Original paper

INFLUENCE OF BLOOD AND MILK SELENIUM CONCENTRATION ON SOMATIC CELL COUNT IN EARLY AND MID LACTATION

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Abstract

The aim of this study was to determine the effect of selenium concentration in blood and milk in early lactation on somatic cell count. The average selenium concentration in the blood serum was 0.62 ± 0.11 μmol/l and in the milk serum 0.61 ± 0.07 μmol/l. Optimal blood selenium concentrations were found in 19 cows and suboptimal concentrations in 11 cows. Optimal milk selenium concentration was found in 14 cows and suboptimal in 16 cows. The average milk production per cow was 23.12 ± 3.1 liters / day and the average somatic cell count in the first and sixth months of lactation was 5.34 ± 5 (log transformed) and 5.12 ± 4.9, respectively. Blood selenium concentration correlated negatively with milk somatic cell count in early and mid lactation. The classification of cows based on blood selenium concentration gave results which suggested that selenium-deficient cows had a significantly higher somatic cell count in early lactation (the first month) and mid lactation (the sixth month). Blood selenium is an important predictor of milk somatic cell count. Somatic cell count in milk is not dependent upon selenium concentration in milk or interaction blood×milk selenium. Selenium concentration is not in connection with milk production.

Key words: *cows, selenium, somatic cell count*

Introduction

Selenium acts as a cellular antioxidant in the cell cytoplasm by preventing cell damage due to peroxidase and plays a major role in the function of the immune response (Miller et al., 1993). Parturition and early lactation lead to a weakened immune system and a subsequent increase in the risk of infection in dairy cows (Mallard et al., 1998). Miller et al. (1995) found that blood selenium concentrations decrease at parturition. Uncontrolled peroxide is highly damaging to healthy cells and healthy tissue of the mammary gland (Kommisrud et al., 2005). Selenium is essential in helping leukocytes: it reduces the formation of peroxides, translates them into safe substances and, then, destroys phagocytized pathogens (Larsen, 1993; Finch and Turner, 1996; Smith et al., 1997; McKenzie et al., 1998). We hypothesized that selenium deficiency in early lactation can affect mammary gland health in cows. The aim of this study was to determine the effect of selenium concentration in blood and milk in early lactation to somatic cell count.

Materials and methods

Animals: The experiment included 30 high-producing dairy Holstein-Friesian cows raised under farm conditions. The cows had similar body condition scores. They were in their third (14 cows) or fourth (16 cows) lactation and gave approximately the same amount of milk in the previous lactation (7000 liters).

Blood analysis: Blood was taken during the first month of lactation (25-30 days) by v.coccygea to determine selenium concentration. Blood sera were further analyzed by atomic absorption spectrometry (AAS) on a Perkin Elmer Elan 6100 ICPMS, Massachusetts, USA. Selenium concentration was determined using the method described by Maas et al. (1992).

Milk analysis: Milk samples were taken at the time of blood sampling. Somatic cell count (SCC) was determined in bulk milk samples from every quarter using MILKOSCAN appliances. Milk serum was separated for the purpose of measuring selenium concentration and further analyzed by atomic absorption spectrometry. The methodology was the same as for the blood serum.

Model and statistics: In the first step results are presented as mean ±SD. In second step we examined correlation (Pearsons) between Se concentration in blood and milk and SCC in early and mid lactation. Finally, a statistical model to assess the impact of selenium in the blood and milk of the number of somatic cells in milk of cows is formed. On the basis of the value of selenium in the milk and blood the cows were denoted as cows with optimal or suboptimal value of selenium in blood and milk. Lower reference range of selenium is 0.6 μmol/l. Data were analyzed by ANOVA as a manual 2x2 factorial experiment, and the influence of the concentration of selenium in blood serum selenium in milk serum and their interaction, according to the model: $yi = \mu + Bi + LJ + FC + fjk + l \times \varepsilon ijkl$, where y - the dependent variable – SCC or milk production, Bi - effect block, Ij - effect of selenium concentration in blood serum (j - optimal concentrations, suboptimal concentration), fk - effect of selenium concentration in the milk serum (k - optimal concentrations, suboptimal concentration), $L \times fjk$ - interaction between the two variables and $\varepsilon ijkl$ - residual error.

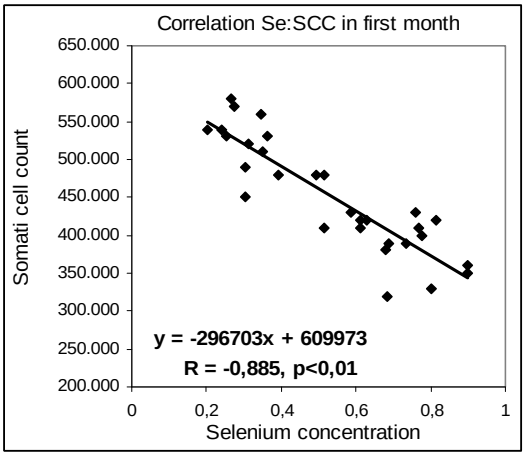
Results and discussion

The average selenium concentration in the blood serum was 0.62 ± 0.11 μmol/l and in the milk serum 0.61 ± 0.07 μmol/l. Optimal blood selenium concentrations were found in 19 cows and suboptimal concentrations in 11 cows. Optimal milk selenium concentrations were found in 14 cows and suboptimal in 16 cows. The average milk production per cow was 23.12 ± 3.1 liters / day and the average somatic cell count in the first and sixth months of lactation was 5.34±5 (log transformed) and 5.12±4.9, respectively. The above data are shown in Table 1.

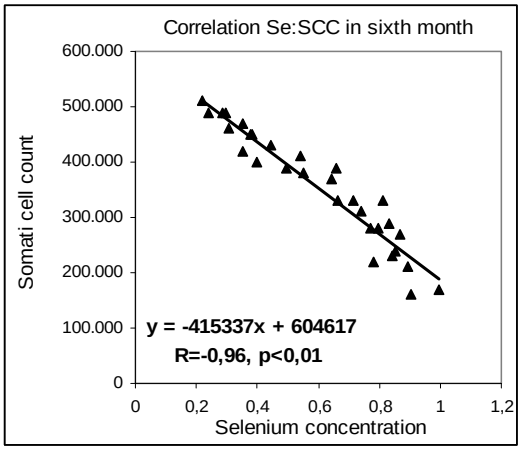
Table 1. *Description data from experimental cows*

Parameter	Mean±SD
Blood selenium (μmol/l)	0.62±0.11
No. of cows with optimal / suboptimal blood selenium concentration	19 / 11
Milk selenium (μmol/l)	0.61±0.07
No. of cows with optimal / suboptimal milk selenium concentration	14 / 16
Milk yield (liters/day/cow)	23.12±3.1
SCC in the first month of lactation (log/ml)	5.34±5
SCC in the sixth month of lactation (log/ml)	5.12±4.9

Blood selenium concentration correlated negatively with milk somatic cell count in early and mid lactation. The above results are given in Graphs 1 and 2. Correlations between other variables were not determined.



Graph 1. *Correlation between blood selenium concentration and milk somatic cell count at first lactating month – early lactation*



Graph 2. *Correlation between selenium blood concentration and milk somatic cell count at sixth lactating month – mid lactation*

The classification of cows based on blood selenium concentration gave results which suggested that selenium-deficient cows had a significantly higher somatic cell count in early (the first month) and mid lactation (the sixth month). Blood selenium is an important predictor of milk somatic cell count. Somatic cell count in milk is not dependent upon selenium concentration in milk or interaction blood×milk selenium. Selenium concentration is not in connection with milk production.The above results are given in Table 2.

Table 2. *Influence of selenium concentration on milk production and SCC in early and mid lactation*

	Treatment					p value		
	OBS*	OMS	SBS	SMS	SEM	BS**	MS	BS×MS
Milk production	25.4	23.5	24.5	24.7	1.4	NS	NS	NS
SCC early (log)	5.12	4.93	5.58	5.45	0.9	<0.01	NS	NS
SCC mid (log)	5.05	4.82	5.33	5.06	0.8	<0.01	NS	NS

*OBS – optimal Se value in blood, OMS – optimal Se value in milk, SBS – suboptimal Se value in blood, SMS – suboptimal Se value in milk.

**BS – influence of blood Se to SCC, MS – influence of milk Se to SCC, BS×MS – influence of interaction of blood and milk Se to SCC.

The range of physiological values for blood selenium in dairy cows is 0.6 to 0.9 mmol/l (Erdeljan et al., 2011, Juniper et al., 2006, Gunter et al., 2003). Our results are in accordance with the above. Pechová et al. (2008) reported that there is no significant correlation between blood selenium concentration and milk selenium concentration, which is consistent with our results. However, Grace et al. (2001) found a statistically significant linear correlation between blood and milk selenium concentrations. The concentration of selenium in the blood and breast milk depends on selenium supplements used on farms, since the use of selenium leads to a significant increase in its concentration in the blood and breast milk (Ran et al., 2010).

Atroshi et al. (1986) and Hogan et al. (1993) found that the occurrence of mastitis in cows is associated with low glutathione peroxidase and vitamin E in the blood plasma. Kruze et al. (2007) observed that cows infected with *Staphylococcus aureus* receiving selenium in their diet showed a significantly higher glutathione peroxidase activity and a significantly lower milk somatic cell count. Low levels of glutathione peroxidase were found to reduce the antioxidant capacity of the defense system of the mammary gland, leading to an increase in mastitis incidence and somatic cell count in milk (Mukherjee, 2008). Selenium concentrations and glutathione peroxidase activity are positively correlated (Pilarczyk et al., 2012). Selenium is an integral part of the enzyme, and this can explain why selenium-deficient cows exhibit higher infiltration of inflammatory cells undergoing excessive inflammation. Selenium deficiency provokes an inflammatory process due to reduced antioxidant activity in tissues when there is an accumulation of immune cells in response to prolonged inflammation; therefore, the concentration of selenium is negatively correlated with the degree of cellular infiltration in the parenchyma of the udder. A reduction in mastitis after dietary selenium and vitamin E intakes occurs as the result of enhanced activities of glutathione peroxidase (Hemmingway, 1999; Weiss et al., 1997). Selenium supplementation leads to a reduction in subclinical mastitis and somatic cell count in dairy cows (Barbano et al., 2006; Cope et al., 2009; Rabiee et al., 2010; Weiss et al., 2002; Davidov et al., 2012).

Conclusion

Blood selenium concentration plays an important role in maintaining mammary gland health. Selenium-deficient cows were found to have a large milk somatic cell count. Blood selenium is an important predictor of milk somatic cell count. Somatic cell count in milk is not dependent upon selenium concentration in milk or interaction blood×milk selenium. Selenium concentration is not in connection with milk production.

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