THE EFFECT OF ZINC ON COPPER AND HELIOTROPE POISONING IN SHEEP

M.M. NOORDIN*, J.McC. HOWELL and P.R. DORLING

The effect of zinc (Zn) on copper (Cu), heliotrope (He) and Cu plus He poisoning was investigated. A low Cu diet, prepared by Milne Feeds of WA, was fed unmodified or after adding air-dried, chopped He giving a 0.13% concentration of alkaloid. $CuSO_4$ (20mg/kg) and ZnO (17mg/kg -ZnA or 35mg/kg -ZnB) were given by mouth.

In each of three experiments, four groups of sheep (numbers shown in parenthesis) were treated as specified in Table 1. The effect of Zn on Cu, He and Cu plus He toxicity was studied in experiments 1, 2 and 3 respectively, in which treatment continued for 30, 28 and 22 weeks. After termination of treatment, concentrations of Cu, Zn and metallothionein (MT) were determined (Table 1). Toxicity was assessed by clinical and histologic examination.

Table 1. Copper, Zinc and Metallothionein Concentration in Liver

Exp	Group	Cu (µg/g DW)	Zn (µg/g DW)	MT (µg/g WW)
1	Control (4)	914±268	107±31	151±77
	Cu (5)	1678±188	99±33	273±194
	Cu+ZnA (5)	1497±262	85±35	360±102
	Cu+ZnB (5)	1254±175	174±46	854±667
2	Control (6)	615±217	108±24	66±14
	He (6)	680±148	91±9	34±4
	He+ZnA (6)	432±177	108±29	198±269
	He+ZnB (6)	405±56	118±14	187±134
3	Control (6)	890±148	145±19	109±81
	He+Cu (4)	2169±206	115±17	119±73
	He+Cu+ZnA (8)	1152±349	152±42	216±206
	He+Cu+ZnB (5)	1256±143	183±63	364±217

Only one sheep fed Cu alone developed haemolysis but all in this group had severe liver injury. The low Zn dose alleviated clinical signs, but the higher dose was required to prevent severe liver damage. Clinical signs were absent in sheep fed He alone, although liver damage was present and was markedly reduced by the higher level of Zn supplementation. In sheep fed Cu and He together, both clinical signs and liver damage were severe. Clinical signs were reduced with both levels of Zn supplementation, but the higher dose was required to markedly reduce liver damage.

The concentration of Cu in the liver of sheep poisoned by He was no greater than in controls but was double in sheep given $CuSO_4$ ($P<0.05$), and trebled in those given $CuSO_4$ plus He ($P<0.01$). The toxins acted synergistically to produce marked liver damage (Howell et al. 1991a,b) and Zn supplements were again shown to prevent Cu poisoning in sheep (Bremner et al. 1976). This study shows, for the first time, that Zn administration successfully prevents hepatogenous Cu poisoning associated with He and Cu ingestion. Zn administration induced MT production and, results not presented here, indicate that the protective role of Zn may be associated with the subsequent binding of Cu to MT in the cytosol of hepatocytes.

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School of Veterinary Studies, Murdoch University, Perth, WA 6150 and *Faculty of Veterinary Medicine and Animal Sciences, Universiti Pertanian Malaysia, 43400 UPM, Selangor, Malaysia.