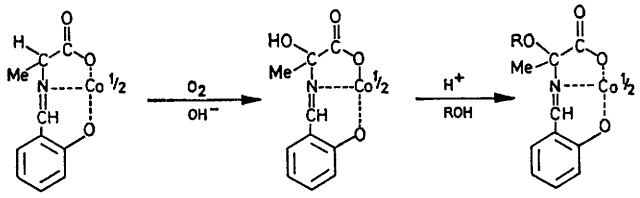
Oxidative Deamination of the Alanine Ligand by Air Oxygen in Stereochemically Inert Bis-(*N*-salicylidenealaninato)cobaltate(III) Complexes

By N. G. FALEEV, Yu. N. BELOKON', V. M. BELIKOV, and L. M. MEL'NIKOVA

(*Institute of Organoelement Compounds of the U.S.S.R. Academy of Sciences, Moscow, U.S.S.R.*)

Summary The optically active potassium Λ(*SS*)-bis-(*N*-salicylidenealaninato)cobaltate(III) (I) is oxidised by air in water at pH 11·0 to a mixture of the Λ(*SS*)-, Λ(*RR*)-, and Λ(*SR*)-diastereoisomers of the α-hydroxyalaninatocobaltate.

MANY amino-oxidases which effect oxidative deamination of amino-acids are pyridoxal-dependent metallo-enzymes.[1] The mechanism of interaction of amino-acids with oxygen has been investigated both in naturally occurring and in model non-enzymatic systems.[2,3] Preliminary oxidation of an amino-acid to the α-hydroxyamino-acid was assumed to be the initial stage in the oxidative deamination of amino-esters in labile complexes containing salicylaldehyde and Cu^{II} and Ni^{II} ions.[4] Schiff bases of α-hydroxyamino-acids have been postulated as intermediates in interconversions of amino-acids and pyruvic acid which are effected, *e.g.*, by tryptophanase EC 4,[5] but their existence has not been proved directly so far.



(I) (II)

SCHEME

We have shown recently[6] that the amino-acid fragment in inert bis-(*N*-salicylideneamino-acidato)cobaltate(III) complexes enters in reactions which are typical of pyridoxal-dependent enzymes. The inertness of these complexes might permit isolation of the α-hydroxyamino-acid derivatives which could be regarded as models for the intermediates in the above enzymatic processes.

The optically active Λ(*SS*)-potassium bis-(*N*-salicylidenealaninato)cobaltate(III) (I)[7] was oxidised with air oxygen in water at pH 11·0. The α-carbon atom of the alanine fragment was oxidised, and three diastereoisomers of the α-hydroxyalaninato-cobaltate(III) (II) were formed (Scheme), which were separated by chromatography on Al_2O_3 with EtOH-H_2O (3:1) as eluent [yield of (IIa) > (IIb) > (IIc)]. Their n.m.r. spectra are in complete agreement with their proposed structures. The components (IIa) and (IIc) of the mixture are the Λ(*SS*)- and Λ(*RR*) isomers; they show C_2 symmetry, and the methyl groups of both ligands are equivalent, giving a singlet n.m.r. signal. The component (IIb) is the Λ(*SR*)-isomer, having no elements of symmetry higher than first order; the two non-equivalent Me-groups of the ligands give a doublet signal. Retention of the mutual arrangement of the ligands during the oxidation is confirmed by the similarity of the o.r.d. curves for (IIa), (IIb), and (IIc) to those of the diastereoisomers of (I) of known absolute configuration.

The structures of the complexes (II) were confirmed by the formation of pyruvic acid ($\leqslant 80\%$ yield) when the Co^{III} was reduced to Co^{II} electrochemically or with excess of Na_2S and the resulting labile complex was hydrolysed.

In acidic solutions (*ca.* 0·1N-H_2SO_4) the hydroxy-group of (II) is very labile, being readily exchangeable with the hydroxy-group of water (6 h; 80 °C) or with the alkoxy-group of alcohols (6—8 h; reflux), this being accompanied by epimerization of each of the three diastereoisomers to a mixture of the three possible ones. O.r.d. data show that the mutual arrangement of the ligands remains unchanged.

When (I) is oxidized in absolute MeOH in the presence of MeONa the main product is (II) rather than the α-methoxy-alanine derivative which would have been expected had the solvent participated in the reaction. The hydroxy-group of (II) may arise from water molecules in the external co-ordination sphere of (I) although we think this is unlikely, and we suggest that the oxygen atom in the α-hydroxy-group of (II) arises from the oxygen molecule. In this respect the mechanism differs from that suggested by Hamilton for oxidative deamination in a model pyridoxal system[3] where direct contact between the oxygen molecule and the ligand oxidized is excluded.

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