*Journal of Organometallic Chemistry*, 172 (1979) C23—C26


**Preliminary communication**

# SYNTHESIS AND CHARACTERIZATION OF AN ARYLCOBALT-CORRIN

KENNETH L. BROWN and RUSSELL J. BACQUET

*Department of Chemistry, The University of Texas at Arlington, Arlington, Texas 76019 (U.S.A.)*

(Received February 20th, 1979)

## Summary

Prolonged reaction of cob(I)inamide with methyl-*p*-bromobenzoate in methanol produces, in low yield, an organocobinamide which appears to be the methyl ester of *p*-carboxyphenylcobinamide. In aqueous base this compound undergoes slow hydrolysis to another organocobinamide assigned as the conjugate base of *p*-carboxyphenylcobinamide.

Because of continuing interest in the nature of the carbon—cobalt bond in organocobalt-corrins and related model systems, we have been interested in obtaining substituted phenylcobalt complexes in order to determine the effect of covalently bound cobalt chelates on *m*- and *p*-phenyl substituents. Recently one of us and others [1] reported the synthesis of the methyl esters of *m*- and *p*-carboxyphenylcobaloximes via "reductive arylation." We would now like to report a similar preparation of the methyl ester of *p*-carboxyphenylcobinamide, to our knowledge the first synthesis of an arylcobalt-corrin.

Prolonged reaction of cob(I)alamin with methyl-*p*-bromobenzoate in aqueous methanol produced no organocobalamins presumably due to the more stringent steric requirements of the cobalamin-corrin equatorial ligand system than of the bis(dimethylglyoximato) system [2]. These results are in accord with the fact that while benzyl- and isopropyl-cobaloximes are stable, well characterized compounds, benzyl-[3] and isopropyl-cobalamin [4,5] are too unstable to isolate. However, the successful syntheses of secondary alkylcobinamides [6,7] encouraged us to attempt the reductive arylation of diaquocobinamide.

Diaquocobinamide was reduced in methanol with sodium borohydride and allowed to react with excess methyl-*p*-bromobenzoate in the dark under argon for 72 h. Following a shift of solvent to water the reaction mixture was worked up by phenol-methylene chloride extraction [8] followed by chromatography on carboxymethyl cellulose. Elution with water produced a fraction which had a typical organocobinamide spectrum [9,10] (Fig. 1 A, solid line). Upon photolysis this compound is converted to a material spectrally identical to diaquo-

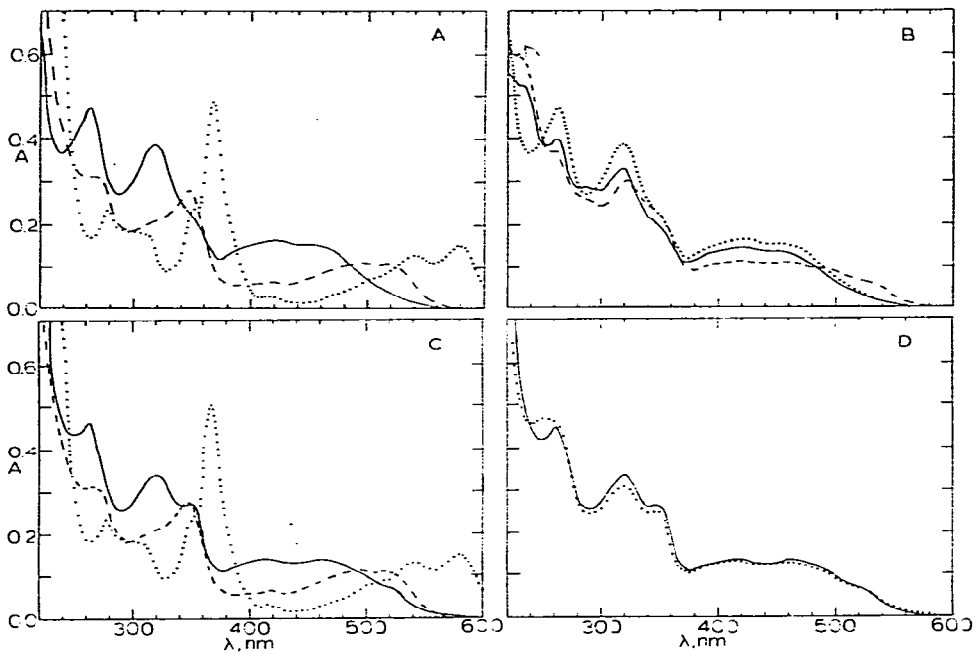
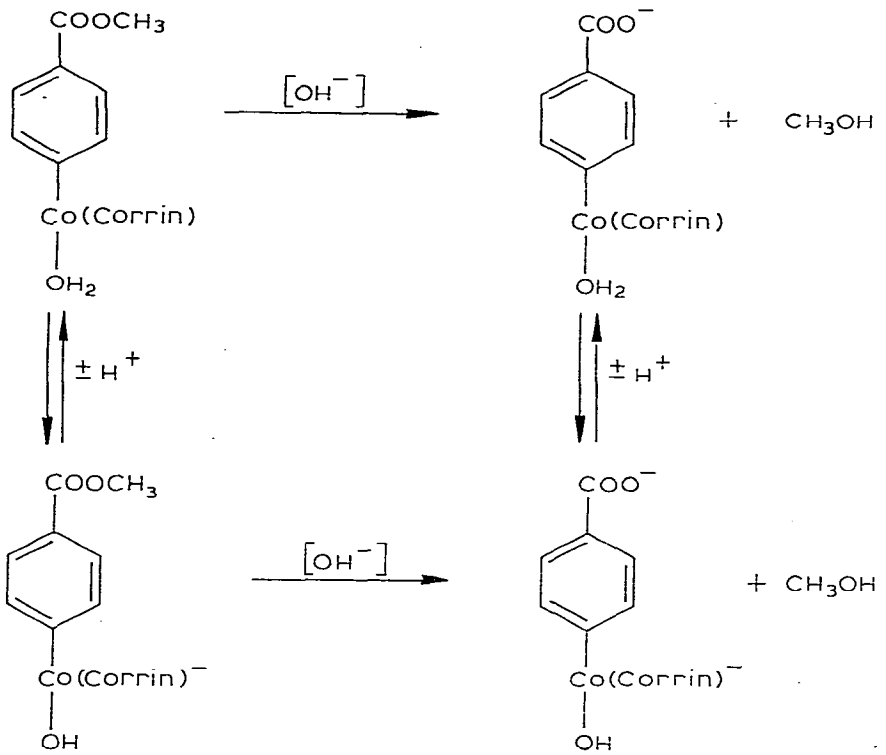



Fig. 1. A. Spectra of the methyl ester of *p*-carboxyphenylcobinamide, $1.67 \times 10^{-5}$ *M*, pH 7.0 (——); after photolysis, pH 7.0 (8 min, Rayonet Photochemical Reactor) (– – – –); in 0.1 *M* KCN, 0.01 *N* KOH (· · · · · ·).
B. Spectra of the methyl ester of *p*-carboxyphenylcobinamide, $1.67 \times 10^{-5}$ *M*, pH 7.0 (· · · · · ·); pH 12.6, immediately after mixing (——); pH 12.6, 2730 min after mixing (– – – –).
C. Spectra of the product of the base-catalyzed hydrolysis of the methyl ester of *p*-carboxyphenylcobinamide, $1.67 \times 10^{-5}$ *M*, pH 7.5 (——); after photolysis, pH 7.5 (2 min, Rayonet Photochemical Reactor) (– – – –); in 0.1 *M* KCN, 0.01 *N* KOH (· · · · · ·).
D. Spectra of the product of the base-catalyzed hydrolysis of the methyl ester of *p*-carboxyphenylcobinamide, $1.67 \times 10^{-5}$ *M*, pH 7.5 (——); pH 2.1 (· · · · · ·).

cobinamide (or aquohydroxocobinamide, depending on the pH) above 260 nm (Fig. 1 A, dashed line), and upon incubation in 0.10 *M* KCN (0.01 *N* KOH) it is rapidly converted to a material spectrally identical to dicyanocobinamide above 260 nm (Fig. 1 A, dotted line). From the molar absorptivities of diaquocobinamide ($\epsilon_{350} = 1.53 \times 10^4\ M^{-1}\ cm^{-1}$, this work) and dicyanocobinamide ($\epsilon_{368} = 3.04 \times 10^4\ M^{-1}\ cm^{-1}$ [9]) the yield was calculated to be 2% (based on cobinamide). When this organocobinamide was placed in aqueous base (pH 12.6) it underwent an instantaneous spectral change (Fig. 1 B, solid line, compare pH 7.0 spectrum, dotted line), which can be interpreted as being due to partial ionization of the axial water ligand (Scheme 1). The instantaneous spectral change was followed by a much slower spectral change (halftime about 400 min) with tight isobestic points at 250, 325, 368 and 484 nm (Fig. 1 B, final spectrum at pH 12.6 is the dashed line). The interpretation of these slow spectral changes as being due to base-catalyzed ester hydrolysis (Scheme 1) is supported by the fact that the product of this slow base-catalyzed reaction also has a typical organocobinamide spectrum after neutralization (Fig. 1 C, solid line). Furthermore, this product was also converted to a material spectrally identical to diaquocobinamide (or aquohydroxocobinamide, depending on the pH) above 260 nm upon photolysis (Fig. 1 C, dashed line) and was converted to a material spectrally identical to dicyanocobinamide above 260 nm upon incubation in 0.10 *M*




KCN (in 0.01 *N* KOH, Fig. 1C, dotted line). In addition, this product underwent minor spectral changes with isobestic points at 239, 273 and 527 nm over the pH range 2.1 to 7.5 (Fig. 2D, solid line pH 7.5, dotted line pH 2.1) consistent with its assignment as a cobinamide-substituted benzoic acid.

From these data we conclude that the product of the prolonged reaction of methyl-*p*-bromobenzoate with cob(I)inamide is the methyl ester of *p*-carboxyphenylcobinamide and that in aqueous base it undergoes equilibrium ionization of its axial water ligand and base-catalyzed ester hydrolysis to generate the conjugate base of *p*-carboxyphenylcobinamide (Scheme 1) as was the case for the analogous cobaloxime [1].

The mechanism of this apparent reductive arylation reaction is unknown. A nucleophilic aromatic substitution mechanism (which could involve hydridocobinamide [7]) seems possible considering the extremely high nucleophilicity of cobalt(I) species [11]. However, a halogen-abstraction free-radical mechanism, as suggested by Tucker [12] for the arylation of $Co^{I}[SALEN]^{-}$ and $Co^{I}[BAE]^{-}$ by aryl halides, cannot be ruled out.

## Acknowledgements

This research was supported by the National Institutes of Health, United States Public Health Service, Grant No. GM 23215 and the Donors of the Petroleum Research Fund, administered by the American Chemical Society (PRF #8925-G3).

## References


1 K.L. Brown, A.W. Awtrey and R. LeGates, J. Amer. Chem. Soc., 100 (1975) 823.
2 J.M. Pratt, Inorganic Chemistry of Vitamin $B_{12}$, London, Academic Press, 1972, p. 80, 81.
3 E.M. Tachkova, I.P. Rudakova and A.M. Yurkevich, Zh. Obsh. Khim., 44 (1974) 2594.
4 R.A. Firth, H.A.O. Hill, J.M. Pratt, R.G. Thorp and R.J.P. Williams, J. Chem. Soc. A, (1968) 2428.
5 H.A.O. Hill, J.M. Pratt, S. Ridsdale, F.R. Williams and R.J.P. Williams, Chem. Commun., (1970) 341.
6 J.D. Brodie, Proc. Nat. Acad. Sci. USA, 62 (1969) 461.
7 G.N. Schrauzer and R.J. Holland, J. Amer. Chem. Soc., 93 (1971) 4060.
8 D. Dolphin, Methods in Enzymology, XVIII C, (1971) 34.
9 C.P. Dunne, Ph.D Dissertation, Brandeis University, 1971.
10 Ref. 2, p. 44ff.
11 G.N. Schrauzer, E. Deutsch and R.J. Windgassen, J. Amer. Chem. Soc., 90 (1968) 2441.
12 S.P. Tucker, Ph.D Dissertation, University of North Carolina, 1975.