

TRACE ELEMENT PROBLEMS IN THE WAIRARAPA

With Particular Reference to Copper and Molybdenum

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Summary

Copper deficiency in cattle is reflected by unthriftiness, reproductive problems, anaemia, poor growth and scours, while in sheep osteoporosis and ataxia conditions are observed in lambs. Copper deficiency can be induced in animals grazing copper-adequate pastures by an increase in dietary molybdenum. The excess molybdenum interferes with the copper metabolism and reduces the blood and liver levels of copper. Increasing the dietary copper intake overcomes the toxic effect of molybdenum. The possibility of inducing a copper deficiency in grazing livestock must be kept in mind when improving pasture production by the addition of molybdenum and changing pasture species.

INTRODUCTION

At present in New Zealand, only four trace elements, namely, iodine, selenium, cobalt and copper, have been associated with mineral deficiency problems in grazing livestock. Of these, the copper deficiency syndrome is probably the most complex because the disorders are not all related to pasture with very low copper levels, as copper deficiency symptoms have been observed on pastures containing adequate copper. In these circumstances it has been shown that dietary factors such as molybdenum can induce copper deficiency by interfering with the copper metabolism of the animal. The copper-molybdenum interaction and its effect on animal health is summarized in Fig. 1.

SYMPTOMS OF COPPER DEFICIENCY

SHEEP

Visible symptoms of copper deficiency are not seen in the adult sheep even though there is a marked depletion of liver copper resulting from long-term grazing on copper-deficient pastures. Copper deficiency in the ewe is reflected by the birth of lambs

with nervous and/or bone disorders. The symptoms may be seen at 3 weeks or 12 to 14 weeks after birth, the former being more severe as these lambs die within 3 or 4 days of showing the characteristic muscular inco-ordination of the hind legs while the older lambs nearly always survive (Cunningham, 1950). This nervous disorder, which is called swayback or enzootic ataxia, is associated with the demyelination of the myelin sheath of the nerve fibre and therefore the conduction of nerve impulse along these fibres is impaired. The demyelination is thought to be the result of a reduction in the synthesis of phospholipids, the fatty substance of which myelin is composed (Underwood, 1962).

The bone disorder which predisposes the lamb to bone fractures is described as osteoporosis, a condition which is characterized by abnormal porousness or rarefaction of bone by the enlargement of its canals. It appears to be associated with less tissue depletion of copper than is necessary to cause ataxia. Lambs from healthy ewes placed on copper-deficient pastures showed signs of osteoporosis in the first and second season while ataxia did not appear until the third season (Cunningham, 1950). A loss in wool crimp has been observed in Merino sheep.

CATTLE

Copper-deficient adult cattle are anaemic, unthrifty, 'poorly grown and have reproductive problems. Changes in the coats of some red animals to yellowish red have been observed. The growth of calves is poor, while bone fracture and loss of co-ordination of the hind limbs have been reported. Seasonal copper deficiency in cattle on certain areas such as reclaimed peats and pumice soils is well documented. The symptoms are similar to those described above except that the cattle also show severe scours on lush pastures in the spring and to a lesser extent in the autumn. The above condition is known as peat scours and only during the summer when the scouring ceases will the cattle regain, to some extent, the loss in weight and milk production (Cunningham, 1950).

TISSUE COPPER LEVELS IN SHEEP AND CATTLE

The liver and blood copper levels reflect the copper status of the animals under conditions of simple copper deficiency as well as conditions when dietary factors modify copper metabolism. In normal sheep the liver copper level ($\mu\text{g/g}$ D.W.) ranges from 171' to 1,374 with a mean value of 500, while in

cattle the range is 23 to 409 with a mean value of 200 (Cunningham, 1946). The blood copper values ($\mu\text{g}/100$ ml) in sheep and cattle range from 70 to 170 with a mean of 100 (Cunningham, 1946). The wide range of values makes it difficult to diagnose possible copper deficiency in a group from a single animal, but a representative number from a group of animals can give a satisfactory indication of the copper status of the group. As a guide, ewes with liver copper levels of $15 \mu\text{g}/\text{g}$ D.W. and blood values below $60 \mu\text{g}/100$ ml may have ataxic lambs. Likewise, in cattle, if the liver copper level falls below $20 \mu\text{g}/\text{g}$ D.W., copper-deficiency symptoms are likely to be observed (Allcroft, 1963).

DIETARY COPPER-MOLYBDENUM INTERACTION

Studies showed that the period of peat scours in grazing cattle in the spring was correlated with a two-fold increase in the pasture levels of molybdenum. Since these pastures contained adequate copper for cattle, it appeared that the high molybdenum level had induced a copper-deficient state in the cattle. Further scouring, poor growth and unthriftiness could be induced in healthy cattle grazing pastures adequate in copper by feeding $50 \mu\text{g}/\text{g}$ D.M. of molybdenum (Cunningham, 1954). The above symptoms were prevented by increasing the level of dietary copper.

Similarly, copper deficiency has been observed in ewes grazing pasture adequate in copper when fed high dietary levels of molybdenum. More recent studies with feeding high intakes of dietary molybdenum and sulphate to pregnant and lactating ewes resulted in lambs being born with ataxia. These lambs showed degenerative changes and demyelination in the nervous system (Mills, 1960).

The excess dietary molybdenum decreased the blood and liver copper levels in cattle and sheep as well as the copper transmitted to the foetal lamb. The effect of excess dietary molybdenum on the tissue copper levels was dependent on the level of dietary sulphate. For example, in the presence of 0.02% sulphate, dietary molybdenum had no effect on copper metabolism while at the 0.45% sulphate level the effect was very pronounced (Dick, 1953). Neither molybdenum nor sulphate alone interferes with the copper retention and as yet the biochemical mechanisms involved in the copper-molybdenum interaction are not known. Since pasture sulphate levels are usually high, it appears that the change in the pasture molybdenum level is the most important

factor in induced copper deficiency. In passing, it must also be pointed out that it has been suggested that other dietary factors may also influence the copper metabolism in sheep and cattle. Dietary copper interactions with other dietary minerals are well documented in other species.

PASTURE LEVELS OF COPPER, MOLYBDENUM AND STOCK HEALTH

The actual level of copper and molybdenum in a pasture is dependent on the plant species present, soil factors, stage of growth and season. Also the increase in pasture levels of copper and molybdenum obtained by topdressing with copper and molybdenum salts depends on soil type. Table 1 summarizes the results of a survey in New Zealand relating copper and molybdenum to stock health.

The table shows that, as the level of pasture molybdenum is increased, the level of copper must also be increased to prevent an induced copper deficiency (Cunningham, 1960).

MANAGEMENT PRACTICES WHICH MAY INFLUENCE PASTURE COPPER AND MOLYBDENUM LEVELS

Pastures grown on soils derived from greywacke, siltstone and mudstones low in calcium carbonate in the Wairarapa show a good response to molybdenum topdressing in many areas (During, 1967). The molybdenum application in turn increases the molybdenum level in the pasture species. The extent of the increase is dependent on the amount of molybdenum applied and the soil type. The application of an excess of molybdenum could

TABLE 1: COPPER, MOLYBDENUM LEVELS IN PASTURE AND STOCK HEALTH

Molybdenum µg/g D.M.	Copper µg/g D.M.	
—	3	Simple copper deficiency in stock likely,
3-5	5-6	Copper adequate for stock health.
7	5-6	Molybdenum toxicity likely in stock. Extra dietary copper required.
7-20	10	Molybdenum toxicity not likely.
20	10	Molybdenum toxicity likely in stock. Extra dietary copper required.

therefore raise the pasture level of molybdenum such that a copper deficiency could be induced in the grazing stock.

Secondly, it appears that introducing more productive grass species into pasture swards may lower the copper levels in the pasture as weeds and lower producing grass species tend to have higher copper levels (Fleming, 1965). Therefore, as a result, certain areas which are marginal as regards providing adequate copper for stock may become deficient in copper in pasture improvement practices. In these situations determinations of pasture and animal blood levels of copper and molybdenum during pasture development would greatly assist in determining the molybdenum and copper status of pasture in terms of animal health.

Finally, it is thought that animals with high worm infestation may also have impaired copper absorption.

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