MONOAMINE OXIDASE IN OVINE PLASMA OF NORMAL AND LOW COPPER CONTENT

C. F. Mills, A. C. Dalgarno and R. B. Williams

Rowett Research Institute, Bucksburn,
Aberdeen, Scotland

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Buffoni and Blaschko (1964) have shown that monoamine oxidase (E.C. 1.4.3.4) of pig plasma is a copper-containing enzyme. Yamada and Yasunobu (1962a, b) have also claimed that copper is a component of bovine monoamine oxidase. Blaschko, Buffoni, Weissman, Carnes and Coulson (1965) reported that no monoamine oxidase activity was detectable in pig plasma with a low copper content but that activity rapidly appeared when the plasma copper content rose after the diet was supplemented with copper.

These findings, coupled with our interest in the nature of metabolic lesions in trace element deficiency disorders, prompted us to investigate the activity of monoamine oxidase in the blood plasma of sheep and lambs of normal and low copper status. Low plasma copper concentrations in sheep and cattle are often observed without the development of clinical manifestations of copper deficiency and consequently it was anticipated that studies of the activity of this enzyme in clinically normal animals of low copper status would indicate whether or not changes in plasma monoamine oxidase activity were related to the clinical syndrome of copper deficiency in sheep.

Pregnant Scottish Blackface ewes were obtained from an area in N.E. Scotland where sheep are normally found to have low concentrations of blood copper. Four (Group A) were transferred to the Rowett Institute in October 1965 and four from the same flock (Group B) were transferred in April 1966.

The mean copper contents of the plasma (μg/ml) of ewes in June 1966 were 1.04 ± 0.07 and 0.21 ± 0.05 for Groups A and B respectively. With the lambs the corresponding values were for Group A 1.20 ± 0.03 and for Group B 0.16 ± 0.02.

Plasma monoamine oxidase was determined by the spectrophotometric method of Buffoni and Blaschko (1964) using benzylamine hydrochloride as substrate. Assays were carried out at 25°C. Results are presented in Fig. 1.

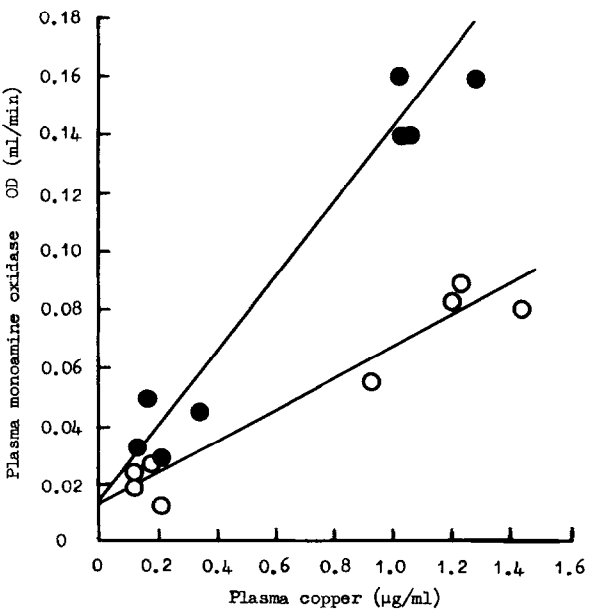

Fig. 1. Relationships between copper concentration and monoamine oxidase activity in ovine plasma.
●—●, ewes; O—O, lambs

There was a close correlation between plasma copper concentration and monoamine oxidase activity in both ewes and lambs, a different relationship being found for ewes than for lambs. The regression equation relating enzyme activity to plasma copper was $y = 1.2x + 0.0165 \pm .0083$ ($.05 < P < .1$) for ewes and $y = 0.053x + 0.0132 \pm .0050$ ($P < .05$) for lambs where y = enzyme activity (Δ OD/ml plasma/min) and x = μg Cu/ml plasma. It is noteworthy that the

regression equations obtained in these experiments suggest that a small component of the monoamine oxidase activity of ovine plasma may not be associated with copper. This is of interest in the light of earlier suggestions based on studies of substrate specificity that individual organs may perhaps contain a mixture of "amine oxidases". Nara, Igaue, Gomes and Yasunobu (1966) have recently reviewed work demonstrating the existence of copper-containing amine oxidases with either flavin or pyridoxal phosphate prosthetic groups. From our studies it appears possible either that other metals may substitute for copper to a limited extent to maintain amine oxidase activity at a low level in plasma of low copper content or that traces of a monoamine oxidase without a metallic component exist in ovine plasma.

The relationship of plasma amine oxidase activity in the pig to the clinical syndrome of copper deficiency is not clear from the work of Blaschko et al (1965). In their studies the mean plasma copper of the copper deficient pigs used was $0.59 \pm .08$ µg/ml; these animals had no detectable plasma amine oxidase activity. Since clinical copper deficiency in pigs is usually associated with plasma copper concentrations considerably lower than this (e.g. $0.15 \pm .07$ µg/ml (Lahey, Gubler, Chase, Cartwright and Wintrobe, 1952)) it appears probable that in the pig a fall in amine oxidase activity is an early manifestation of copper deficiency.

None of the ewes or lambs included in our experiments showed any clinical signs of copper deficiency despite the very low plasma copper concentrations found in ewes and lambs of Group B and it must be concluded that a low plasma amine oxidase activity is no more closely associated with the clinical syndrome of copper deficiency in this species than is the plasma concentration of copper.

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