

Survey of Heavy Metals in Minnesota Holstein Dairy Cattle: Soil, Feed and Liver Concentrations

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Introduction

Heavy metals such as Cadmium (Cd), Lead (Pb) and Chromium (Cr) are of concern because of their potential toxicity. Various cases of environmental and accidental contamination of soil and animal feed have been reported over the years. Data from the Minnesota Diagnostic Laboratory between 1994 and 2000 showed 2, 19, 17, 15, 10, 2 and 18 positive cases of Pb toxicity were reported for each of the years, respectively. Lead poisoning accounted for 0.5 to 8% of all the cases submitted to the Diagnostic Laboratory during those years. This survey was conducted to profile the heavy metal concentrations existing on Minnesota dairy farms.

Materials and Methods

The data on heavy metals was collected concurrently with a survey on the copper status of Holstein cows in Minnesota. To assess the status of copper (Cu) and other trace minerals, liver biopsies were taken from Holstein dairy cows in 29 dairy herds in 6 different geographic regions in Minnesota. Herds selected had been on a constant amount and source of Cu for 1 to 2 years or more. Within herds, biopsies were taken at calving ± 10 days, 90 to 150 days of lactation and 270 days to dry off. Biopsies were taken from up to 7 animals in each stage of lactation. Samples were taken of all feedstuffs fed and a "typical" diet for the stages of lactation cows were in was recorded. Soil samples were taken from areas where no manure had been applied for several years and from heavily manured fields. Determination of mineral content in feeds, liver and manure was made by the Soil Lab at the University of Minnesota. From the mineral analysis of the feeds and the amounts of the average diet provided, the parts per million (ppm) of Cu and other minerals in the diet were calculated.

Results

Lead concentrations in feedstuffs were below the levels of detection. No correlation between the concentration of heavy metals in soil, feed and liver tissue was found. Table 1 shows the average and range in non-nutritional minerals found in the liver of biopsied dairy cows. The data reported in Table 2 shows concentrations of heavy metals from land receiving no manure (native) and crop land fertilized with manure is there for informational purposes.

Summary

Heavy metal content of typical feeds is reported. No feedstuffs contained detectable concentrations of lead. One animal out of 440 animals contained a trace concentration of lead in its liver. Soil concentrations of heavy metals including lead were of barely detectable

amounts. Because of the cases of lead poisoning that occur every year, the source is likely to be a contaminant from a source other than feedstuffs.

Table 1. Concentrations of some non-nutritional mineral elements in the liver of dairy cows from dairy herds surveyed in Minnesota¹.

Mineral element	No. of cows	Minimum	Maximum	Mean	SD ²	Mean + (3*SD)
Al	440	2.2	94.5	11.3	10.0	41.5
B	440	1.4	22.3	5.0	2.8	13.2
Cd ³	440	0.1	3.1	0.4	0.3	1.2
Cr ⁴	440	0.2	21.2	1.2	1.5	5.5
Ni ⁵	440	0.6	12.5	1.7	1.6	6.5
Pb ⁶	440	1.5	23.4	4.5	2.9	13.3

¹ Concentrations in parts per million.

² Standard deviation.

³ Concentrations were below the detection limit in 27 cows.

⁴ Concentrations were below the detection limit in 52 cows.

⁵ Detectable levels in only 165 cows.

⁶ Detectable levels in only 76 cows.

Table 2. Concentrations of some heavy metals in native soils with no manure application and soils receiving manure for crop fertilization on the surveyed dairy farms.

Mineral	Soil type	No. of samples ¹ with detectable levels	Concentration, ppm (DM basis) ²			
			Minimum	Maximum	Mean	SD ³
Cd	Manured	24	0.03	0.23	0.12	0.05
	Native	24	0.04	0.34	0.13	0.08
Cr	Manured	6	0.02	0.06	0.03	0.02
	Native	7	0.02	0.06	0.03	0.02
Ni	Manured	24	0.22	4.53	1.94	0.93
	Native	24	0.14	3.88	1.95	0.97
Pb	Manured	24	0.37	2.79	1.54	0.74
	Native	24	0.36	6.09	1.76	1.27

¹ A sample of native soil and one of manure-fertilized soil was taken from each of twenty-four farms (N = 24). In several samples, mineral concentrations were below limits of detection.

² Concentrations in parts per million. Statistics computer-based on number of samples with detectable levels for each mineral.

³ Standard deviation.

References

1. Puls, R. 1994. Mineral levels in animal health. Diagnostic Data. pp. 183-188.
2. National Academy of Sciences, Subcommittee on Dairy Cattle Nutrition. Nutrient Requirements of Dairy Cattle. 1988 and 2001.