Use of Orally Administered Oxidised Copper Wire Particles for Copper Therapy in Cattle

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Summary

Oxidised copper wire particles (OCWP) were given per os to cattle as an alternative to subcutaneous copper glycinate injections. OCWP were recovered from the stomachs of cattle slaughtered 3 months after treatment. OCWP (50g) treatment resulted in sustained higher plasma copper concentrations than subcutaneous injections of copper glycinate. OCWP given at high doses (300g) raised liver copper concentrations to 16 mmol/kg without clinical effects. It is concluded that OCWP could be a practical alternative to current injection methods of copper therapy. *Aust. Vet J.* 63:1-3.

Introduction

Hannam and Marret (1976) established that copper deficiency in cattle at Eight Mile Creek, in southeastern South Australia, could not readily be corrected by copper application to pasture and direct supplementation to grazing stock was needed.

Oxidised copper wire particles (OCWP) administered orally to marginally deficient sheep raised the copper concentration in their liver to 18.6 mmol/kg dry weight compared with 1.2 mmol/kg in untreated sheep, 64 days after treatment (Dewey 1977). OCWP administered orally to calves at Eight Mile Creek resulted in sustained higher concentration of plasma copper, increased weight gain and higher liver copper reserves than in calves treated with copper glycinate (Deland *et al* 1979).

Following those promising results 5 trials were undertaken to evaluate aspects of the use of OCWP for copper therapy in cattle.

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Materials and Methods

Trial 1

A comparison was made between OCWP, "ICI Pour on"¶ and Copper glycinate supplements on 2 farms in the Eight Mile Creek area, south of Mount Gambier, of their effect on plasma copper levels.

On each farm 4 groups, each of 5 Friesian cows (550 kg approx.) in late lactation, were allocated to the following treatment groups: no treatment (Control); subcutaneous copper glycinate injection (120 mg Cu); ICI pour on (40ml, equivalent to 200 mg Cu); oral dosing with capsules of 50g OCWP (1 mm x 5-10 mm), reagent grade of copper oxide.

All cattle were bled for plasma copper analysis prior to the administration of treatments and at 3 subsequent monthly intervals.

Trial 2

Plasma copper concentrations were compared between steers dosed with either 50g OCWP (approx. 1.2 mm x 4.5 mm, 10% oxidised), 50g analytical reagent grade of copper oxide** and untreated controls.

Three groups of 5 steers were matched on mean bodyweight. They were weighed and bled for copper analysis every 7 weeks from 10 May to 22 November 1978.

Trial 3

The aims of this trial were to determine whether, in cattle, OCWP particles are retained in the stomach for extended periods (3 months), and whether treatment with OCWP results in increased copper concentrations in muscle, blood, kidney and liver. Twenty-four cows of mixed breeding were allocated to 6 treatment groups. Half were given 50g of OCWP (0.5 mm x 5-10 mm, 60-80% oxidised) contained in gelatin capsules, which were administered with a cobalt bullet gun. Four treated and 4 control cows were slaughtered 4, 8, and 12 weeks after treatment.

The day prior to slaughter blood samples were collected by tail bleeding. At slaughter the caudate lobe of the liver,

¶ Imperial Chemical Industries, Melbourne. Pat. applic. 41516/78; Cuprous Chloride/Sodium Chloride/Sulphur dioxide solution in polyeth, equivalent to 0.5% Cu.

** BDH Chemicals Australia Pty Ltd, Kilsyth, Victoria 3137.

muscle from the neck, and a piece of kidney were removed. The stomachs of treated animals were removed for washing and collection of OCWP. Stomach compartments were separated, cut into small pieces and washed. Digesta was broken up by hand and water to release particles. Tissue and digesta were removed by flotation, leaving a sediment of sand and OCWP, which was oven dried and the OCWP separated off using tetrabromoethane, washing with ethanol and drying, prior to weighing.

Tissue samples were analysed for copper at the Institute of Medical and Veterinary Science, Adelaide.

Trial 4

The aim of this trial was to determine the effect on milk production of oral dosing with OCWP compared with subcutaneous copper glycinate injection given to dairy cows grazing over peat soils.

In May 1979, on 2 farms, 30 Friesian cows in early lactation were allocated to 3 groups of 10, with similar mean plasma copper concentrations.

Subsequent treatments were as follows: Control (no copper): 50g OCWP (0.5 mm x 5-10 mm, 60-80% oxidised) per cow; 120 mg copper per cow as copper glycinate, subcutaneously.

All cows were tested monthly for butterfat and milk production and blood samples were analysed for copper concentrations over a 9-month period.

Trial 5

This trial was carried out to determine if dose rates higher than those hitherto used would cause copper toxicity.

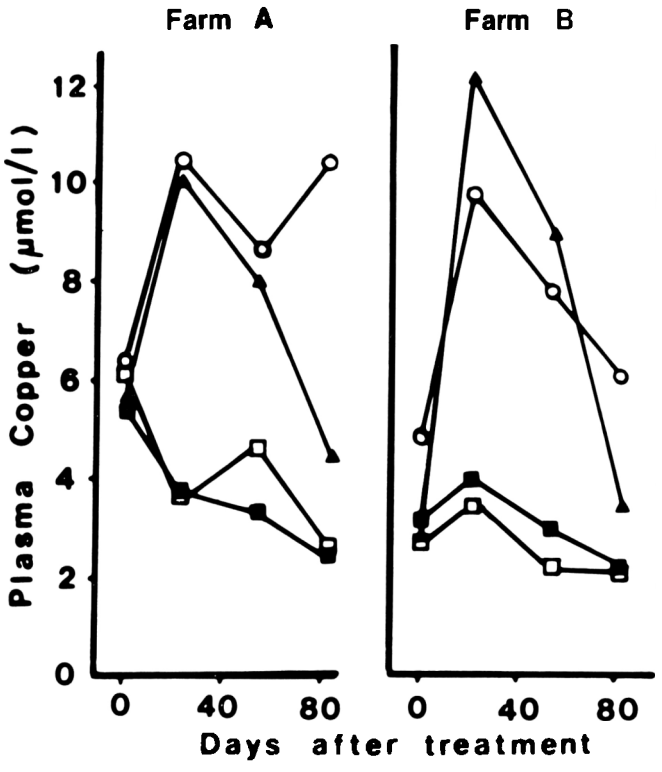
Six heifers (approx. 300 kg bodyweight) were dosed with 100g, 200g or 300g of OCWP (1 mm x 5-10 mm). They were slaughtered 4 weeks after treatment and liver, kidney and neck muscle samples assayed as in Trial 3.

Results

Trial 1

On both farms, OWCP treatment resulted in higher final plasma copper concentrations than did the other treatments, but the effect was statistically significant only on one of the farms. The copper pour on treatment did not increase plasma copper concentration (Figure 1).

Figure 1. Effects of a single dose of 50g oxidised copper wire particles and 120mg copper glycinate on plasma copper concentrations in dairy cows on 2 farms. Treatments were administered on 16 December 1978; trial 1. □, control; ○, oxidised copper wire; ▲, copper glycinate; ■, "pour on" (see text for composition).



Trial 2

Mean plasma copper concentrations of 12.8, 14.8 and 15.0 mmol/l were noted for the control, OCWP and copper oxide (analytical grade) respectively, but did not differ significantly.

Trial 3

Mean weights of OCWP recovered from stomach compartments are given in Table 1, which shows that OCWP are retained in all compartments for at least 3 months.

TABLE 1

Mean weight ± sd of oxidised copper wire particles (g) recovered from the stomach of cows from an orally administered dose of 50g in Trial 3

Time after administration (months)	Rumen	Reticulum	Omasum	Abomasum	Total
1	5.74 ± 7.93	5.53 ± 5.16	1.19 ± 1.63	7.79 ± 4.92	20.24 ± 12.12
2	4.61 ± 1.12	5.63 ± 3.53	0.69 ± 0.37	2.74 ± 3.42	13.66 ± 6.33
3	0.79 ± 0.75	1.24 ± 1.14	0.12 ± 0.20	1.87 ± 1.85	4.02 ± 2.14

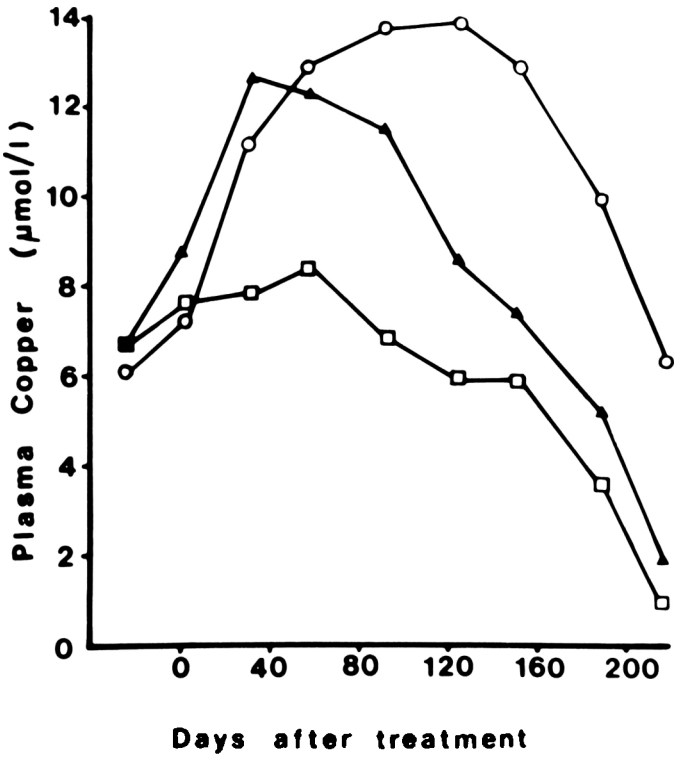
Much of the OCWP had lost its oxide coat, exposing the wire core. This was more noticeable in the abomasum than in the other stomach compartments, although there appeared to be a reduction in diameter of particles in all stomachs; that is, there was no coating with calcium phosphate, such as is commonly deposited on cobalt bullets in the reticulo-rumen. There was no significant difference between the control groups and the OCWP treated group in their muscle (range 0.07-0.1 mmol/kg) or kidney (range 0.36-0.44 mmol/kg) copper concentration.

Liver copper concentrations in OCWP treated animals were significantly higher than in the control animals ($p<0.01$; Table 2).

TABLE 2
Mean copper concentration ± sd (mmol/kg dry weight) in liver from cows at times after the administration of 50g oxidised copper wire particles (OCWP) in Trial 3

Time after administration (months)	OCWP treated	Control
1	6.04 ± 1.56	2.16 ± 1.31
2	4.11 ± 1.20	1.71 ± 0.96
3	5.80 ± 1.76	1.23 ± 0.06

Figure 2. Effects of a single dose of 50g oxidised copper wire particles and 120mg copper glycinate on plasma copper concentrations in lactating dairy cows. Treatmens were administered on 6 June 1979; trial 4, farm C. □, control; ○, oxidised copper wire; ▲ copper glycinate.



Trial 4

Plasma copper levels given in Figure 3 indicate an apparent "copper adequate" status of cows on farm D despite the fact that cows on both properties used in Trial 4 have been used in the past for copper studies and low plasma concentrations noted. The owners routinely inject cows with glycinate and had applied superphosphate plus copper to pastures, which could explain the copper adequate status noted at the commencement of observations on farm D. After 200 days, cows treated with OCWP had a significantly higher plasma copper concentration ($p<0.01$) than animals receiving the other 2 treatments (Figures 2 and 3). These differences were still evident, although not statistically different, in the lactation following the trial.

There was no statistically significant effect of treatments on milk production or copper concentration (range 1.1 to 2.6 mmol/l). Butterfat analysis of milk samples indicated that the variation with time (23.1 to 13.6 kg/month) was greater than the variation due to treatments (maximum difference 3.7 kg/month). However, butterfat production was significantly related to plasma copper concentrations on farm D for the months of November and January, which correspond with the final 2 data points on Figures 2 and 3.

Figure 3. Effects of a single dose of 50g oxidised copper wire particles and 120mg copper glycinate on plasma copper concentrations in lactating dairy cows. Treatments were administered on 15 June 1979; trial 4, farm D. □, control; ○, oxidised copper wire; ▲, copper glycinate.

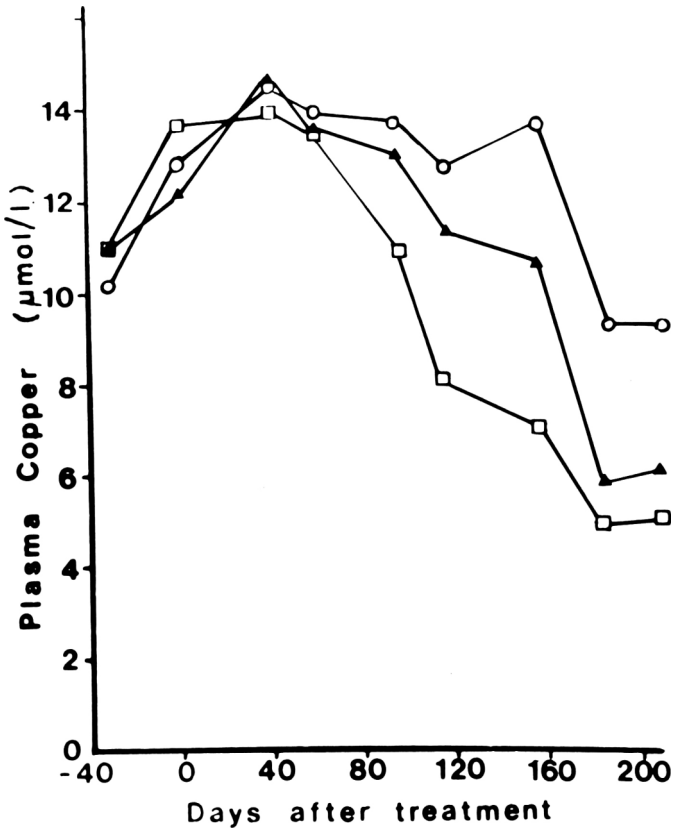


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TABLE 3
Oxidised copper wire particles (OCWP) recovered from stomachs of cows given capsules of OCWP and slaughtered 4 weeks later in Trial 5

Cow No.	Dose of OCWP (g)	Rumen (g)	Reticulum (g)	Omasum (g)	Abomasum (g)	Total recovered (g)
1	100	7.9	16.2	0.4	20.5	45.0
2	100	2.4	8.4	0.1	23.5	34.4
3	200	3.9	4.4	0.1	2.9	11.3
4	200	9.7	12.5	19.4	91.1	132.7
5	300	45.6	60.6	8.7	15.1	130.0
6	300	3.6	2.6	0.1	120.6	126.9

Trial 5

Results presented in Table 3 indicate that OCWP were distributed between all 4 stomach compartments and that this distribution was not the same in all cattle. Cows given large doses (300g) did not exhibit any toxicity symptoms despite high (16.0 mmol/kg) liver concentrations of copper. There was no evidence of higher concentrations of copper in muscle, but kidney concentrations were higher than those noted in Trial 3 (mean 0.38 *vs* 0.51 mmol/kg; $p<0.01$). However, as the 2 trials involved different animals and different times, they are not directly comparable.

TABLE 4
Tissue copper concentration (mmol/kg dry weight) of cows given capsules of oxidised copper wire particles and slaughtered 4 weeks later in Trial 5

Cow No.	Dose (g)	Kidney	Muscle	Liver
1	100	0.40	0.09	16.0
2	100	0.49	0.08	12.7
3	200	—	0.07	10.8
4	200	0.64	0.08	13.7
5	300	0.51	0.08	11.7
6	300	0.54	0.08	15.0

Discussion

Copper application to pastures has become a very expensive method of overcoming hypocuprosis and many farmers seek safe, direct methods of supplementation as an alternative. For long term therapy for copper deficiency, dairy cattle can be effectively treated with widely spaced doses of OCWP as an alternative to frequently repeated injections of copper glycinate, which are present normal practice and cause stress on the cattle.

The recovery of OCWP from all 4 stomachs of cattle 3 months after dosing is consistent with results of Costigan and Ellis (1980) and Suttle (1981), who concluded that copper oxide particles were retained in the gut of cattle for over 100 days. The results also show that much larger doses (300g OCWP) can result in high liver concentration of copper without clinical effects on the animal or accumulation of copper in muscle.

Acknowledgments

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