Dairy Research Summary

DRECA
Dairy Research and Extension Consortium of Alberta

March 2019

# Alberta Dairy Cows Need Adequate Amounts of Trace Minerals

B. Hoff[1], P. Whittaker[2] and M.G. Colazo[3]

[1]Animal Health Laboratory, University of Guelph, Guelph, ON; [2]The Farm Animal Hospital, Leduc, AB; [3]Livestock Systems Section, Alberta Agriculture and Forestry, Edmonton, AB. E-mail: marcos.colazo@gov.ab.ca

## Why is this important?

Providing the correct amounts of bioavailable trace minerals in the diet is necessary for healthy, productive dairy cows. Excess or inadequate trace minerals may negatively impact reproductive performance, milk production and animal health. The 2001 Dairy NRC (*7th revised edition*) established requirements for cobalt (Co), copper (Cu), iodine (I), iron (Fe), manganese (Mn), selenium (Se) and zinc (Zn). However, identifying dietary effects on cow health and reproduction is inaccurate and usually requires a very large number of animals. Appropriate diagnosis of trace mineral status involves evaluation of groups of animals and should include a thorough health history, feeding history, supplementation history, and analysis of several animals for their mineral status. Proof of mineral deficiencies or mineral excess requires laboratory testing since most do not have unique clinical signs. Testing of blood, plasma or serum, and liver samples is a popular and potentially valuable means of assessing trace mineral nutritional status that is generally more practical than other functional approaches. Modern analytical techniques, i.e. inductively coupled plasma/mass spectroscopy (ICP/MS analysis), make blood and tissue analysis for trace minerals practical, relatively inexpensive and very accurate.

## What did we do?

Blood plasma samples were taken from 227 dry cows on 11 Alberta dairy farms and tested for levels of trace minerals (i.e. Co, Cu, Fe, Mn, Se and Zn). Blood samples from 60 clinically healthy cows between 35 to 110 days in milk, taken from 10 farms, were used to calculate reference intervals for normal trace mineral concentrations. For all other cows, biochemical profiles were analysed to identify any metabolic abnormalities. Additionally, Cu and Se concentrations in the liver were measured in 11 fresh cows on a farm with a high incidence of ketosis.

**Table 1.** Percentage of dry cows with low and high plasma concentrations of copper (Cu), Selenium (Se) and Molybdenum (Mo) from 11 Alberta dairy farms[1]

| Farm | High Cu (%) | Low Se (%) | High Mo (%) | Low Mo (%) |
|---|---|---|---|---|
| A (n=10) | 0 | 60 | 0 | 40 |
| B (n=41) | 10 | 12 | 0 | 73 |
| C (n=21) | 10 | 76 | 0 | 62 |
| D (n=13) | 31 | 92 | 0 | 54 |
| E (n=13) | 38 | 0 | 0 | 100 |
| F (n=8) | 0 | 38 | 25 | 0 |
| G (n=30) | 33 | 7 | 0 | 77 |
| H (n=26) | 12 | 31 | 23 | 8 |
| I (n=39) | 27 | 92 | 0 | 90 |
| J (n=21) | 14 | 71 | 0 | 24 |
| K (n=5) | 0 | 100 | 100 | 0 |
| Total (n=227) | 20 | 48 | 11 | 58 |

[1]Low and High concentrations were determined based on reference intervals for each trace mineral.

Table 2. Liver concentrations of Copper (Cu) and Selenium (Se), and serum concentrations of liver enzymes[1] (GGT, AST, CK and GLDH) and β-hydroxybutyrate (BHB) in 11 fresh cows

| Item | COW | | | | | | | | | | | RI[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | |
| Cu (ug/g) | 67 | 2.4 | 75 | **170** | **150** | **110** | 67 | **130** | **140** | 96 | **150** | 25-100 |
| Se(ug/g) | 0.47 | **7.7** | 0.38 | **1.2** | **0.78** | **0.75** | 0.38 | **0.54** | **0.65** | **0.64** | **0.74** | 0.25-0.5 |
| GGT (U/L) | 25 | **52** | **154** | 22 | 48 | 18 | 22 | 28 | -- | 19 | **102** | 11-51 |
| AST (U/L) | 59 | **169** | 76 | 108 | 96 | 65 | 63 | 93 | -- | 74 | **259** | 44-153 |
| CK (U/L) | 135 | **560** | 105 | **507** | 120 | **319** | 107 | **357** | -- | 110 | **410** | 44-211 |
| GLDH (U/L) | 33 | **64** | 35 | **56** | 41 | 32 | 16 | 7 | -- | 7 | **251** | 3-45 |
| BHB (mmol/L) | 708 | 410 | 519 | 531 | 547 | 514 | **2058** | **1632** | **--** | 828 | **1383** | 324-1296 |

[1]GGT = gamma-glutamyltransferase; AST = aspartate aminotransferase; CK = creatine kinase; GLDH = Glutamate dehydrogenase
[2]Reference intervals based on 60 clinically healthy cows at 30-150 days in milk from 10 farms.

## What did we find?

Plasma concentrations of Co, Cu, Mo and Se in dry cows were significantly different among farms. Overall, 20% of cows had high plasma concentrations of Cu and 48% had low concentrations of Se (Table 1). There was large variation between cows for plasma concentrations of Mo, with 11 and 58% of cows classified as high and low, respectively (Table 1). Greater than normal concentrations of Cu and Se were found in the liver of 73 and 55% of fresh cows, respectively (Table 2). Additionally, a high proportion of those cows had concentrations of liver enzymes above the normal level.

Summary Points

- Understanding the trace mineral status of cows is important for health and production
- 48 % of cows were deficient in selenium and 20% had excess copper in blood plasma
- 27% of cows had high liver copper concentrations, indicating copper toxicity, and high liver enzymes, indicating liver damage

## What does this mean?

The results indicate that a significant proportion of dry cows were deficient in Se but in excess of Cu. A high percentage of the liver samples tested had high concentrations of Cu and Se, with 27% of cows having very high liver copper concentrations, indicating that a significant proportion of lactating cows were at risk of chronic copper toxicity. The high level of liver enzymes in most of these cows also suggests that liver is negatively affected.

Dietary mineral evaluation should only be used to aid the mineral evaluation of animal groups. If minerals are adequate in the diet, but the animals are found to be deficient or in excess, interactions with other minerals and true average daily intake of supplements need to be investigated. Several dietary conditions can greatly influence the absorption of trace minerals. For example, high concentrations of sulphur, Mo or Fe can greatly reduce Cu and Se absorption, leading to deficiencies. Excessive Cu and Se can also negatively impact Zn status and cause liver dysfunction. Therefore, in dairy operations one must correctly identify the cause of mineral status abnormality, once an abnormality is identified.

Alberta Agriculture and Forestry

DRECA

This project was financially supported by *Growing Forward 2* (a federal-provincial-territorial initiative) and Alberta Agriculture and Forestry. The authors thank veterinarians, owners and staff of all participating farms.