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Assessment of the role of manganese in congenital joint laxity and dwarfism in calves *

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Summary — Pregnant beef cows were winter-fed (November 15 to calving) hay (24 cows), red clover silage (21 cows) or grass silage (52 cows). Blood samples were taken from each cow in December and February. A condition of congenital joint laxity and dwarfism was observed in 38% and 28% of calves born to cows fed red clover silage and grass silage, respectively. None of the calves born to hay-fed cows were affected by the condition. The congenital joint laxity and dwarfism was associated with a lower serum manganese concentration in silage-fed cows than in hay-fed cows. However, manganese concentrations were similar in red clover silage, grass silage and in hay. A lower bioavailability of manganese in silages other than in hay, resulting in an apparent manganese deficiency in silage-fed cows, is suggested as a possible factor contributing to the etiology of congenital joint laxity and dwarfism in calves.

congenital joint laxity and dwarfism / manganese / hay / silage / cattle

Résumé — Rôle possible du manganèse dans le relâchement congénital des articulations et nanisme chez le veau. Des vaches gestantes ont été nourries de la mi-novembre jusqu'au vêlage, soit au foin (24 vaches), soit à l'ensilage de trèfle rouge (21 vaches), soit à l'ensilage d'herbe (52 vaches). Des échantillons de sang ont été prélevés sur chaque vache en décembre et en février. Un état de relâchement des articulations et de nanisme a été observé chez 38% et 28% des veaux nés des vaches nourries à l'ensilage de trèfle rouge et à l'ensilage d'herbe respectivement. Aucun veau né de vache nourrie au foin n'a présenté cet état. Cette absence de trouble était associée à une concentration en manganèse sérique plus élevée chez les vaches nourries à l'herbe que chez les vaches nourries à l'ensilage. Cependant les concentrations en manganèse étaient équivalentes dans l'ensilage d'herbe, dans l'ensilage de trèfle et dans le foin. Ces résultats suggèrent que la déficience en manganèse observée chez les vaches nourries à l'ensilage proviendrait d'une biodisponibilité du manganèse plus faible dans l'ensilage que dans l'herbe et qu'elle pourrait être un facteur contribuant à l'étiologie du relâchement congénital des articulations et du nanisme chez le veau.

relâchement congénital des articulations et nanisme / manganèse / foin / ensilage / bovin

* Contribution no 1656 from the Animal Research Centre

INTRODUCTION

Manganese (Mn) deficiency in ruminants results in a wide variety of disorders which include high neonatal death, impaired growth, congenital ataxia and skeletal deformities (Anke *et al*, 1973; Hidioglou, 1979). Ribble (1987) reported a disease under the name of congenital joint laxity and dwarfism (CJLD) in calves. The disease was characterized at birth by generalized joint laxity, disproportionate dwarfism, and occasionally, superior brachygnathia. It can affect up to 46% of a calf crop (Ribble *et al*, 1989). Ribble *et al* (1989) demonstrated the condition by winter-feeding red clover and grass silages to pregnant beef cows. Supplementation of the silage with hay and rolled barley eliminated the problem.

Kuersten (1986) reported low liver Mn concentrations in calves from farms with a high incidence of CJLD. In addition calves from dams fed manganese-deficient diets can be born with enlarged joints, stiffness, twisted forelimbs, "knucked-over" patterns, and generalized physical weakness (Dyer *et al*, 1964; Rojas *et al*, 1965). Although this differs considerably from the clinical signs of CJLD, Mn deficiency may nevertheless play a contributing role in the incidence of CJLD. The purpose of the present study was to determine if the incidence of CJLD in calves was associated with manganese deficiency in pregnant beef cows.

MATERIALS AND METHODS

An experiment with pregnant cows was carried out at Robin Hill Farm, Oxdrift, Northwestern Ontario, during the winter months (November 15 to calving). It consisted of 3 groups of cows fed hay (24 cows), red clover silage (21 cows) or grass silage (52 cows). The grass used for

hay and silage consisted of 95% Timothy and 5% mixed varieties. Feeding management was described previously (Ribble *et al*, 1989). Blood samples were taken from the jugular vein of each cow in December and February.

Serum was separated by centrifugation of blood and stored at -20°C until analyzed for Mn. Feed samples were collected from each diet, dried, ground and sub-sampled for mineral analysis.

Serum samples were analyzed for Mn by graphite furnace atomic absorption spectrophotometry (Subramanian and Meranger, 1985). Feed samples were analyzed for mineral elements by atomic absorption spectrophotometry following wet digestion in nitric and perchloric acids (Hoffman *et al*, 1968). Analysis of variance was used for comparison of experimental results.

RESULTS

The concentrations of Mn in serum was highest for pregnant cows fed hay during the winter months and lowest for those fed red clover silage (table I). The differences were significant ($P < 0.05$) 1 month after the initiation of the experiment. However, 2 months later, the differences between the Mn concentrations for red clover silage and grass silage were small ($P > 0.05$) and both concentrations were lower ($P < 0.05$) than that for cows fed hay. This was associated with 38% and 28% CJLD appearance in calves born to cows fed red clover silage and grass silage, respectively. CJLD was not apparent in any calves born to cows fed hay. However, Mn concentrations in grass silage were not lower than in corresponding hay (table II).

DISCUSSION

The CJLD condition in calves was produced experimentally by winter-feeding pregnant beef cows with red clover silage

Table I. Mean (\pm standard error) serum manganese concentrations (ng/ml) in pregnant cows winter-fed hay, red clover silage or grass silage.

| <i>Feed</i> | <i>No of cows</i> | <i>December</i> | <i>February</i> | <i>Offspring exhibiting CJLD¹ (%)</i> |
|-------------------|-------------------|------------------------------|------------------------------|--|
| Hay | 24 | 2.88 ^a \pm 0.08 | 2.60 ^a \pm 0.09 | 0 |
| Red clover silage | 21 | 2.39 ^b \pm 0.08 | 1.99 ^b \pm 0.08 | 38 |
| Grass silage | 52 | 2.67 ^c \pm 0.06 | 2.06 ^c \pm 0.06 | 28 |

a-c Means with different superscripts within the same column are significantly different ($P < 0.05$); ¹ Congenital joint laxity and dwarfism.

or grass silage; it was completely prevented by supplementation of the silages with hay or hay and grain (Ribble *et al.*, 1989). In addition, CJLD affected 28% of calves born to dams fed grass silage and none of those born to dams fed hay that originated from the same field as the grass silage (Ribble *et al.*, 1989). The authors suggested 3 possibilities responsible for the association of CJLD with red clover and grass silage feeding:

- a deficiency from leaching of nutrients during the process of ensiling of grass;
- fungal production of mycotoxins in the silage;
- the product of fermentation in the silage.

It would appear that leaching of Mn during ensiling of grass was not a factor associated with the incidence of CJLD in calves in the present experiment. Therefore, the

Table II. Mean concentrations of mineral elements in hay, red clover silage and grass silage.

| <i>Element</i> | <i>Hay</i> | <i>Red clover silage</i> | <i>Grass silage</i> |
|------------------------------------|------------|--------------------------|---------------------|
| Manganese (mg/kg DM ¹) | 51 | 64 | 63 |
| Copper (mg/kg DM) | 8.4 | 9.0 | 5.1 |
| Zinc (mg/kg DM) | 23 | 24 | 21 |
| Iron (mg/kg DM) | 71 | 166 | 79 |
| Molybdenum (mg/kg DM) | 1.60 | 0.63 | 0.97 |
| Selenium (mg/kg DM) | 0.07 | 0.07 | 0.07 |
| Sodium (mg/kg DM) | 14 | 26 | 29 |
| Potassium (% DM) | 1.22 | 1.77 | 1.90 |
| Calcium (% DM) | 0.37 | 0.49 | 0.43 |
| Phosphorus (% DM) | 0.17 | 0.17 | 0.23 |
| Magnesium (% DM) | 0.12 | 0.14 | 0.14 |
| Sulphur (% DM) | 0.11 | 0.15 | 0.13 |

¹ Dry matter.

results point toward the possibility of a decline in Mn bioavailability as a result of the ensiling process, or as a result of differences in ruminal fermentation of forages when fed in dry or silage form, or both. Such differences have been reported for copper; grazing cattle accumulated less copper in the liver and had higher rumen sulphide concentrations than cattle given hay which had been harvested at the same growth stage and had a similar mineral content (Hartmans and Bosman, 1970). In addition rumen degradability of protein is lower in dry compared with fresh forage (Beever *et al*, 1976). There are no reports, however, documenting the effects of different methods of preserving forages on the bioavailability of dietary Mn to cattle.

Considering the fact that the signs of CJLD are different from those of Mn deficiency, it was not suspected that dietary Mn alone was the factor responsible for the CJLD condition in calves. However, a Mn deficiency associated with the ensiling of red clover and grass could be a contributing factor in the etiology of CJLD in calves. Serum Mn concentrations indicated that the deficiency was more severe for red clover silage than for grass silage, resulting in a higher percentage (38% vs 28%) of CJLD in calves born to dams fed the former silage.

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