron impact at 70 eV on a Hewlett-Packard 5985-B instrument. 80 MHz pmr and 20 MHz cmr spectra were recorded in a Fourier transform mode in a Bruker WP-80-SY spectrometer. Multiplicities in cmr spectra were determined by the gated decoupling J-modulated spin-echo technique, generally known as SEFT [14]. Elemental analyses were determined by Servei de Microanálisi, Secció de Químiques, in our University.

3-(2,4-Dinitro)phenylbenzoxazolone (**3**) and 10-(2,4-Dinitro)phenyl-3-nitrophenoxazine (**4**).

A solution of 2,4-dinitrochlorobenzene (**2**) (1.01 g, 5.0 mmoles) in 3 ml of benzene was slowly added dropwise to a stirred mixture of benzoxazolone (**1**) [7] (530 mg, 3.9 mmoles), finely ground sodium hydroxide (550 mg, 14 mmoles), potassium carbonate (310 mg, 2.3 mmoles) and tetrabutylammonium bisulfate (130 mg, 0.39 mmole) in 4 ml of benzene under reflux, and boiling was maintained for 15 hours. Extractive isolation (water-benzene) followed by chromatography on silica gel (hexane-dichloromethane) gave 170 mg (17%) of **4**, as a red solid which, after recrystallization from ethanol, showed mp 234-235° dec; ir (potassium bromide): 1530 m, 1480 s and 1315 s cm^{-1}; pmr (80 MHz, hexadeuteriodimethyl sulfoxide): δ 9.09 (d, J = 2.6 Hz, 1H, H-3'), 8.84 (dd, J = 8.7 Hz, J' = 2.6 Hz, 1H, H-5'), 8.20 (d, J = 8.7 Hz, 1H, H-6'), 7.60 (dd, J = 8.4 Hz, J' = 2.5 Hz, 1H, H-2), 7.55 (deceptive singlet, 1H, H-4), 6.93-6.63 (m, 3H, H-6, H-7 and H-8), and 6.25-5.97 (m, 2H, H-1 and H-9); see Figure 1; cmr (20 MHz, hexadeuteriodimethyl sulfoxide): δ 147.9 s (two carbons), 142.7 s, 142.2 s, 141.6 s, 137.9 s, 135.5 d, 134.6 s, 130.8 d, 130.0 s, 124.2 d, 124.1 d, 122.6 d, 120.3 d, 115.8 d, 113.7 d, 112.6 d and 110.5 d; ms: (EI, 70 eV), m/e (%) 394 (M^+, 100), 348 (19), 256 (20), 255 (23), 228 (25), 227 (22), 226 (23), 75 (49), 74 (40) and 46 (39).

Anal. Calcd. for $C_{18}H_{10}N_4O_7$: C, 54.83; H, 2.56; N, 14.21. Found: C, 54.65; H, 2.51; N, 13.97.

Compound **3** (169 mg, 15%) was isolated in later fractions as an orange solid which, after recrystallization from ethanol, showed mp 209-210°; ir (potassium bromide): 1755 s, 1520 s and 1330 s cm^{-1}; pmr (80 MHz, hexadeuteriodimethyl sulfoxide): δ 8.98 (dd, J = 2.5 Hz, J' = 0.3 Hz, 1H, H-3'), 8.78 (dd, J = 8.8 Hz, J' = 2.5 Hz, 1H, H-5'), 8.25 (d, J = 8.8 Hz, J' = 0.3 Hz, 1H, H-6'), 7.6-7.1 (m, 4H, H-4 to H-8); cmr (20 MHz, hexadeuteriodimethyl sulfoxide): δ 151.1 s 147.0 s, 144.4 s, 142.2 s, 130.8 s, 130.7 d, 129.6 s, 129.3 d, 124.4 d, 124.0 d, 121.7 d, 110.4 d and 109.4 d; ms: (EI, 70 eV), m/e (%) 301 (M^+, 100), 164 (23) and 52 (21).

Anal. Calcd. for $C_{13}H_7N_3O_6$: C, 51.84; H, 2.34; N, 13.95. Found: C, 51.73; H, 2.46; N, 13.81.

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