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Zinc sulphate in the drinking water of lactating dairy cows for facial eczema control

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ABSTRACT

Zinc sulphate (0.35 g Zn/litre) in the drinking water of lactating dairy cows prevented the effects of both a mild natural spore challenge and the subsequent severe challenge of dosed sporidesmin. The changes recorded (serum gamma glutamyl transferase, liver and urinary bladder injury score, daily milk production and clinical and live weight changes) in the unprotected control group indicate considerable toxic injury whereas the changes in the group receiving zinc in drinking water were minimal indicating excellent protection.

Water consumption records for the 2 groups did not indicate that the zinc treated water was substantially discriminated against.

Keywords Zinc; prevention; prophylaxis; sporidesmin; facial eczema; drinking water; milk; calcium; *Pithomyces chartarum*

INTRODUCTION

Recent Ruakura research has endeavoured to establish convenient, effective and safe forms of zinc administration to ruminants for facial eczema control (Towers, 1977; Smith *et al.*, 1977; Towers and Smith, 1978; Smith, 1981).

Zinc sulphate in drinking water has long been considered as a convenient method of facial eczema control. However daily intakes of drinking water vary from animal to animal (Wright *et al.*, 1978) and from day to day, especially when influenced by rainfall (Wright *et al.*, 1978; Smith, 1980). It has been suggested that the downturn in drinking water and hence zinc consumption which follows rain may be compensated for by temporarily increasing the concentration of zinc in the water. Unfortunately the concentrations necessary to prevent facial eczema border on the unpalatable and it was suggested (Smith, 1980) that in addition to decreasing the safety margin, the unpalatability of drinking water may affect water consumption and perhaps milk production. It was also thought that zinc needed to be given at the time of exposure to sporidesmin. However it has recently been shown (N. R. Towers, unpublished) that long term zinc administration results in excellent protection and that intermittent zinc administration can maintain protection from facial eczema in the field.

These latter findings removed the main objections to the drinking water method of zinc administration. This experiment examines its effectiveness for facial eczema control.

MATERIALS AND METHODS

Twelve sets of identical-twin lactating dairy cows of mixed breed and age were split into 2 groups and rotated about 9 paddocks which had, where possible, been topped to increase spore numbers. Trap spore counts and wash counts were performed on all paddocks. Each paddock was halved by an electric fence and in each half either water alone or water containing 0.35 g Zn (as ZnSO₄.7H₂O/litre) was offered to the appropriate group of cows. Water consumptions were measured daily. The plain water was supplied by metered water reticulation and the zinc treated water was measured as a prepared solution from a trailer-borne stainless steel vat into sledge-mounted troughs. The cow groups and their treatments were rotated about the paddocks, the high spore count paddocks being preferentially grazed. The zinc treatment was offered before spore or sporidesmin challenge as indicated in Fig. 1. Because the initial spore challenge was not severe enough, a second challenge was provided by intraruminally administering 0.3 mg sporidesmin/kg body weight as pre-alumina sporidesmin (Smith *et al.*, 1977) equally divided over 3 days.

The cows were bled, weighed and had milk production recorded weekly. At the conclusion of the experiment, 36 days after the experimental sporidesmin challenge, the cows were slaughtered. Livers were scored for facial eczema injury on a 0 to 5 scale of severity and urinary bladders likewise on a 0 to 5 scale.

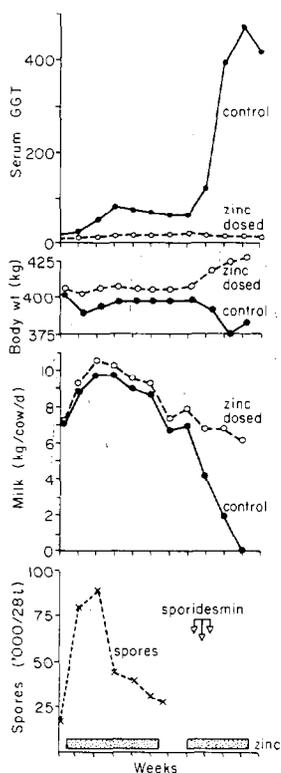


FIG. 1 Time of spore and sporidesmin challenge in relation to the time of administration of zinc sulphate via drinking water together with the effect of the zinc on serum gamma glutamyl transferase, body weight and milk production.

RESULTS

The administration of zinc sulphate via drinking water to cows which were challenged, first with exposure to moderately elevated pasture *P. chartarum* spore numbers and later with a high dose of sporidesmin, achieved almost total protection (Fig. 1, Table 1). The response of the control cows to the experimental dosing with sporidesmin showed that this was a severe challenge and indicated that good protection was afforded by zinc in drinking water.

Water intakes were similar for both groups (Fig. 2) and showed fluctuations throughout the trial with higher intakes being recorded in the first half of the trial. Zinc intakes calculated from the mean cow body weights and water intakes varied between approximately 15 and 30 mg Zn/kg/d. Mean water consumption appeared to decline in the control herd about 5 days after the commencement of sporidesmin dosing and in the zinc treated herd after the occasional rain during the experiment.

Serum calcium concentrations, determined at days 14 and 27 of the trial (when water and hence zinc

consumption was greatest) were similar in both control and zinc treated groups (Table 1). Organ zinc concentrations, 3 weeks after zinc administration ceased were not higher in the zinc treated group. However, throughout the trial period milk zinc concentrations were higher ($P < 0.01$) (Table 1) in the zinc group.

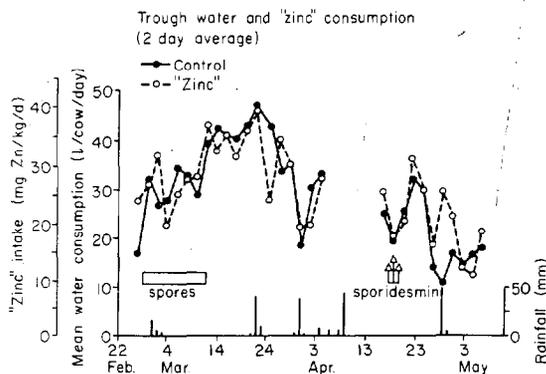


FIG. 2 Mean group water consumptions and calculated zinc intakes based on mean group live weights.

TABLE 1 Effect of zinc in drinking water on facial eczema liver and urinary bladder injury, serum calcium and organ and milk zinc concentrations (\pm S.D.).

Group	Control	Zinc
Liver injury		
number ¹	11	1
mean score ²	3.08	0.04
Bladder injury		
number ¹	5	0
mean score ²	1.1	0
Serum calcium (mg/l)		
d ³ 14	100 \pm 5.2	101 \pm 2.4
d 27	103 \pm 4.3	103 \pm 5.2
Organ zinc (μ g/g) ⁴		
liver	47.1 \pm 19.8	47.4 \pm 13.9
pancreas	41.5 \pm 14.6	47.1 \pm 12.5
kidney	18.2 \pm 3.1	19.2 \pm 3.1
Milk zinc (μ g/ml)		
d 5	3.77 \pm 0.71	5.38 \pm 1.29
d 26	3.58 \pm 0.74	5.43 \pm 1.09

¹ n = 12.

² Both scores maximum 5.

³ d = days after start of zinc.

⁴ 21 days after zinc treatment.

DISCUSSION

The pattern of sporidesmin challenge, i.e., a small challenge followed by a major challenge, which

occurred in this experiment is typical of that which happens in many natural outbreaks of facial eczema and is typical of the pattern of challenge used in potentiation experiments (P. H. Mortimer, pers. comm.). Despite the obviously severe challenge and reaction the concentration of zinc in drinking water has caused virtually complete protection.

It must be realised that only 1 concentration of zinc in drinking water was used in this experiment and therefore neither an optimal minimal concentration of zinc in water for protection nor an accurate measure of the safety margin can be given. However, Smith (1980) showed that pancreatic lesions occurred after 9 weeks exposure to 1.0 g Zn/litre but not 0.5 g Zn/litre. Therefore the safety margin for the concentration of zinc used in this experiment is probably at least 2 or 3 fold but may be more if the minimal effective concentration is less than 0.35 g Zn/litre. There was no major palatability effect in the present experiment but there was a reduction in water consumption at 0.5 g Zn/litre especially in the first few weeks after introduction of the zinc to the drinking water (Smith, 1980). There were 10 days when greater than 5 mm rain fell and a total of 240 mm fell during the 10 weeks of zinc administration. There were 2 long rainless periods and a total of 53 rainless days. Therefore large reductions in water and hence zinc consumption due to rain (Smith, 1980; Wright *et al.*, 1978) were not very great. Concern over the effect of such reductions on the effectiveness of zinc in preventing facial eczema have not been allayed.

Two other areas of concern regarding the use of zinc, its effect on calcium metabolism and the possi-

bility of zinc residues in offal organs have not arisen in this experiment. Three weeks elapsed between the end of zinc dosing and the slaughter of the cows. Although milk zinc concentrations were higher in the zinc group the elevation is not considered to be significant to the dairy industry.

Further experiments are planned with lactating dairy cows to determine a minimal effective concentration of zinc in drinking water and to obtain an estimate of the margin of safety for this method of use.

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