Topical Administration of Trace Elements and Vitamins in Cattle

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The ease with which iodine passes through the skin of cattle has long been recognised. We have now shown that selenium and vitamin E can also cross cattle skin in sufficient quantities to significantly increase concentrations in the peripheral circulation.

Twenty-four non-lactating New Zealand Friesian dairy cows were used in a study to examine the effect of topical administration of selenium on serum selenium concentrations. The cows were kept on pasture with a low selenium content (0.03 ppm Se, DM basis). The cows were randomly allocated to 4 groups of 6 animals. Three groups were treated with one of three selenium pour-on formulations and one group was left untreated. Blood samples were drawn prior to treatment and then 12 times over a period of 58 days. Serum concentrations of selenium following treatment are presented in Figure 1. All three formulations (groups A, B and C) resulted in significantly increased serum selenium concentrations when compared to control values (group D), with the group A formulation being clearly superior in absorbtion. This formulation resulted in significantly elevated serum selenium concentrations for the entire length of the experiment, providing meaningful selenium supplementation to this group. We conclude that a single topical application of selenium can increase serum concentrations of selenium for at least 58 days.

In a further experiment, thirty non-lactating Friesian cows were used to examine the effects of topical vitamin E on serum and liver concentrations of α-tocopherol. The cows were fed only pasture hay (< 20 mg/kg DM α-tocopherol) for 6 weeks prior to the experiment and during the experiment. The cows were randomly allocated to five groups of six animals. Four groups were treated with one of four vitamin E pour-on formulations.

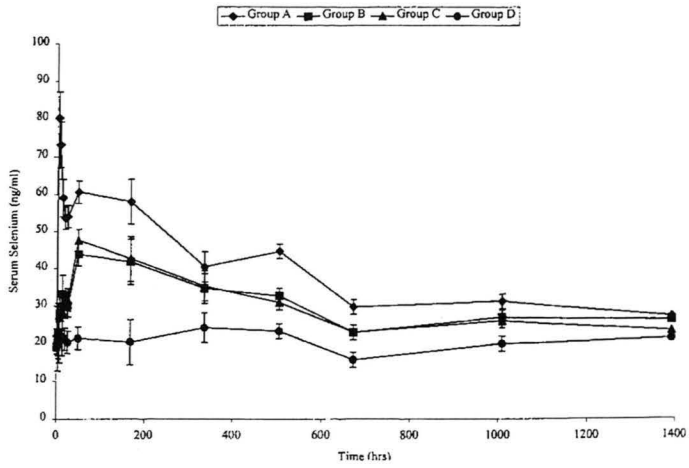

Figure 1. Least square means of serum selenium from Friesian cows dosed with 1 of 3 selenium pour-on formulations and untreated control group D graphed against time (hrs).

The fifth group was left untreated. Blood samples were obtained prior to treatment and again at 2, 6, 14 and 20 days post treatment. Liver samples were obtained by percutaneous biopsy from three animals in each group prior to treatment on day 0 and again on days 6 and 20. Serum and liver concentrations of α-tocopherol are presented in Tables 1 and 2 respectively. The group C formulation resulted in significantly increased serum α-tocopherol concentrations when compared to control group D at 2 and 6 days post treatment. The group A formulation also showed a significant increase over the control group at 6 days post treatment. We conclude that topically applied α-tocopherol can enter the systemic circulation and increase serum α-tocopherol levels.

Table 1. LSM for serum α-tocopherol (mg/l) for cows treated topically with 1 of 4 formulations of vitamin E, and untreated control group D. LSM are adjusted for serum α-tocopherol concentration on day 0.

	Group A	Group B	Group C	Group D	Group E	Pooled SE
Day 2	2.18	2.29	2.56 *	2.24	2.24	0.11
Day 6	3.07 *	2.41	2.95 *	2.19	2.63	0.17
Day 14	2.02	1.84	2.03	1.99	1.76	0.11
Day 20	1.99	1.99	2.08	2.13	1.81	0.11

* = Statistically different from respective value for control group D ($P<0.05$).

Table 2. Least square means for hepatic α-tocopherol concentration (mg/kg) for cows treated topically with 1 of 4 formulations of vitamin E, and untreated cows (group D). LSMs are adjusted for hepatic concentration of α-tocopherol on day 0.

	Group A	Group B	Group C	Group D	Group E
Day 6	19.1±3.4	14.3±3.1	19.3±2.7	13.6±3.2	12.6±2.8
Day 20	14.1±4.9	9.9±3.7	7.8±4.3	13.9±3.2	12.1±2.4

There are a number of factors which could influence the efficacy of topical formulations. These include rainfall (timing and amount), ambient temperature and condition of the skin. In these studies, ambient temperatures ranged from 5- 15° C and significant rainfall did not occur during the first 48 hours following administration. Future research should examine the effects of these variables on absorbtion.

A significant increase in the serum concentration of the applied nutrient confirms that absorbtion has taken place. To be useful, the formulation must provide meaningful supplementation which will prevent clinical and subclinical deficiency. In the case of the selenium formulations, the group A formulation provided sufficient selenium to maintain cows above deficient status for at least 3 weeks. Deficiency is reflected by serum selenium concentrations < 40 ng/ml (Gerloff, 1992). The amount of selenium applied may need to be varied depending on the amount of selenium obtained from their basal diet.

Only modest increases in the vitamin E status of the treated cows were observed in this study and treated cattle remained in the range considered marginal (< 4 mg/l; Olsen, 1994). Further modifications of the formulations and an increase in the amount of α-tocopherol applied may enhance the magnitude and duration of the increase in serum α-tocopherol concentrations.

Pour-on formulations provide a convenient route for administration of drugs and nutrients in situations where they cannot be incorporated in the ration. Further development of this technology could allow inclusion of a number of micronutrients in pour-on formulations, alone or in combination with selected parasiticides.

Acknowledgment

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References

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