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## PREPARATION AND NMR STUDIES OF BENZO (h) QUINOLINE DERIVATIVES

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**M**ONO nitration of 2, 4-dimethyl benzo (h) quinoline has been achieved by the use of nitric acid. NMR studies have served to establish the structures of the two products as the 9 and 7-nitro, 2, 4 dimethyl benzo (h) quinolins. The NMR spectra of benzo (h) quinoline as reported by E. Vender Donck<sup>1</sup> is very complicated. The spectrum could be simplified by preparing its suitable derivatives. Although many of the reactions of benzo (h) quinoline and its derivatives have been thoroughly studied<sup>2</sup>, nitration has received only limited attention. Baltrop and McPhee<sup>3</sup> recently investigated the nitration of 1-azaphenanthrene by Haid's<sup>4</sup> directions and separated the isomers on an alumina column monitored by ultraviolet light. These authors have shown that in 1-azaphenanthrene, electrophilic substitution takes place preferentially at the 9 and 7 positions. There is no report of an electrophilic reaction of 1-azaphenanthrene containing a functional group in the heteroaromatic ring. This investigation was undertaken in order to develop a practical method for the preparation of these compounds

### *Results and Discussion*

Although several workers have claimed to have isolated 2, 4-dimethyl benzo (h) quinoline, no direct evidence for its formation has been obtained. Melting point also varies as reported in the literature. Vasser-

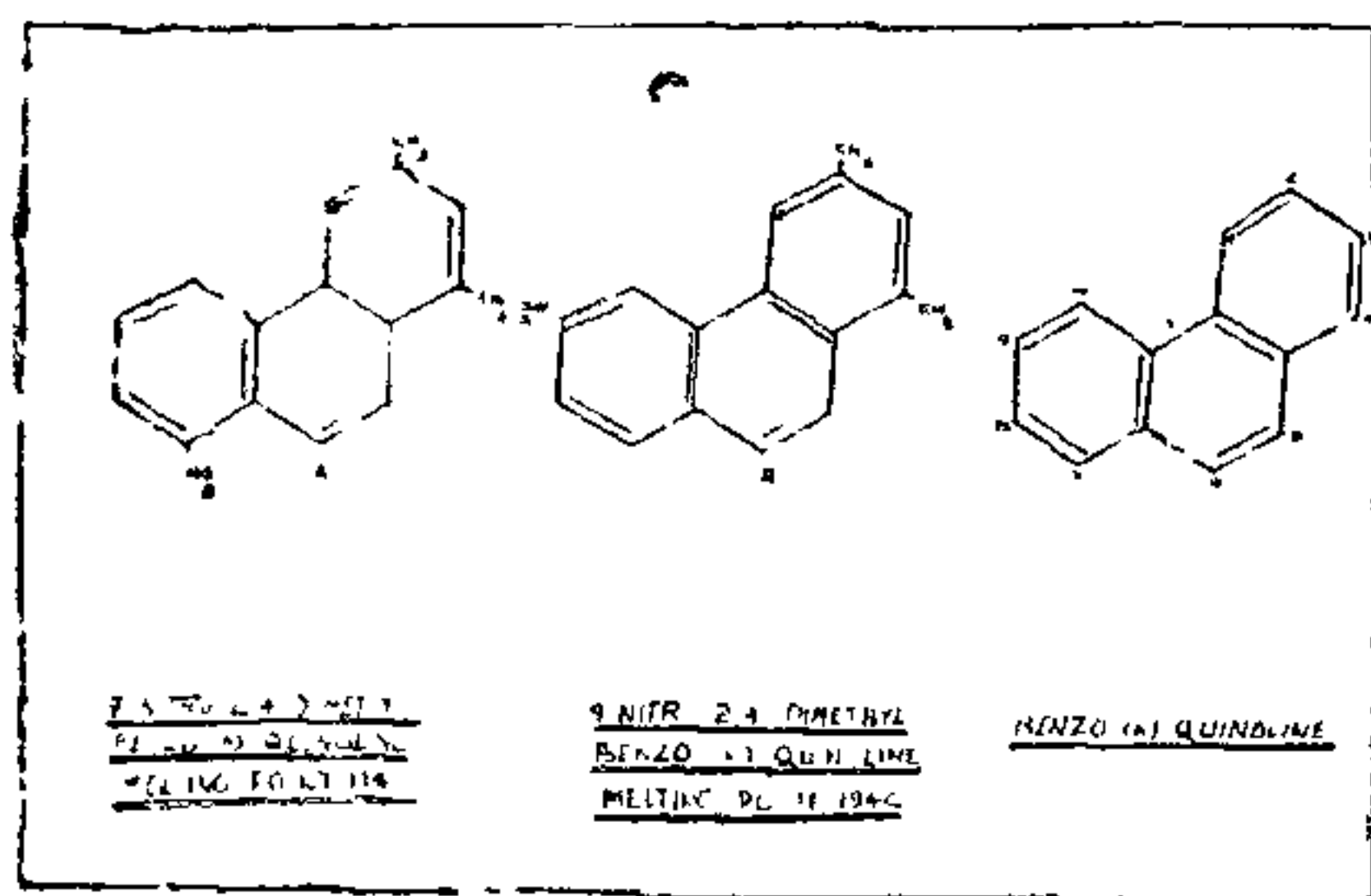
man<sup>5</sup> reported a melting point of 44°, as did Combes<sup>6</sup> and Reed<sup>7</sup>. Johnson and Mathews<sup>8</sup>, reporting 51.5–53°, agreed with Van Braun<sup>9</sup> at 52° but Scherk and Baily<sup>10</sup> gave the melting point as 55–56°.

Definite evidence for its structure was, therefore, needed. The NMR spectra were consistent with all the intermediates and end product. The H-10 signal in the NMR spectrum at 60 M/C of 2, 4-dimethyl benzo (h) quinoline arising from the ring protons is very little informative due to its complexity. This is caused by the coincidence of most of the chemical shifts resulting in strongly overlapping signals. H-3 proton and 2 and 4 methyl groups on ring containing hetero atom are easily detectable. The difficulties in the interpretation of the very complex pattern of the low field H-10 signal could be alleviated by a further increase of the spectrometer frequency, because this leads to a corresponding increase of the chemical shift differences and hence to a simplification of the analysis of spectra.

An important progress in this connection has been achieved by the introduction of high resolution 100 MHz NMR spectrometer using magnets of high magnetic field strength. A comparison of the 60 and 100 MHz spectra shows that the former already reveals all spectral subtleties of the ring containing nitrogen atom whereas the low field signal of H-10 is not very

informative. All other protons give rise to the complex patterns. The situation is completely different in the second spectrum presenting the H-10 proton at 100 MHz. Here, this part consists of 16 lines showing ortho, meta, para and long range coupling.

The successful nitration of 1-azaphenanthrene with nitric acid prompted us to investigate this method for the benzo (h) quinoline system. 2, 4-dimethyl benzo (h) quinoline when nitrated gave compounds I and II which are yellow crystalline solids and have melting points of 174° and 194° C respectively. The mass spectra and quantitative analysis of both substances support the correctness of the molecular formula  $C_{15}H_{12}N_2O_2$  assigned for a mononitro 2, 4-dimethyl benzo (h) quinoline.



The assignment of the positions of the nitro group in I and II presents a problem. In the series pyridine < quinoline < isoquinoline < acridine < benzo (h) quinoline, the ease of nitration increases significantly. Pyridine gives 22% yield of 3-nitro pyridine when a solution

of pyridine in 100% sulphuric acid reacts with potassium nitrate and nitric acid at 300° C. This is contrasted with the quantitative yield of mononitro benzo (h) quinoline obtained when benzo (h) quinoline nitrate was dissolved in conc. sulphuric acid. The increasing reactivity of the benzo and dibenzo pyridines can be attributed to the decreasing effect of the hetero nitrogen atom on the more distant benzenoid ring. This leads to an increased polarizability at the C atom being nitrated. A comprehensive review of the experimental results and theoretical implications of aza-aromatic nitration has been prepared by Schofield<sup>11</sup>.

Since it is extremely unlikely that a heterocyclic ring would be nitrated under the conditions used, the logical positions are C (7) and C (9). Collateral evidence in support of this is provided (a) by the fact that phenanthrene, through steric hindrance, is resistant to substitution at C (4) which corresponds to (C10) in benzo (h) quinoline and (b) by Longuet-Higgins and Coulson's calculations (*J. Chem. Soc.*, 1949, p. 977). The authors computed the electron density at the various C atoms of benzo (h) quinoline and showed that the highest electron densities are located at C (9) and C (7). It may be objected that the entity existing in the nitration is the salt of 2, 4-dimethyl benzo (h) quinoline whereas the calculations of electron density are given only for the uncharged form of benzo (h) quinoline; however, the nitration products of 2, 4-dimethyl benzo (h) quinoline in the order of decreasing abundance are the 9- and 7-nitro, 2, 4-dimethyl benzo (h) quinoline. The mononitro structures are further confirmed by their NMR spectra. The NMR data of the 2, 4-dimethyl, 7 nitro 2, 4-dimethyl and 9 nitro 2, 4-dimethyl benzo (h) quinolines, are shown in Table I.

TABLE I

NMR data of benzo (h) quinoline derivatives

Compound	H-3	H-5	H-6	H-7	H-8	H-9	H-10	2-CH <sub>3</sub>	4-CH <sub>3</sub>
2, 4-dimethyl benzo (h) quinoline $\tau = 2.9$							$\tau = 0.69$	$\tau = 7.32$	$\tau = 7.5$
7-nitro-2, 4- dimethyl benzo (h) quinoline $\tau = 2.72$	$\tau = 1.98$	$\tau = 1.62$	..	$\tau = 1.72$	$\tau = 2.27$	$\tau = 0.26$	$\tau = 7.26$		$\tau = 7.33$
(c/s)	$J_{5,8} = 9.5$	$J_{9,10} = 8.2$	$J_{8,10} = 1.4$	$J_{8,9} = 7.8$					long range coupling = .7
9-nitro-2, 4- dimethyl benzo (h) quinoline $\tau = 2.72$	$\tau = 1.95$	$\tau = 2.24$	$\tau = 2.09$	$\tau = 1.55$		$\tau = -0.15$			$\tau = 7.32$
(c/s)	$J_{8,10} = 1.4$	$J_{7,8} = 8$	$J_{5,8} = 9.5$	$J_{7,10} = 0.4$					long range coupling = .7

Consideration of spectra of these compounds permitted the assignments shown and the basis for making the assignments is discussed below.

For the aromatic protons of the 9-nitro derivative the least deshielded one. H-7 appears as a broadened doublet, predicted by a first order treatment for the ortho coupling to H-8 and para coupling to H-10. H-8 and H-10 are also deshielded by the nitro group. H-10 appears further downfield as compared to its position in 2, 4-dimethyl benzo (h) quinoline.

The positions of the aromatic proton signals in the 7-nitro isomer reflect the deshielding influence of the nitro group as expected H-8 > H-10 > H-9. The H-8 signal shows a major ortho coupling with H-9 broadened by meta coupling with H-10.

Of major importance is the evidence provided by the C(5) and C(6) protons which give a doublet and is consistent with the nitro group being in the 7 and 9 positions.

#### Experimental

4-(1-naphthylimino)-pentanone-2 and 2, 4-dimethyl benzo (h) quinoline were prepared according to the method given in the literature<sup>8</sup>.

#### Nitration of 2, 4-dimethyl benzo (h) quinoline

2, 4-dimethyl benzo (h) quinoline (1 g) was dissolved in glacial acetic acid (10 ml) and nitric acid (2, 1 ml) was added dropwise. The white precipitate formed was filtered off, washed with a little alcohol and dried. It was treated with conc. sulphuric acid (10 ml) and heated on a steam bath for one hour. The contents were poured on to crushed ice (200 g) and made alkaline. The residue (2 g, m.p. 152°) was removed by filtration. The benzene chloroform extract (1:1) of the residue was chromatographed on an alumina column and developed with benzene. The benzene eluates on evaporation yielded yellow solids, which on crystallisation from ethanol gave pure specimens of two isomeric nitro 2, 4-dimethyl benzo (h) quinoline. The higher melting isomer (0.8 g, m.p. 194°) was found to be 9-nitro-2, 4-dimethyl benzo (h) quinoline. Yield (65.7%).

Analysis calculated for C<sub>15</sub>H<sub>12</sub>N<sub>2</sub>O<sub>2</sub>

C = 71.41; H = 4.80; N = 11.11.

Found C = 71.14; H = 4.83; N = 10.90.

The lower melting isomer (0.4 g, m.p. 174°) was found to be 7-nitro, 2, 4-dimethyl benzo (h) quinoline

Yield = 32.8%

Calculated for C<sub>15</sub>H<sub>12</sub>N<sub>2</sub>O<sub>2</sub>

C = 71.41; H = 4.80; N = 11.11.

Found

C = 71.13; H = 4.85; N = 10.85.

Total Yield = 1.2 g (98.5%).

#### Mass spectra

9-nitro, 2, 4-dimethyl benzo (h) quinoline  
 m/e (relative intensity)

206 (100), 252 (50), 194 (30), 191 (15%).

I.R. (Nujol mull), 710 (M), 740 (M), 780 (S), 840 (M), 960 (M), 1340 (S), 1370 (S), 1580 (S), 1610 (M) cm<sup>-1</sup>.

7-nitro, 2, 4-dimethyl benzo (h) quinoline

m/e (relative intensity)

194 (100), 252 (50), 206 (25), 222 (15).

I.R. (Nujol mull) 715 (M), 750 (S), 880 (M), 1350 (S), 1400 (S), 1466 (S), 1484 (M), 1600 (S), 1605 (M) cm<sup>-1</sup>.

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