Agronomic Biofortification with Selenium: Effects on Whole-blood Selenium and Humoral Immunity in Beef Cattle

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Introduction

Although the essentiality of selenium (Se) has been known for five decades, the most effective method of Se delivery to cattle is unclear. Se may be administered as an injection or in feed and mineral supplements, with Se usually provided as inorganic sodium selenite. One limitation of inorganic Se is the apparent short duration of Se storage in the body. Natural Se sources in plants are organic forms, namely selenomethionine, selenocysteine, or Se-methylselenocysteine. Organic Se accumulates in muscle as selenoproteins, and subsequently becomes available during dietary inadequacy or during stress conditions when the Se requirement is increased but feed consumption is decreased. Agronomic biofortification is defined as increasing the bioavailable concentration of an essential element in edible portions of crop plants through the use of fertilizers. The purpose of this study was to evaluate Se status in beef cattle after short-term exposure to high-Se-fertilized forage vs a commonly used mineral supplement containing inorganic sodium selenite.

Materials and Methods

Selcote Ultra® was mixed with urea-sol fertilizer and applied to pasture at a rate of 7.5 lb (3.4 kg)/ha and 197.1 lb (89.6 kg) nitrogen/ha. Pasture forage samples were obtained for Se analysis prior to fertilization and on days 1 and 42 relative to the grazing period, using a grid pattern with one sample generated from 25 subsamples. Mature beef cows (n=45) were randomly divided into three groups, balanced by age. Group 1 grazed Se-fertilized forage (FSe) for 42 days and had no additional mineral supplementation. Group 2 (LSe) grazed a non-Se-fertilized pasture and received limited supplementation (42 days) from a custom-made free choice mineral supplement that contained 91 mg/lb (200 mg/kg) sodium selenite. Subsequently, these two cow groups were combined and grazed a non-Se-fertilized pasture with no mineral supplementation. Group 3 (CSe) grazed non-Se-fertilized forage but continuously received a free choice mineral supplement containing 55 mg/lb (120 mg/kg) Se from sodium selenite. Cows were bled pre- and post-grazing and then every four weeks thereafter for approximately five months to assess whole-blood Se (WB-Se). Cows in the FSe group were bled weekly during the grazing period. We also hypothesized that humoral immunity would be enhanced after short-term exposure to high-Se-fertilized forage. Cows were immunized with J-5 *Escherichia coli* bacterin at the end of the 42-day supplementation period, and serum was collected for antibody titers two and four weeks after the third immunization (indirect ELISA procedure). Effects of treatment, time, and their interaction on WB-Se concentration and antibody titer were determined by ANOVA for repeated measures.

Results

Forage Se (dry matter basis) was 0.11, 1.52, and 1.06 mg/kg at pre-fertilization, day 1 and day 42 of the grazing period, respectively. Cows in the CSe group (135 ng/mL) tended (P=0.11) to have higher WB-Se concentrations at study initiation compared to the others (107 ng/mL, FSe; 108 ng/mL, LSe) therefore, initial WB-Se concentrations were used as a covariate in all models. WB-Se were influenced (P<0.0001) by group, time and their interaction. Cows in the FSe group had higher (P<0.0001) WB-Se (186 ± 5 ng/mL) immediately post-grazing (42 days) compared to LSe (117 ± 5 ng/mL) and CSe cows (130 ± 5 ng/mL). WB-Se in FSe cows remained higher (range P<0.02 to <0.0001) over the next four (CSe) and five (LSe) months. Higher (P<0.05) WB-Se were observed in CSe compared to LSe cows over the last four months of the study. Within FSe cows, WB-Se were higher (P<0.0001) by one week of grazing and reached a plateau within four weeks. Antibody titers are currently being measured and results will be presented.

Significance

Short-term exposure of cattle to Se-fertilized forage elevates WB-Se within several weeks, and levels are sufficient to maintain adequate concentrations throughout grazing periods when there is limited access to Se supplements. Short-term exposure to higher levels of inorganic Se supplementation is not equivalent to ongoing inorganic Se supplementation at lower rates.