# EVALUATION OF A SUSTAINED RELEASE BOLUS TO SUPPLY TRACE ELEMENTS AND VITAMINS TO BEEF CATTLE

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## SUMMARY

An intraruminal bolus containing copper, cobalt, selenium, manganese, zinc, iodine, sulphur, vitamin A, vitamin D3 and vitamin E was evaluated in young steers on one farm and steers and heifers on another farm. When given at the recommended dose of two boluses per animal a significant liveweight response was recorded in steers on both farms but not in the heifers.

The bolus treatment raised blood selenium concentrations in cattle on both farms and plasma copper concentrations in cattle on one farm. A transient increase in plasma vitamin $B_{12}$ concentrations was observed in cattle on one farm but plasma zinc concentrations were unaffected by treatment on both farms. The effective life of the supplement in providing additional copper and selenium was shown to be at least 43 weeks in steers on one farm.

*Keywords*: cattle, selenium, copper, vitamin $B_{12}$, rumen bolus

## INTRODUCTION

Trace element deficiencies reported to endanger health and productivity of the grazing ruminant in southern Australia include those of selenium, copper and cobalt (vitamin $B_{12}$). A survey of over 9,000 cattle slaughtered in South Australia in 1989-90 indicated that 22% were at risk of selenium deficiency, 19% of copper deficiency and 6% of cobalt deficiency (Koh *et al*. 1993).

Supplements suitable for administration to livestock for long-term correction and prevention of trace element deficiencies include intraruminal pellets containing cobalt or selenium and oral doses of copper oxide particles. Recently a sustained-release bolus containing trace elements and vitamins ('All-Trace', Young's Animal Health Pty. Ltd., Victoria) was released onto the Australian market for use in cattle weighing more than a 150 kg. When given at the recommended dose of two boluses per animal, it is claimed that the boluses will provide daily 2 mg selenium, 2 mg cobalt, 138 mg copper, 113 mg zinc, 71 mg manganese, 2.1 mg iodine, 4644 IU vitamin A, 929 IU vitamin D and 9 IU vitamin E over a period of 8 months (Allan *et al*. 1993). Studies with cattle have shown that the boluses raised the activity of the selenium-containing enzyme glutathione peroxidase in blood for about 11 months (Allan *et al*. 1993) and plasma copper concentrations for about 5 months (Parkins *et al*. 1994).

The present study was undertaken to assess the effectiveness of the bolus in providing trace nutrients to cattle at pasture.

## MATERIALS AND METHODS

Experiments were conducted on two farms, one on Kangaroo Island (farm KI) and the other on irrigated river flats in the Murray lakes region (farm ML) of South Australia. Cattle used in the experiments were 2-3 month old heifers and steers on farm KI and 8 month old steers on farm ML. On each farm, animals were paired within gender by liveweight and one from each pair was allocated at random to one of two treatment groups. The treatment groups were: control - no trace element supplements, and bolus - two 'All-Trace' boluses given orally to each animal. The boluses were administered to steers at the start of the experiment on farm ML (week 0, December 1995) but this treatment was delayed on farm KI until week 10 of the experiment (September 1995) when cattle weights were above 150 kg. At week 0 on farm KI the cattle assigned to the bolus group were each given a subcutaneous injection of 4 mg vitamin $B_{12}$ and an oral dose of 10 mg selenium as sodium selenite, treatments usually recommended for young cattle in this area at risk to cobalt and selenium deficiency.

On each farm the experimental cattle were run as one mob. The number of animals per treatment group were 9 steers and 9 heifers on farm KI and 24 steers on farm ML. Cattle were weighed on four occasions during the experimental period of 27 weeks on farm KI and on five occasions during the period of 43 weeks on farm ML. At the time of weighing, blood samples for trace element and vitamin assay were collected into heparinised tubes ('Vacutainer' Ref. 367735, Becton Dickson) from 5 to 10 animals in each experimental group. On some occasions faecal samples were collected for trace element assay at time of weighing. Analytical techniques were as described by Cavanagh and Judson (1994) and Judson *et al*. (1995).

Statistical analyses of the liveweight data were performed using GENSTAT 5.1 (Rothamsted Experimental Station, UK). The results were subjected to a split-plot analysis with time as the split plot. The main plots were cattle x treatment (farm ML) and sex x cattle x treatment (farm KI) and the respective subplots were cattle x treatment x time, and sex x cattle x treatment x time. Other statistical analyses were performed by analysis of variance using the Statistix 4.1 program (Analytical Software, Tallahassee, USA). Plasma vitamin $B_{12}$ concentrations were subjected to $\log_{10}$ transformation to standardise variances before statistical evaluation. Differences between means were tested using the l.s.d. procedure when a test of means was significant.

## RESULTS AND DISCUSSION

Statistical analyses of the liveweight data indicated a significant treatment by time interaction ($P < 0.001$) in the steers on farm ML and a significant sex by treatment by time interaction ($P < 0.01$) in the herd on farm KI (Table 1). On farm KI the liveweight response to treatment occurred in the steers but not in the heifers. Shallow *et al*. (1989) reported a sex-related response in liveweight of prime lambs to cobalt, with wethers responding but not ewes and Nelson and Miller (1987) also reported that steers but not heifers showed a significant liveweight response to selenium supplementation. It is likely that the liveweight response in steers on farm KI was due to the bolus treatment at week 10 and not to the vitamin $B_{12}$ and selenium treatments at week 0 because the liveweight response did not occur until week 18 of the experiment.

Mean plasma vitamin $B_{12}$ concentration was only raised by treatment at the first sampling after the boluses were given to cattle on farm ML (Table 2). This result is not unexpected as other studies with cattle have shown little or no response in plasma vitamin $B_{12}$ concentrations to cobalt pellet therapy (Judson *et al*. 1997). The administration of the boluses significantly raised the mean plasma copper concentration above the mean value of the untreated cattle for the duration of the experiment on farm ML but not on farm KI (Table 2). Mean blood selenium concentration was raised in cattle on both farms by bolus treatment and the raised values were maintained for the duration of the experiment on each farm (Table 2). Mean plasma zinc concentrations were unaffected by treatment ($P > 0.05$) although there was an indication from the faecal results (Table 3) that the bolus was releasing zinc (farm ML) and other trace elements at 17 (week 27, farm KI) and 34 weeks (farm ML) but not at 43 weeks after bolus treatment.

The trace nutrient or nutrients limiting the growth rate of steers were not identified. From a summary of the blood constituents given in Table 2 it appears that untreated steers may have been at risk of selenium and/or cobalt deficiency on both farms and also of copper deficiency on farm ML. The present work shows that the boluses when given at the recommended dose to cattle were effective for at least 43 weeks in providing physiological quantities of copper and selenium to cattle at pasture.

**Table 1. Effect of treatment on the mean liveweight (kg) of cattle**

| Farm and treatment groups | Sex | Week of experiment[A]: 0 | 8 (10) | 22 (18) | 34 (27) | 43 |
|---|---|---|---|---|---|---|
| Farm KI[B] | | | | | | |
| Control | M | 113 | 186 | 260 | 301 | |
| | F | 109 | 182 | 245 | 291 | |
| Bolus | M | 113 | 200 | 284 | 344 | |
| | F | 107 | 180 | 249 | 291 | |
| Farm ML[B] | | | | | | |
| Control | M | 272 | 317 | 380 | 406 | 484 |
| Bolus | M | 267 | 315 | 378 | 412 | 497 |

[A] When two weeks are given, the week in parentheses refers to Farm KI. Boluses were given to cattle at weeks 10 (farm KI) and 0 (farm ML).

[B] The s.e.d. of means are 7.417 (n=9) and 5.232 (n=24) for farms KI and ML respectively.

**Table 2. Analyses of variance of mean concentrations[A] of blood selenium (µmol/L), plasma copper and zinc (µmol/L) and plasma vitamin $B_{12}$ (pmol/L) in cattle given different treatments**

| Farm and treatment groups | Sex | Week of experiment[B] 0 | 8 (10) | 22 (18) | 34 (27) | 43 |
|---|---|---|---|---|---|---|
| *Plasma copper (normal > 8)*[D] | | | | | | |
| Farm KI | | | | | | |
| Control | M | 13.0±2.1 | 11.6±1.4 | 11.8±0.8 | 9.8±0.6 | |
| | F | 13.3±1.1 | 10.1±2.7 | 12.5±1.8 | 11.2±1.5 | |
| Bolus | M | 13.5±2.1 | 12.9±1.5 | 12.6±0.5 | 11.0±0.8 | |
| | F | 14.7±2.8 | 12.2±1.6 | 12.4±1.2 | 11.7±1.8 | |
| | | ns | ns | ns | ns | |
| Farm ML | | | | | | |
| Control | M | 9.7±2.4 | 8.5±2.3 | 8.3±1.7 | 8.4±1.4 | 7.9±2.0 |
| Bolus | M | 9.9±1.9 | 11.1±0.8 | 11.5±0.7 | 13.2±1.4 | 12.2±0.9 |
| | | ns | ** | *** | *** | *** |
| *Log plasma vitamin $B_{12}$ (normal > 1.74)*[E] | | | | | | |
| Farm KI | | | | | | |
| Control | M | 1.90±0.08 | 1.55±0.10 | 1.98±0.30 | 2.03±0.34 | |
| | F | 1.78±0.19 | 1.63±0.23 | 2.17±0.07 | 2.19±0.13 | |
| Bolus | M | 1.84±0.10 | 1.60±0.17 | 2.28±0.10 | 2.09±0.16 | |
| | F | 1.88±0.10 | 1.76±0.22 | 2.21±0.10 | 2.33±0.18 | |
| | | ns | ns | ns | ns | |
| Farm ML | | | | | | |
| Control | M | 1.54±0.15 | 1.57±0.20 | 1.77±0.22 | 1.62±0.31 | 1.48±0.00 |
| Bolus | M | 1.54±0.15 | 1.81±0.14 | 1.81±0.14 | 1.57±0.19 | 1.48±0.00 |
| | | ns | ** | ns | ns | ns |
| *Blood selenium*[C] *(normal > 0.25)*[D] | | | | | | |
| Farm KI | | | | | | |
| Control | M | 0.29±0.05 | 0.10±0.04 | 0.18±0.04[a] | 0.22±0.05[a] | |
| | F | 0.43±0.17 | 0.13±0.05 | 0.24±0.04[a] | 0.24±0.04[a] | |
| Bolus | M | 0.32±0.04 | 0.14±0.03 | 1.90±0.21[b] | 2.18±0.17[b] | |
| | F | 0.38±0.05 | 0.14±0.06 | 1.85±0.23[b] | 1.91±0.49[b] | |
| | | ns | ns | *** | *** | |
| Farm ML | | | | | | |
| Control | M | 0.26 (2) | 0.16±0.04 | 0.16±0.03 | 0.15±0.02 | 0.12±0.02 |
| Bolus | M | 0.32 (2) | 1.81±0.26 | 1.58±0.33 | 0.87±0.34 | 0.47±0.15 |
| | | ns | *** | *** | *** | *** |
| *Plasma zinc (normal > 9)*[D] | | | | | | |
| Farm KI | | | | | | |
| Control | M | | 16.1±2.0 | | 12.4±0.9 | |
| | F | | 16.6±3.0 | | 12.8±1.6 | |
| Bolus | M | | 14.5±1.6 | | 11.5±3.3 | |
| | F | | 17.8±2.0 | | 14.1±1.5 | |
| | | | ns | | ns | |
| Farm ML | | | | | | |
| Control | M | | 14.1±1.7 | 12.2±1.7 | 13.4±1.2 | 13.1±0.9 |
| Bolus | M | | 14.7±1.9 | 12.1±1.6 | 12.3±1.6 | 12.5±1.2 |
| | | | ns | ns | ns | ns |

[A] Mean values with their s.d. are for 3-5 (farm KI) or for 8-10 (farm ML) animals.
ns not significant; * P < 0.05; ** P < 0.01; *** P< 0.001.

[B] When two weeks are given, the week in parentheses refers to farm KI. Boluses were given to cattle at 10 weeks (farm KI) and 0 weeks (farm ML).

[C] Within columns, values followed by different superscripts are significantly different (P < 0.05).

[D] Judson *et al.* (1987).

[E] Mills (1981).

**Table 3. Mean and range in trace element concentrations (mg/kg dry matter) in faeces from heifers on farm KI and steers on farm ML given different treatments**

| Farm and treatment groups | Week of expt. | Cobalt | Copper | Manganese | Zinc |
|---|---|---|---|---|---|
| Farm KI | | | | | |
| Control (n=5) | 27 | - | 10, 10-12 | 181, 156-206 | 46, 35-67 |
| Bolus (n=4) | 27 | - | 23, 10-42 | 209, 192-242 | 53, 42-67 |
| Farm ML | | | | | |
| Control (n=4) | 34 | 0.08, 0.06-0.09 | 10, 10-11 | 160, 138-153 | 41, 37-48 |
| Bolus (n=5) | 34 | 0.10, 0.06-0.17 | 13, 11-15 | 171, 154-184 | 66, 42-87 |
| Control (n=4) | 43 | 0.21, 0.13-0.29 | 22, 16-24 | 238, 166-280 | 66, 41-78 |
| Bolus (n=5) | 43 | 0.20, 0.10-0.34 | 23, 19-33 | 197, 157-239 | 62, 47-84 |

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