# Effect of Selenium on Cold Adapted Beef Cattle

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**ABSTRACT :** Cattle in Alaska seemed to be tolerant to low blood selenium (Se) although arctic winter energy demands might exacerbate oxidative damage to tissues lacking protection by Se. The thermogenic properities of brown adipose tissue (BAT) and the long cold adaptation period for Alaskan cattle indicates that they might develop BAT. Eighteen mature beef cows with whole blood Se of < 19 ppb were used to examine possible relation-ships among Se deficiency, tissue lesions, and observable BAT. All cows were wintered on a diet low in Se and nine cows were given supplemental Se provided by intraruminal bolus. Blood Se was elevated ($p < .05$) from November through February by supplemental Se, but body weight and back fat thickness were unaffected ($p < .10$). Tissues were taken from two Se deficient cows, two cows supplemented with Se, and two cows given large doses of Se (300 mg by injection) four weeks before slaughter. Histopathological examination of 187 samples of fat (7 to 55 from each cow) showed no observable amount of BAT. Examination of other tissues showed no lesions attributable to Se deficiency.

**(Key Words :** Beef Cattle, Selenium, Brown Adipose Tissue, Lesions)

## INTRODUCTION

Cattle in south central Alaska seem tolerant of low blood selenium (Se), Brundage, 1985. Even with low blood levels of Se cattle show few symptoms of deficiency (Bruce, 1985). These cattle are also able to survive harsh winters on less energy than expected (Bruce, 1985). At birth, calves have stores of brown adipose tissue (BAT) used in non-shivering thermogenesis (Nougues et al., 1993). Brown adipose tissue is specific for production of heat and is important in neonates, especially in cold conditions. Brown adipose tissue changes to white adipose tissue in a few days after birth, but this rate of change may be slowed by exposure to cold (Chapman et al., 1994). Because of BAT's importance in heat production and survival of the young, many studies have been conducted with the goal of extending the time BAT is present (Chapman et al., 1994; Nougues et al., 1993; Rattan et al., 1995). In cattle that have adapted to cold extremes, such as Alaskan beef cattle in winter, the re-induction of BAT might be possible. Alaskan cattle are also tolerant to Se deficiency. Rats with long term Se deficiency had lesions of oxidative tissue damage and an unusual abundance of brown adipose tissue (BAT, observed by G. S. Smith in laboratory of Prof. K. Yasumoto, Kyoto Univ., Japan; unpublished data). Malignant tumors and other lesions are known to appear in BAT (Fox et al., 1989). This suggests a possibles relationship of BAT in pathology of prolonged Se deficiency. Although BAT is found in young ruminants, the presence of BAT has not been demonstrated in mature cows. If BAT does exist in adult cattle, selenium deficient cattle in Alaska were expected to exhibit BAT. An abundance of BAT might help to explain the ability of cattle to withstand the harsh winter conditions since BAT is primarily thermogenic (Metzler, 1977). This study was designed to determine if cattle wintered in Alaska exhibit a proliferation of BAT and if Se deficient cattle show any unusual tissue lesions, and if sudden massive doses of supplemental Se affect BAT or other tissues.

## MATERIALS AND METHODS

Eighteen mature beef cows ($588 \pm 58$ kg BW) all with whole blood Se of less than 20 ppb were used to examine possible relationships among Se deficiency, tissue lesions, and observable abundance of BAT. All cows were wintered on an all Alaskan feedstuff diet (low in Se) and fed according to NRC (1984) quidelines. Body weights, backfat thickness (by ultrasound), and whole

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Received June 7, 1997; Accepted November 26, 1997.

blood Se content were measured at the beginning and end of the trial. Nine of these cows were randomly selected and given supplemental Se by intraruminal bolus at the start of the trial. Of the nine unsupplemented cows, two were given large doses of Se (300 mg by injection) four weeks prior to slaughter in early March 1990. One hundred twenty days after administering the bolus to the cows, two Se deficient cows, two cows supplemented with intraruminal Se, and the two cows given large doses of Se were slaughtered. Tissues (heart, skeletal muscle, liver, kidney, lung, spleen, adrenal, ovary, and body fat from each of these areas as well as the back) were taken from these animals for histopathological examination by the New Mexico Veterinary Diagnostic Services. Statistical analysis of BW, back fat, and Se were conducted with appropriate analysis of variance (Steel and Torrie, 1960).

## RESULTS

There were no changes due to Se treatment in body weight or backfat thickness (table 1, $P > .1$). Blood Se was elevated (table 1, $P < .05$) from November through February by supplemental Se. Histopathological data are presented in table 2. Histopathological examination of 187 samples of fat (7 to 55 from each cow) showed no observable amount of BAT. No BAT was found in any sample. Examination of other tissues showed no lesions attributable to Se deficiency. The Se bolus cows had no significant lesions of any kind. The Se deficient cows had no significant lesions except for bronchitis. The rapidly repleted Se cows showed signs of myocarditis and bronchitis. The bronchitis and other lung problems may be explained by breathing of ash from an ash cloud that was caused by volcanic eruption (Mt. Redoubt) two weeks before slaughter. All animals were equally exposed to the ash fallout.

**Table 1.** Back fat thickness, body weights, and blood selenium (Se) levels of cows

| Treatment group | BW (kg) | Back fat thickness, (cm) | Blood Se content (ppb) |
|---|---|---|---|
| Se deficient | | | |
| before experiment | 572 ± 79 | 1.35 ± .2 | 19 ± 7 |
| end of experiment | 593 ± 93 | 1.4 ± .25 | 15 ± 4 |
| With Se bolus | | | |
| before experiment | 543 ± 34 | 1.14 ± .38 | 17 ± 3 |
| end of experiment | 577 ± 46 | 1.14 ± .33 | 131 ± 17 |

**Table 2.** Histopathological diagnosis and tissue lesions of selenium deficient, non-deficient and repleted beef cattle

| Treatment group | Diagnosis |
|---|---|
| Se adequate | |
| Cow 1 | No significant lesions |
| Cow 2 | No significant lesions |
| Se deficient | |
| Cow 1 | Bronchitis (lymphocytic) |
| Cow 2 | Bronchitis (lymphocytic)<br>Fat necrosis (multifocal) |
| Se repleted | |
| Cow 1 | Bronchitis (lymphocytic)<br>Myocarditis (multifocal, nonsuppurative)<br>Myopathy (multifocal, degenerative)<br>Fat necrosis (focal) |
| Cow 2 | Myocarditis (multifocal, nonsuppurative)<br>Nephritisis (interstitial, focal) |

## DISCUSSION

Brown adipose tissue was not found in any of the 187 fat samples examined from the six different cows. This strongly implies that BAT does not occur in mature cows, even those exposed to extremely long and cold winters. If BAT is involved in Se deficiencies, lack of it appears not to be detrimental as the Se deficient cows are tolerant of this condition. The ability of Alaskan cows to tolerate winter and Se deficiencies does not seem to be related to BAT. Although the number of cows was too small for there to be any statistical significance, some important observations can be made. Selenium adequate cows exhibited no unusual lesions. The Se deficient cows all had bronchitis. All of the cows were equally exposed to volcanic ash several weeks before slaughter, and this exposure could make them susceptible to bronchitis. Considering the role Se plays in tissue health, it is not surprising that those deficient developed bronchial lesions while those adequate did not. This area certainly deserves more investigation. The other observation is that the rapidly repleted Se cows (given a massive 300 mg injection) both had myocardial problems. If the massive Se injection caused this, it could have implications in human health in areas of Se deficiency. Too rapid of repletion might cause serious injury.

This experiment has shown that body weight and back fat thickness were unaffected by blood Se levels. There

were no observable amounts of BAT in any cow. There were no observable lesions in any body tissues attributable to Se deficiency, however rapid repletion with large doses of Se may have implications for heart function. Selenium deficient cows appeared to be susceptible to bronchitis (when exposed to volcanic ash inhalation) and Se adequate were not.

## ACKNOWLEDGMENTS

The author wishes to acknowledge M. L. Herlugson (University of Alaska Fairbanks), J. P. Thilsted (New Mexico Veterinary Diagnostic Services, Albuquerque), and G. S. Smith (New Mexico State University, Las Cruces) for support and technical assistance in this project.

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