Nitration of 1-Benzylpyrrole

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1-Benzyl-2,4-dinitropyrrole has been obtained by nitration of 1-benzylpyrrole, 1-benzyl-2-nitropyrrole, and 1-benzyl-3-nitropyrrole. The latter product has also been obtained from 2-carbethoxy-4-nitropyrrole.

The nitration and substitution patterns of pyrrole (*1, 9, 11*), 1-methylpyrrole (*1, 11*), 1-phenylpyrrole (*3*), and 1-benzylpyrrole (*2*) have been the subject of several publications. At this time, we report an observation made during the nitration of 1-benzylpyrrole (I).

In addition to obtaining 1-benzyl-2-nitropyrrole (II) and 1-benzyl-3-nitropyrrole (III) (*2*), a third product has now been isolated and characterized as the 1-benzyl-2,4-dinitropyrrole (IV). The appearance of this product reduced the overall yield of the 3-nitro isomer (III). Furthermore, nitration of 1-benzyl-2-nitropyrrole (II) gave only 1-benzyl-2,4-dinitropyrrole (IV) and unreacted starting product (II), with no evidence for the formation of a 2,5-dinitro isomer. Nitration of 2-nitro derivatives of pyrrole, furan, or thiophene has been reported (*8, 10, 12*) to give varying amounts of 2,5-dinitro-substituted products, whereas the 1-methyl-2-nitropyrrole gave a 2,4-dinitro product (*11*). This is interpreted as additional support for the previous indication (*1, 2*) that the *beta*-directing effect is greatly increased as compared to pyrrole.

The 3-nitro isomer (III) was also prepared by condensation of sodium nitromalondialdehyde and glycine ethyl ester hydrochloride to give 2-carbethoxy-4-nitropyrrole (V) (*4*), followed by benzylation (VI) of the potassium salt (*5*), hydrolysis of the ester (VII), and decarboxylation (*9*) to give a product (III) identical to that obtained by direct nitration of 1-benzylpyrrole. (Nitration of III also gave IV and unreacted starting material.)

It was impossible to accomplish further nitration of IV or 1-benzyl-2-carbethoxy-4-nitropyrrole (VI) employing nitric acid-acetic anhydride or nitric acid and sulfuric acid under temperatures varied from 0 to 100° C.

EXPERIMENTAL

All melting points were determined on a Mel Temp apparatus and are uncorrected. Elemental analyses were by Galbraith Laboratories, Inc., Knoxville, Tenn., or Atlantic Microlab, Inc., Atlanta, Ga. Infrared spectra were measured on a Perkin-Elmer Infracord Model 137 using the potassium bromide technique. NMR spectra (Varian Model A-60) were by Simon Research Laboratories, Elgin, Ill. (tetramethylsilane as internal standard).

Nitration of 1-Benzylpyrrole (I). I was prepared from 2,5-diethoxytetrahydrofuran and benzylamine by the procedure of Josey and Tuite (*6*). The procedure for nitration was adapted after Safonova *et al.* (*11*). Physical data for the 2- and 3-nitro isomers were consistent with those reported by Anderson and Griffiths (*2*). In experiments where the initial molar quantity of nitric acid was twice that of 1-benzylpyrrole, a substance precipitated from the crude oily mixture of 2- and 3-nitro-1-benzylpyrrole. This solid, which constitutes about 13–15% of the product isolated, was identified as 1-benzyl-2,4-dinitropyrrole (IV), m.p. 130–31° C after recrystallization from carbon tetrachloride (*7*). Thin layer chromatography (TLC) on Eastman Chromatogram sheet (Type 6060), using chloroform as solvent, showed the product to be homogeneous. R_f = 0.475 (benzene); 0.68 (dioxane); 0.65 (CCl_4). The NMR spectrum in deuteriochloroform exhibits a pair of doublets centered at τ 2.18 and 2.28 (C_3 and C_5 protons, J = 2 cps), a complex multiplet centered at 2.50 (phenyl protons), and a singlet at 4.25 (methylene protons).

1-Benzyl-2,4-dinitropyrrole (IV) was also prepared from direct nitration of the 2-nitro or 3-nitro isomer by standard procedures in yields of 83 to 89%. [The dinitro-compound (IV) appears to be thermal (>200° C, seal tube) and impact stable.]

Anal. Calcd. for $C_{11}H_9N_3O_4$: C, 53.44; H. 3.67; N, 17.00. Found: C, 53.54; H, 3.79; N, 17.16.

Preparation of 1-Benzyl-2-carbethoxy-4-nitropyrrole (VI). 2-Carbethoxy-4-nitropyrrole (V) was prepared according to the procedure of Hale and Hoyt (*4*). Benzylation of the potassium salt was accomplished with benzyl chloride in tetrahydrofuran-dimethylsulfoxide by the method of Hobbs *et al.* (*5*) in a 90% yield. The analytical sample was recrystallized from 95% ethanol as a colorless substance, m.p. 75.5–76.5° C. The NMR spectrum in carbon tetrachloride showed a pair of doublets centered at τ 2.48 and 2.69 (C_3 and C_5 protons, J = 2 cps), a singlet at 2.8 (phenyl protons), a singlet at 4.49 (methylene protons), a quartet at 5.75 (ester methylene protons), and a triplet centered at 8.7 (ester methyl protons). The peak areas were in the ratio 1:1:5:2:2:3. TLC showed the product to be homogeneous. R_f = 0.40 (benzene); 0.70 (dioxane); 0.63 (CCl_4).

Anal. Calcd. for $C_{14}H_{14}N_2O_4$: C, 61.31; H, 5.14; N, 10.21. Found C, 61.21; H, 5.10; N, 10.02.

Preparation of 1-Benzyl-3-nitropyrrole (III). The ester (VI) was hydrolyzed by the method of Morgan and Morrey (*9*) to give 1-benzyl-4-nitropyrrole-2-carboxylic acid (VII) in a 90% yield, m.p. 205–7° C. The acid (VII) was decarboxylated with copper chromite in quinoline (60 to 70% yield) to give a product (III) identical (melting point, infrared spectra, NMR spectra, TLC, etc.) to the 3-nitro isomer obtained by nitration of I.

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