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EVALUATION OF A LONG-ACTING SELENIUM AND COPPER PREPARATION FOR INTRARUMINAL ADMINISTRATION TO CATTLE

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Selenium (Se) deficiency is a widespread problem in the livestock industry, in particular, it can cause nutritional muscular dystrophy (NMD) in young ruminants (Nelson et al 1964). Various methods have been used to increase Se intake including adding Se to mineral mixture (Jenkins et al 1973), oral or intramuscular Se dosing (Hidiroglou et al 1969), and Se-implantation utilizing slow-release Se pellets (Hidiroglou et al 1972). Advantages and disadvantages of these techniques have been reviewed (MacPherson and Chalmers 1984, Allen and Mallinson 1984). A potentially practicable method for improving the Se status of ruminant animals under pasture conditions is the use of selenium soluble glass boluses (SGB) (Hidiroglou et al 1987). Earlier studies (Ho et al 1980) showed that beef cattle raised in Northern Ontario and fed grass silage during the winter had low copper status. Consequently, because the SGB is also impregnated with copper (Cu) (Calamari et al 1985), both the Se and Cu status of calves born from SGB-administered or not administered was investigated. Two experiments were carried out in successive years at the Kapuskasing Experimental Farm (Northern Ontario), by winter feeding cattle with roughage, low in Se and Cu.

Materials and Methods

Experiment 1

Twelve crossbred pregnant beef cows were divided into two groups (1-control and 2-SGB-treated) of six. Each cow in group 2 was administered intraruminally by balling gun, two 120 g soluble glass boluses coated with 0.31 % Se and 13.7 % Cu obtained from Pilkington, Latham, Ormkirk, UK. Cows of both groups shared the same barns and pasture, and received the same management during the trial. The roughage fed during the winter was a mixture of grasses with timothy as the dominant species. During the experiment, all animals had free access to water and a mineral mixture containing 65 % cobaltized-iodized salt and 35 % dicalcium phosphate. The animals were released to pasture at the end of May. The blood Se status of cows was monitored by collecting samples at the beginning of the trial and then at various intervals (table 1). Blood samples were drawn from the jugular vein and a part of each sample centrifuged at 3 000 x g. The rest of the blood samples and plasma were stored at - 20 °C for analysis.

Milk samples were collected twice during the indoor season (April and May) and also while the cows were on pasture (July and October). Cows were milked by hand to give a sample of about 150 ml for laboratory analysis.

Résumé

ÉVALUATION D'UNE PRÉPARATION RETARD DE CUIVRE ET DE SÉLÉNIUM EN VUE D'UNE ADMINISTRATION INTRARUMINALE CHEZ LES BOVINS. - Un bolus intra-ruminal en verre soluble contenant du sélénium et du cuivre a été utilisé pour améliorer l'état nutritionnel en sélénium et cuivre chez les vaches gestantes, et chez leurs veaux. Chez les vaches, il y a une nette amélioration de l'état nutritionnel en sélénium après le traitement par le bolus en verre soluble. Chez les vaches non traitées, la concentration en sélénium dans le sang (27-31 ng/g) aussi bien que dans le lait (5,1-6,8 ng/ml) reste faible ce qui montre une déficience en sélénium. Chez les vaches traitées, l’administration du bolus en verre soluble produit des concentrations en sélénium plus élevées, qui augmentent au cours de la période expérimentale (10 mois). Chez les veaux nés de vaches traitées avec le bolus, les concentrations plasmatiques en sélénium (11-28 ng/ml) et en cuivre (0,43-0,83 µg/ml) sont plus élevées (sauf à la naissance pour le cuivre) que chez les veaux provenant de vaches non traitées. Malgré ces différences, les quantités de sélénium et de cuivre dans le plasma des veaux nés de vaches traitées est encore faible.
Experiment 2

Blood samples were collected at birth and various times thereafter (table 3) from two groups of calves that were born either from non-treated (control) (22) or SGB-treated (23) beef cows. In the treated group, each cow had been administered 2 months before parturition intraruminally with two 120 g SGB (Se and Cu coated). The management and feeding of the cows were similar to those of Experiment 1. A part of each blood sample was centrifuged at 3000 x g and the plasma and remainder of blood samples were stored at - 20 °C for Cu and Se analysis, respectively.

Chemical analyses

Se concentration in the blood, milk and feed was measured by the method of Hoffman et al (1968). Cu concentration in blood plasma and feed was determined by atomic absorption spectrophotometer (Model 460), Perkin-Elmer Corp, Norwalk, Conn) following wet digestion (Hoffman et al 1968). A method described by Khan et al (1979) was used to determine molybdenum in the feed. Sulfur was determined by the AOAC magnesium nitrate method for plants (1965).

Statistical analyses

The blood and milk data were analyzed statistically by conventional least squares procedures. The linear models procedure of Statistical Analysis Systems(1979) was used.

Results

Mineral content of the rations

Analysis of the rations showed that the composite monthly samples were inadequate in Se (< 0.1 μg/g dry matter), Cu (4.5 to 5 μg/g DM), Mo (0.7 to 1.2 μg/g DM), but adequate in S (0.2-0.3 %).

Experiment 1: Effects of SGB dosing on Se concentration in blood and milk of cows.

The data on whole blood Se concentration are given in table 1. At the beginning of the experiment, all cows were in a low Se status. In the SGB-treated group, blood Se increased during the experimental period, reaching an average value of 120 ng/g by the end of the experimental period (10 months) while that in control group remained unchanged.

Milk Se concentrations were higher in the SGB-treated cows than in untreated cows (P < 0.01) (table 2). In the SGB-treated cows, the milk Se concentrations increased progressively with highest Se concentration occurring at the end of the pasture season. Se milk concentration in con-

| Table 1. – Experiment 1. Whole blood Se concentration (ng/g ± SD) in cattle administered intraruminally with two 120 g soluble glass boluses containing selenium (0.31 %) and copper (13.7 %) compared to controls. |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Cows           | January         | February        | March           | May             | July            | October         |
| Control        | 27 ± 3          | 27 ± 4          | 31 ± 3          | 26 ± 3          | 28 ± 4          | 29 ± 6          |
| Glass-boluses  | 26 ± 3          | 45 ± 6          | 47 ± 6          | 62 ± 17         | 81 ± 29         | 120 ± 24        |
| Significance (P)| NS              | < 0.01          | < 0.05          | < 0.01          | < 0.01          | < 0.01          |

NS : not significant.

| Table 2. – Experiment 1. Milk Se concentration (ng/ml fresh milk ± SD) of cattle administered intraruminally with two 120 g soluble glass boluses containing selenium (0.31 %) and copper (13.7 %) compared to controls. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Cows           | April           | May             | July            | October         |
| Control        | 5.33 ± 0.82     | 5.08 ± 1.41     | 5.67 ± 2.86     | 6.83 ± 0.41     |
| Glass-boluses  | 8.67 ± 2.73     | 8.50 ± 2.07     | 9.17 ± 2.23     | 12.33 ± 2.88    |
| Significance (P)| < 0.01         | < 0.01          | < 0.01          | < 0.01          |

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control cows remained relatively unchanged except for a slight increase at the end of the experiment.

**Experiment 2** : Se and Cu plasma response of calves born from SGB-treated cows.

The effects of the Se-treatment of cows on blood plasma Se of calves are shown in table 3. Mean blood plasma Se concentrations of calves born from the SGB-treated cows were higher (P < 0.05) than of those born from the control cows. The highest Se concentration in the blood plasma of the SGB-treated group occurred at birth, then declined drastically. In the calves born from the controls, blood plasma Se showed a decline from birth until four months, then there was a steady state, which is typical of low selenium status.

At birth and at one month of age, all calves were hypocupraemic (table 4). Only at 2 and 4 months of age did the calves born from the Cu-treated cows show normal blood plasma concentrations. The plasma copper levels from the SGB treated group were higher than those of the calves from the control, however, in terms of adequacy even these levels were low to marginal.

**Discussion**

The results indicate that the Se content of blood of beef cows and their calves were responsive to change in Se intake and indicate that the intraruminal administration of SGB coated with Se may be used to maintain an adequate Se status in cattle. Indeed, in the Se-deficient gestating cows, with less than 30 ng Se/g blood, Allen and Mallinson (1984) showed that the treatment with SGB gave rise to an adequate Se status at calving. In addition, plasma Se concentrations in the offsprings from Se-dosed cows may be sufficient to provide protection against NMD. Zervas (1985) reported that the SGB lodged in the reticulorumen released a satisfactory amount of Se in the rumen of goats over a one-year period. The concentration of Se in cow’s milk varied greatly with the intake of the animal. Binnerts (1979) reported that in « low-Se » herds of cows in the Netherlands, fresh milk contained 3-5 ng Se/g and in « high-Se » herds 6-11 ng Se/g. This may be one explanation for the higher Se concentrations in the blood plasma of calves born from SGB dosed cows in the present experiment.

The results of the second experiment showed that plasma Se and Cu levels in calves born from the SGB treated cows were higher than those from the control calves, although the increase in copper concentration was not sufficient to produce normal plasma Cu concentrations in the calves. Knott et al (1985) reported that the SGB treatment for cows gave higher blood Cu levels in the cows as well as their calves. According to Judson et al (1985), provision of Cu in glass bullets significantly raised the plasma Cu levels of hypocupremic cattle and...
maintained them in adequate Cu status for at least 32 weeks. Telfer et al (1984) found that the administration of SGB was an effective and simple method for preventing Cu, Co and Se deficiencies in cattle for at least a year. However, Gallagher and Cottrill (1985) reported that in hypocupraemic cattle in the UK, the use of soluble glass boluses produced normocupraemia for at least three months only, and by seven months, 67% of the SGB-treated cattle were hypocupraemic. The cattle used by Callagher and Cottrill (1985) as well as those used by us, were on a low copper and molybdenum diet. Recently, Koh and Judson (1987) reported that in cattle dosed with glass bolus, Se exerts an antagonistic effect on the availability of Cu from CuO as indicated by reduced Cu concentrations in blood and liver of cattle. According to Zervas (Ph D thesis, Leeds 1983), the effectiveness of glass boluses for the prevention of trace mineral deficiencies depends on their solubility in the rumen. It can be concluded from the present experiments that the administration of SGB impregnated with Cu to cows was not effective in alleviating copper deficiency of their offspring as judged by blood plasma Cu levels of the calves. As reported by Gallagher and Cottrill (1985), further development of the soluble glass boluses may be necessary if the full potential of this technique for the control of trace element deficiencies is to be realized.

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**Abstract**

An intraruminal, soluble glass bolus containing selenium (Se) and copper (Cu) was evaluated for improving the Se and Cu status of pregnant cows and their calves. In the cows, there was a marked increase in the Se status following treatment with the soluble glass bolus. In the untreated cows, Se concentration in the blood (27-31 ng/g) as well as milk (5.1-6.8 ng/ml) remained low which was indicative of Se-deficiency. In the treated cows, the soluble glass bolus administration produced higher blood and milk Se concentrations, which were increased during the whole experimental period (10 months). In calves born from soluble glass treated cows, blood Se (11-28 ng/ml) and Cu (0.43-0.82 ug/ml) concentrations were higher (except at birth for Cu) than in those from the untreated cows. Despite these differences, the status of the calves born from the treated cows was still low in both Se and Cu.

**References**


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