The Influence of Dietary Selenium as Selenium Yeast or Sodium Selenite on the Concentration of Selenium in the Milk of Suckler Cows and on the Selenium Status of Their Calves

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ABSTRACT: The aim of this trial was to determine whether the selenium status of suckling calves could be improved by supplementing their dams’ diet with organic Se instead of sodium selenite. A herd of 103 Hereford cows, which were on grass paddocks all year round, was divided into two groups. Both groups had free access to a mineral supplement that contained 30 mg of Se/kg; for one group the source of the Se was a Se yeast product, and for the other group the source was sodium selenite. The basal feed contained .02 mg of Se/kg DM. During the trial, the mean daily consumption of the mineral supplement was approximately 110 g/cow. The calving season started in the middle of March and ended in the middle of May. Blood samples were taken from 11 cows and their calves in the yeast group and from nine in the selenite group at the end of April and again at the beginning of June, and milk samples were taken at the same times. At both samplings, the concentration of Se in whole blood and the activity of glutathione peroxidase (GSH-Px) in the erythrocytes of the cows and calves in the yeast group were higher than in the samples from the animals in the selenite group. The same pattern was seen for plasma, except for the cows at the first sampling. The mean concentrations of Se in whole blood from calves in the yeast and selenite groups were 130 and 84 µg/L, respectively, and plasma concentrations were 48 and 34 µg/L, respectively. Mean Se concentration in the milk from the yeast group (17.3 µg/L) was higher than that in milk from the selenite group (12.7 µg/L). There were significant correlations (r = .59 to .68) between the concentrations of Se in the cow’s milk or cow’s whole blood compared with Se concentrations in the calf’s whole blood or plasma or with the erythrocyte GSH-Px activity of the calves. The Se status of the calves in the selenite group was considered to be marginal, but the status of the calves in the yeast group was considered to be adequate. Supplementation of the suckler cows’ diet with organic Se in the form of Se yeast rather than sodium selenite improved the Se status of their calves when the Se was mixed into a mineral supplement containing 30 mg of Se/kg. In practice, such supplementation would probably eliminate the risk of nutritional muscular degeneration in suckling calves.

Key Words: Milk, Muscular Degeneration, Selenium, Suckling Calves

Introduction

Dietary supplements of organic Se for dairy cows, in the form of a yeast product, result in higher concentrations of Se in their milk than supplements of inorganic Se as sodium selenite (Ortman and Pehrson, 1997). Sweden is generally Se-deficient, and, since 1980, all commercial feedstuffs for farm animals have been supplemented with Se in the form of sodium selenite, most often mixed into a mineral supplement or a premix. Many categories of Swedish farm animals also get a substantial proportion of their dietary Se from imported feedstuffs with naturally higher Se concentrations. As a result, the Se status of Swedish farm animals has been much improved, and with a few exceptions, among which are suckling calves, Se-dependent diseases are no longer prevalent.

The relatively poor capacity of inorganic Se compounds to increase the Se content of milk (Perry et al., 1977; Suoranta et al., 1993; Ortman and Pehrson, 1997) suggests that suckling calves are at risk of being Se-deficient when the calves’ dams are offered only domes-
tically produced feedstuffs and commercial minerals supplemented with inorganic Se compounds. The aim of the present study was to test whether the Se status of such calves would be improved if the sodium selenite in the mineral feeds was replaced with an organic Se compound.

Materials and Methods

A commercial Hereford herd of 103 cows was used during 1998. The calving season began in the middle of March and ended in the middle of May, and most calvings occurred in the middle of April. The cows were kept outside all year round in two adjacent fields, one of 33 ha and the other of 25 ha, and they had had free access to grass hay and to a vitamin/mineral supplement during the winter. The cows also had free access to the hay and a commercial mineral supplement during the following spring and summer when most of their nutritional intake came from pasture. Both fields had been grazed permanently during several years and were, consequently, composed of different kinds of grasses. The mineral supplement used before the start of the trial contained 30 mg of Se/kg as sodium selenite.

On March 15, the cows were divided into two groups. The selenite group of 70 cows was moved to the larger field and still had free access to the mineral feed containing sodium selenite. The yeast group of 33 cows was moved to the smaller field, where they had free access to a mineral feed that also contained 30 mg Se/kg but as organic Se in the form of a Se yeast product (Sel-Plex 50, Alltech, Nicholasville, KY). With the exception of the chemical form of the Se, the ingredients in the two mineral feeds were identical (Ca 9.9%, P 12.2%, Mg 7.0%, Na 7.8%, Zn 5,000 mg/kg, Mn 4,000 mg/kg, Cu 500 mg/kg, I 300 mg/kg, Co 20 mg/kg, vitamin A 400,000 IU/kg, vitamin D3 75,000 IU/kg, and vitamin E 500 IU/kg). On April 28, blood samples were taken with heparinized tubes from the coccygeal vein of the first 11 cows of each group that passed the catching fence and had already calved, and milk samples were also taken. At the same time blood samples were taken from a jugular vein of their calves. Further samples of blood and milk were planned to be taken from the same animals on June 3. On that occasion, however, two calves in the selenite group broke through the catching fence and were not sampled. The samples taken in April from these calves and the samples taken from their dams in April and June were also excluded. The final evaluations were, therefore, based on 11 cows and their calves in the yeast group and nine cows and their calves in the selenite group.

At the April sampling, the mean age of the calves in the yeast group was 22.5 d (range: 8 to 41), and the mean age of the calves in the selenite group was 22.2 d (range: 3 to 34). There were two primiparous cows and seven multiparous cows in the selenite group and no primiparous cows and 11 multiparous cows in the yeast group.

The concentrations of Se in whole blood and plasma were analyzed with hydride generation atomic absorption spectrophotometry (HG-AAS) as described by Ortman and Pehrson (1997). The concentration of Se in the hay and pasture grass from the two fields was analyzed with a flow-injection HG-AAS technique (Galgan and Frank, 1993). The activity of glutathione peroxidase (GSH-Px) in the erythrocytes was measured with the method of Paglia and Valentine (1967).

The mineral supplement was provided in a wooden box that was protected from rain. The mean daily consumption of the supplement by each cow was estimated by dividing the total amount fed by the number of days from March 15 to June 3, and by the number of animals consuming it, assuming that the calves did not consume any significant amount. Thus, the estimated daily consumption of the mineral supplement by the cows in the yeast group was 110 g/cow, and the daily consumption by the cows in the selenite group was 107 g/cow.

One calf in the yeast group was stillborn, and another was found dead when it was 9 d old. In the selenite group, one calf was found dead when it was 14 d old. None of these calves had been blood-sampled. They were not necropsied. With these exceptions, no signs of disease were recorded in any of the animals during the trial.

All the calves were weighed when they were sampled in April and again at the end of September. However, because the mineral supplement containing Se yeast was used up in the beginning of July, all cows got the selenite containing mineral feed from this time to the last weighing in September. The weight gain results must, therefore, be interpreted with a certain reservation.

Statistical Analyses

The overall difference between the two treatments at the two occasions of samplings was calculated with ANOVA for a completely randomized design. The differences between the selenite and the yeast groups at each sampling and the difference within a group between the samplings were evaluated separately for the cows and calves using Student’s t-test. The P-values were corrected in accordance with the method of Bonferroni (Altman, 1991). The correlations between each variable in a cow and her calf were calculated with the program STATISTICA (StatSoft, 1994), and, for these calculations, the mean of the two values for each animal were used. For data taken at two times, a split plot design was used. The effects of time and treatment × time were also analyzed with STATISTICA.

Results

The concentration of Se was .02 mg/kg DM in the hay used for both groups when sampled in the beginning
Table 1. Selenium concentration (µg/L) in whole blood and plasma from cows and their calves and in milk from the cows when supplemented with selenite or selenium yeast, starting on March 15. Mean ± SE

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Table 2. Glutathione peroxidase activity in erythrocytes (µkat/L)a of cows and their calves when supplemented with selenite or selenium yeast, starting on March 15. Mean ± SE

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<td>April 28</td>
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Discussion

There is no agreement in the literature about what can be considered as adequate, marginal, or deficient concentrations of Se in the whole blood of cattle. However, concentrations up to 30 µg/L have been found in animals with clinical signs of nutritional muscular degeneration (NMD; Rosenberger, 1978; Pehrson et al., 1986; Radostits et al., 1994), and most authors (Coutnotte and Hartmans, 1982; Eversole et al., 1988; An-
Wichtel (1998) has pointed out that most of the trials upon which the highest estimates of the whole blood Se requirements have been based have used only small numbers of herds. They have also been very variable in design, particularly with respect to the methods used to supplement the cows with Se and the Se concentration of the basal diets. As a result, they have not established the requirement convincingly; we accept that whole blood Se concentrations below 50 µg/L may induce clinical signs of Se deficiency, and we consider that concentrations above 100 µg/L should be adequate.

At the first sampling, five of the nine calves in the selenite group had whole blood Se levels below 100 µg/L (64, 64, 86, 91, and 91 µg/L); at the second sampling all nine had a concentration less than 100 µg/L, and two of them had concentrations below 50 µg/L (48 and 49 µg/L). Consequently, these two calves could be considered to have been at risk of developing NMD.

At the first sampling, 3 of the 11 calves in the yeast group had whole blood Se concentrations below 100 µg/L (87, 91, and 94 µg/L). At the second sampling, all but one of the calves had levels above 100 µg/L (102 to 211 µg/L); the exception had only 65 µg/L. This calf’s dam had a much lower whole blood Se concentration at both

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4Some of the results in the referred literature were presented as serum or plasma values. If so, they have been transformed to whole blood values by multiplying by 2.
In contrast, the supplement of Se yeast was sufficient to meet the antioxidative demands, and there was a slight increase in the plasma selenium concentration of the cows, there was a significant decrease in the whole blood Se concentration during the period of supplementation with Se yeast. This suggests that she did not consume sufficient quantities of the mineral feed and indicates that when minerals are offered as optional supplements some cows may not consume sufficient Se to prevent a risk of Se deficiency, irrespective of which form of Se is provided as the supplement.

In the yeast group, there was a trend for the means of all the variables to increase between the sampling in April and the sampling in June, whereas in the selenite group the trend was toward a decrease in all the variables during the same period. However, only the plasma Se concentration in the selenite-supplemented cows was significantly decreased at the second sampling. For the plasma selenium concentration of the cows, there was also a significant treatment × time of sampling interaction. The concentration of unsaturated fatty acids, mainly linolenic acid (C 18:3), in fresh grass is higher than in dried roughage (Arthur, 1982; Rice and McMurray, 1982; Hakkarainen and Pehrson, 1987). Between April and June, one may assume that the cows’ daily intake of fresh grass would have increased at the expense of hay, and that their need for antioxidative substances to protect them against the oxidative effects of linolenic acid would, therefore, also have increased. If so, the results indicate that the sodium selenite supplement was not adequate to meet the animals’ increased antioxidative demands, and there was a slight deterioration of the Se status of the cows and calves.

In the present study, the Se status of the calves in the selenite group was not very decreased, in accordance with those presented by Awadeh et al. (1998), who found no or only small differences in blood and milk Se concentrations between beef cows and their calves when the mineral feed was supplemented with 60 mg Se/kg as either selenite or Se yeast. However, the Se concentration in their basal diet was about 10 times higher than in our trial. We, therefore, conclude that Se yeast is more efficient than selenite to increase the Se status of suckling calves only when the basic feed is deficient or marginal in Se.

There have been reports of positive effects on weight gain after the Se supplementation of sheep (e.g., Oldfield et al., 1960; Hartley and Grant, 1961) and young cattle (Gleed et al., 1983; Wichtel et al., 1996). However, in all of these studies, the basal diet of the animals was extremely deficient in Se, and no effect of Se supplementation on weight gain has been found when the basal diet fed to young cattle has been marginal or normal in Se content (Weiss et al., 1983; Sweeney et al., 1989). In the present study, the Se status of the calves in the selenite group was not very deficient, possibly explaining the lack of a difference in daily weight gain between the groups and also why the herd remained in good health during the summer season.

Implications

Suckling calves may be at risk of Se deficiency if their dams are fed extensively on Se-deficient feedstuffs, even if the cows are provided with sodium selenite mixed into a mineral supplement at a dosage level of 30 mg of Se/kg. However, if the cows are supplemented...
with organic Se in the form of a yeast product at the same dosage level, that risk should be almost eliminated.

**Literature Cited**


