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ON THE CHEMICAL METHYLATION OF QUINONES WITH METHYLCOBALAMIN

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In this paper, we wish to report a facile methylation of simple quinones as revealed by their reactions with methylcobalamin in aqueous solutions. Previous report[1] from this laboratory concerned with similar reactions but by the use of synthetic cobalt complex such as methylcobaloxime (bis(dimethylglyoximato)cobalt) in CH_3OH-CH_3CN solutions, where the transmethylations were recognized to only a very small extent unless some transition metal salts were added to the reaction system. In the present work, C-methylation of 1,4-benzoquinone (BQ) as well as of 1,4-naphthoquinone (NQ) was found to take place to 30—50 % yield without any additive at 37° in the presence of methylcobalamin (CH_3-B_{12}) in aqueous solutions.

Materials and experimental procedures are largely the same with those previously reported; BQ (0.3 mmol) or NQ (0.3 mmol) was allowed to react with CH_3-B_{12} (0.15 mmol) in an aqueous solution (20 ml) at 37° under a nitrogen atmosphere in the dark. After a day or week, the solution was concentrated to an extent by vacuum distillation, and residues were extracted with a small amount of benzene. The extracts were then subjected to identification by gas chromatograph (JGC-TYPE 20 K) coupled with mass spectrometer (JMS-OlSG-TYPE 2).

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Fig. 1 shows a typical FID gas chromatogram** (Shimadzu GC-1B) obtained with BQ or NQ reacted with CH_3-B_{12} for a week at 37°, where the occurrence of methylation of BQ or NQ would be apparent (the first peak is due to solvent).

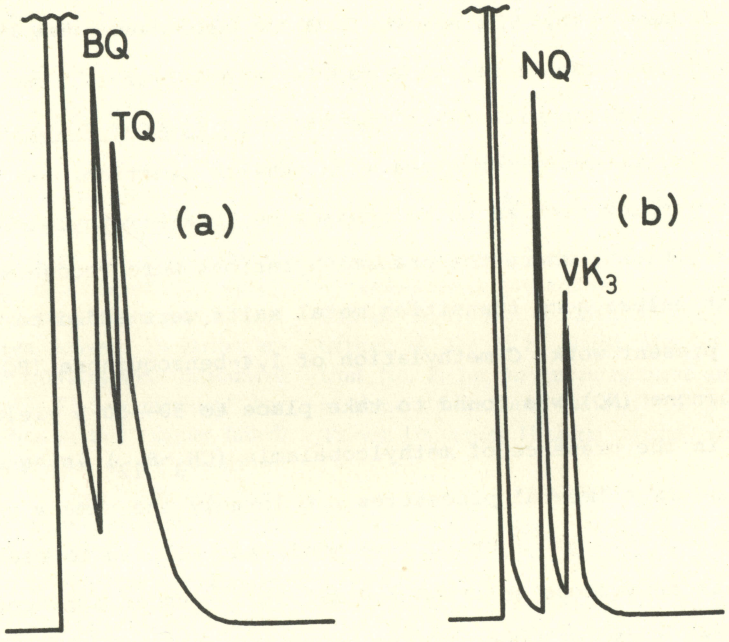


Fig. 1 Gas chromatograms of the reaction products for BQ and CH_3-B_{12}(a) and for NQ and CH_3-B_{12}(b).

While the retention time of the third peak appeared to be identical with that of 2-methyl-1,4-benzoquinone (TQ) and of 2-methyl-1,4-naphthoquinone (VK_3) respectively, further investigations were carried out on the mass spectral analysis of each component, i.e. by the use of a gas-mass technique. In Fig. 2 are shown the mass spectra of, for example, the third component. It is quite clear from the mass fragmentation pattern of Fig. 2 that m/e 122 and m/e 172 ions are present as the parent peaks which may correspond to M.W. of methylbenzoquinone

** 2.0 m Silicone DC-11 on Uniport B was used as the column packing operated at 150° for (a), and 1.5 m Apieson grease L on Uniport KS at 210° for (b).

and of methylnaphthoquinone, respectively.

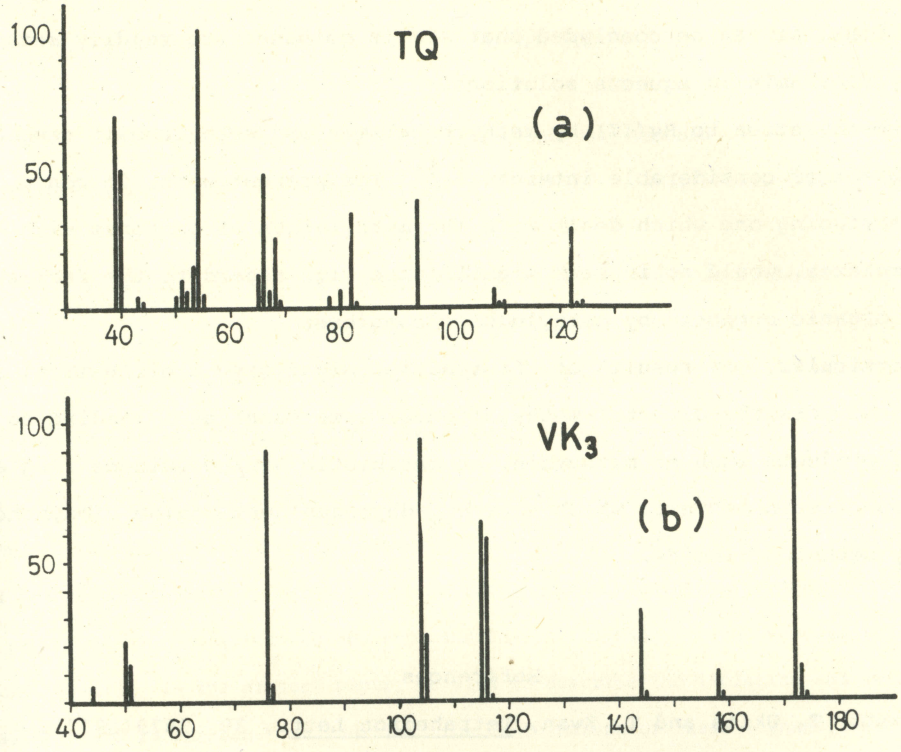
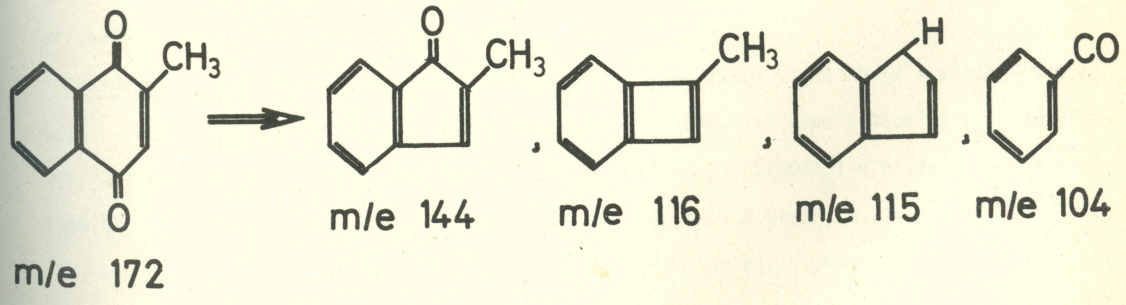


Fig. 2 Mass spectra of the reaction products.

Moreover, the presence of the major fragments such as m/e 144, 116, 115 and 104 in the high-mass region of methylnaphthoquinone (Fig. 2b), would indicate that the methyl group is not incorporated into the benzene ring but into the quinone group and that the parent ions thus formed decompose in a mode as shown below.



The fragmentation of this sort is in agreement with that of 2-methyl-1,4-naphthoquinone.[2] Therefore, apart from the detailed mechanism of fragmentation of parent ions, it can be concluded that simple quinones are readily methylated with methylcobalamin in aqueous solutions.

Transmethylation to Hg(II) by methylcobalamin and methylcobalt complexes has been a subject of considerable interest.[3-5] The present work, in conjunction with the foregoing one which dealt with the methylation of quinones with synthetic cobalt complexes, would again bear significance with regard to the facile C-methylation of organic compound by methylcobalt complexes.

In particular, the results of the reaction might give a biochemical implication on the possible direct C-methylation of some substrates leading to the methylated products such as mitomycin, an antibiotic having quinone ring and produced in certain bacteria which have B_{12}-dependent methionine biosynthesis system, by methylcorrinoids.

References

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