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MESO-NITRO- AND AMINO-AETIOPORPHYRINS

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THE recent Communication by Bonnett and Stephenson[1] on the preparation of the meso-nitro derivative of octaethylporphyrin prompts us to record that we have examined the nitration of aetioporphyrin I. This reaction has been reported by Fischer and his coworkers,[2] who described mono-, di-, and trinitro derivatives although the positions of the nitro groups were not defined. We have found that nitration of a solution of aetioporphyrin I in 63% sulphuric acid with 25% nitric acid at 12-13° for 30 min. gave 55% of a mononitro derivative contaminated with a little of the dinitro compound, which was removed by chromatography on alumina of a carbon tetrachloride solution. Thin layer chromatography of benzene-light petroleum solutions is particularly effective for the separation of the mixed nitro derivatives. In agreement with the observations of Fischer,[2] mononitroaetioporphyrin I formed a bright red copper complex which was also obtained by nitration of the porphyrin with cupric nitrate in acetic anhydride at room temperature for 2 hr. Satisfactory analyses for all of the compounds mentioned in this Communication have been obtained. Using a longer nitration period, aetioporphyrin I gave a mixture of two dinitro derivatives and the corresponding copper complex has also been obtained directly by reaction with cupric nitrate and acetic anhydride. The isomeric dinitroaetioporphyrins I could be separated either by thin layer

chromatography or in a steady state distribution apparatus using benzene - 30% sulphuric acid as the solvent system. Under still more vigorous conditions of nitration, trinitroaetioporphyrin I could be obtained and this was also converted to its copper derivative.

All of these nitro compounds have been shown to be meso-substitution products by interpretation of their nuclear magnetic resonance (n.m.r.) spectra, which have been measured mainly on trifluoracetic acid (TFA) and deuterotrifluoracetic acid (DTFA) solutions, when the porphyrins are present as the dications.

When compared with the n.m.r. spectrum of aetioporphyrin I itself,[3] that of the mononitro derivative shows a substantial decrease in the strength of the ring current, indicated by movement of the signals associated with the protons of the meso- and β-alkyl groups to higher field, and of those associated with the imino groups to lower field (see Table). The magnitude of these effects indicate that the nitro group must occupy a meso position on the macrocyclic ring. The decrease in the ring current is presumably caused partly by loss of planarity of the ring and partly by the electron-withdrawing properties of the substituent. Displacements of the signals associated with the various types of proton in the trinitro derivative compared with aetioporphyrin I itself are even greater as expected.

Reduction of mononitroaetioporphyrin I with stannous chloride and hydrochloric acid has given the corresponding aminoporphyrin, the first mesoaminoporphyrin to be described. The copper derivative and the N-acetyl derivative of monoaminoaetioporphyrin I have also been prepared. The n.m.r. spectrum of the aminoporphyrin (in TFA, when the amine was present as its salt) showed a remarkable divergence from that of aetioporphyrin I and the effect of the protonated amine group on the positions of absorption of the meso and imino protons exceeds that of

three nitro groups. The spread of absorption (0.19 τ) associated with the side chain methyl groups is appreciably less in the case of the amino compound than that observed (0.40 τ) in the spectrum of mononitroaetioporphyrin I. This effect may be due to several causes, but it is relevant that the aminium group, being smaller than nitro, would cause less distortion of the molecule.

TABLE

N.m.r. Signals of Aetioporphyrins I (TFA solution except where otherwise stated)

Compound	Meso Groups(s)	Imino Groups(s)	β-Methyl Groups(s)	β-Ethyl Groups	
				CH_2 (q)	CH_3 (t)
Aetioporphyrin I[3]	-1.0	14.8	6.2	5.7	8.16
Mononitroaetio-porphyrin I	-0.77(2;βδ) -0.68(1;γ)	13.72 14.17	6.36 6.46 6.76	5.89	8.29
(in DTFA)	-1.11(1) -1.19(2)	-	6.22 6.31 6.54	5.69	8.2
Trinitroaetio-porphyrin I	-0.54	11.7	6.63 6.79 6.93	6.55	8.53
(in DTFA)	-0.76	-	6.53 6.78 6.89	6.42	8.47
Monoaminoaetio-porphyrin I	+0.56(2;βδ) +0.99(1;γ)	9.01 10.49	6.73 6.78 6.92	6.37	8.33
Monoacetylamino-aetioporphyrin I	-0.68(2;βδ) -0.59(1;γ)	13.3 13.48 14.3 14.4	6.3 6.55 6.69	5.9	8.26

s = singlet; q = quartet; t = triplet

N.m.r. spectra of solutions of the meso substituted aetioporphyrins in deuterated trifluoracetic acid (DTFA) were also determined and with the nitro compounds the entire spectra were shifted downfield relative to those in TFA. No exchange of meso protons with deuterium was observed in common with the behaviour of other porphyrins.[e.g.4] However in the case of monoaminoaetioporphyrin I, the meso γ-proton exchanged with deuterium at room temperature after about 20 min. When the amino compound was heated in DTFA at 100° for one hour, the remaining meso protons were also exchanged for deuterium. This is the first example of deuterium exchange in the porphyrin series, the electrophilic substitution no doubt being facilitated by the presence of a small quantity of the unprotonated amino compound. In this case the positions of bands associated with the alkyl substituents were identical in both TFA and DTFA solution. It is of interest that the effect of the acetylamino group on the spectrum of aetioporphyrin I approximates to that of one nitro group.

Further studies of these compounds are in progress.

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