Tetrahedron Letters No. 12, pp 1079 - 1080, 1974. Pergamon Press. Printed in Great Britain.

INTERACTION BETWEEN DINITROPYRROLES AND METHOXIDE ION: AN NMR STUDY

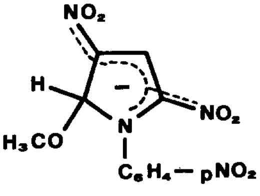
Franco De Santis and Franco Stegel*
Department of Chemistry and Centro C.N.R. sui Meccanismi di Reazione,
University of Rome, 00185 Roma, Italy

(Received in UK 18 January 1974; accepted for publication 12 February 1974)

The formation of Meisenheimer-type adducts from thiophene (1,2,3), selenophene (2), and furan (4) derivatives containing electron-attracting substituents has been reported. Owing to the higher π-electron density of the pyrrole ring, it seemed worthwhile studying also, in view of the lack of data on the reactivity of pyrrolic substrates toward nucleophilic reagents, the reaction of nitro-substituted pyrroles with methoxide ion. Since this ion would convert 2,4-dinitropyrrole into the conjugate base, we have considered the behaviour of two 1-substituted derivatives, 2,4-dinitro-1-(p-nitrophenyl)-pyrrole (I) and 2,4-dinitro-1-methylpyrrole (II).

The nmr study of the interaction of I and II with methoxide ion reveals significant differences in the behaviour of the two substrates and, more specifically, indicates the first Meisenheimer-type adduct ever reported so far in the pyrrole series.

The nmr spectrum of I in DMSO-d_6 shows the expected doublets for the pyrrole-ring protons (J = 2 Hz) at τ 1.34 (H_α) and 1.93 (H_β), and two doublets for the phenyl-ring protons (J = 9 Hz) at τ 1.58 and 2.07. Addition of the equivalent amount of 4.5 M methanolic sodium methoxide to the 0.5 M solution of I in DMSO-d_6 produces several changes in the nmr spectrum. Two singlets of the same intensity appear at τ 2.27 and 4.05, while the intensity of the pyrrole-ring signals of I decreases. At the same time the pair of phenyl doublets is displaced upfield, to τ 1.87 and 3.13, and retains the initial coupling. The appearance of the signal at τ 4.05 and the reduced coupling between the pyrrole-ring protons indicate a change of hybridization from sp^2 to sp^3 for the carbon atom bonded to the high-field proton. These changes can be well understood in terms of formation of a Meisenheimer-type adduct. Structure III for the adduct, as alternative to a structure where the methoxide ion attacks position β, seems more likely by analogy with the adducts formed from 2,4-dinitrothiophene (1,2) and 2,4-dinitroselenophene (2). Nmr data suggest structure III; however, the complete elucidation of the structure needs the examination of deutero-derivatives, which we are now carrying out. The signals of the adduct reach the highest intensity within few minutes, and thereafter decrease with



III

the appearance of broad, unresolved signals between τ 1.5 and 3. Owing to the low solubility of I in methanol, no attempt was made to study by nmr the reaction of I with methoxide ion in this solvent.

The behaviour of I toward methoxide ion is contrasted by that of II, which, in DMSO, undergoes an irreversible reaction leading to the complete disappearance of nmr signals in the aromatic region. This result cannot be immediately understood on the basis of nmr evidence only, but can be probably related to a decomposition. In much milder conditions, namely in methanol, II undergoes a base-catalyzed hydrogen exchange at α. The nmr spectrum of II in methanol is not modified by the presence of methoxide. However, when the reaction occurs in CD_3OD, the doublet of II at τ 1.86 (H_α, J = 2.5 Hz) immediately disappears and the doublet at τ 2.23 (H_β) collapses into a singlet. The $N-CH_3$ signal at τ 5.87 is not modified. The easy formation of 2,4-dinitro-1-methyl-5-deuteropyrrole, as inferred from the nmr spectrum, probably requires the formation of an intermediate carbanion (5). Owing to the low concentration of the carbanion, the nmr spectrum of II in CH_3OH, in the presence of the base, does not differ appreciably from that of II alone. Base-induced hydrogen exchange reactions on unactivated five-membered heteroaromatic substrates do not occur easily; thus, the rate constant (6) for the selective exchange at position α in 1-methylpyrrole, in C_2H_5OD, at 140°, in the presence of 0.57 M $C_2H_5O^-$, is as low as $1.2\times10^{-6}s^{-1}$. In the presence of electron-attracting groups, the exchange rate is increased, but the reaction can be obscured by the formation of Meisenheimer-type adducts (4,7,8). Therefore, the reaction of II is an unusual example of fast, clear-cut exchange reaction on a polynitro heteroaromatic compound.

The different behaviour of I and II toward methoxide ion is related to the electronic effect of different 1-substituents. It has been indicated (9) that 1-substituents of different electronegativity can affect the π-electron density and, consequently, the reactivity of the pyrrole-ring. Thus, the p-nitrophenyl group may have a significant role, together with that of nitro groups on the pyrrole-ring, in lowering the high π-electron density of the ring and in favouring the attack of the nucleophilic reagent.

The authors wish to thank Professor G. Illuminati for helpful discussions.

REFERENCES

1. G. Doddi, G. Illuminati, and F. Stegel, Chem.Comm., 1143 (1972).
2. C. Paulmier, M.P. Simonnin, A.P. Chatrousse, and F. Terrier, Tetrahedron Letters, 1123 (1973).
3. D. Spinelli, V. Armanino, and A. Corrao, J.Heterocyclic Chem., 7, 1441 (1970).
4. G. Doddi, A. Poretti, and F. Stegel, J.Heterocyclic Chem., in press.
5. E. Buncel and E.A. Symons, Can.J.Chem., 44, 771 (1966).
6. N.N. Zatsepina, Yu.L. Kaminsky, and I.F. Tupitsyn, Reakts.Sposobnost Org.Soedin., Tartu Gos. Univ., 3, 753 (1969).
7. M.P. Simonnin, F.Terrier, and C. Paulmier, Tetrahedron Letters, 2803 (1973).
8. G. Doddi, G. Illuminati, and F. Stegel, Tetrahedron Letters, 3221 (1973).
9. R.A. Jones, T.M. Spotswood, and P. Cheuychit, Tetrahedron, 23, 4469 (1967).