Urinary magnesium—an indicator of magnesium status/intake?

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ABSTRACT

Urinary magnesium concentrations in dairy cows follow a distinct seasonal pattern, being high during the summer and lowest during August and September, coinciding with the period when the incidence of hypomagnesaemia is at its greatest. During this critical period mean urinary Mg concentrations (Y, mg/mg creatinine) measured weekly were related to mean plasma Mg concentrations (X, mM) by the expression in $Y = -7.5 + 6.2X$ ($R^2 = 0.61$). Urinary Mg levels were largely dependent on Mg intake and were rapidly influenced by changes in diet, times of feeding and introduction or removal of Mg supplements. "On farm" urinary Mg determinations show considerable promise as a guide to herd management but a greater understanding of the factors influencing urine Mg concentrations, and thus capable of biasing management decisions, is required.

INTRODUCTION

In recent years it has been demonstrated that suboptimal Mg status leads to significant reductions in the productive performance of dairy cows (Young and Rhys, 1977) and that the incidence of hypomagnesaemia is much greater (at least in the areas surveyed) than previously believed (Young, 1980). Significant economic advantages accrue from Mg supplementation of hypomagnesaemic stock but the practice introduces new management problems if unnecessary supplementation is to be avoided.

The only currently available diagnostic test for Mg status—the determination of plasma Mg concentration—suffers in practice from a relatively long delay from sample collection to return of results which, given the very rapid changes in blood Mg concentrations recorded after changes in weather and/or diet, means the results may no longer be relevant to the current situation. Furthermore limitations on analytical capacity frequently prevents submission of sufficient samples to adequately represent the herd. Thus a simple, reliable procedure for "on farm" assessment of either Mg status or Mg intake appears desirable.

The determination of urinary Mg as an indicator of either Mg status or Mg intake has been proposed by a number of authors who have reported various relationships between plasma and urine Mg concentrations or Mg intake and urinary Mg output (Kemp *et al.*, 1961; Storry and Rook, 1962). Accordingly there have been several studies investigating the usefulness of "on farm" determinations of urinary Mg as a measure of status or adequacy of intake. These studies generally support the concept but have not always been entirely satisfactory or relevant to New Zealand conditions because of such factors as inadequately defined diagnostic criteria, unavailable analytical methods, differences in feeding practices, and in some cases, the very low numbers of animals used in the trials (Collins, 1980; Halse, 1976; Simesen, 1977).

This paper is a preliminary report on our investigation of the potential of urinary Mg determinations under N.Z. conditions.

RESULTS AND DISCUSSION

Hypomagnesaemia is a seasonal problem. Thus to be of any diagnostic value urinary Mg concentrations should follow a seasonal pattern that readily identifies the problem period. Fig. 1 shows the changes in urine and plasma Mg concentrations recorded in the No. 4 Dairy herd, Ruakura, over a period of 18 months. Urinary Mg data are presented on a mg Mg/mg creatinine basis to partially correct for variations in urine concentration. A definite seasonal pattern was apparent with low urinary Mg concentrations during winter months, falling further during August and September, and thereafter rising to maximum levels over the summer months before declining during autumn to winter levels. This pattern was repeated during the 1981/2 season, but delayed 2 to 3 weeks. Numerically the differences between winter and summer Mg levels were large, being 13 fold in 1980/1 and 4 fold in 1981/2.

Blood Mg concentrations showed a somewhat similar pattern but the changes were not so marked.

To confirm this pattern in commercial herds 11 were chosen for their varied histories of hypomagnesaemia and supplementation procedures and monitored by collecting samples from 15 to 20 cows at 3 to 4 week intervals from late August until December. The herds fell into 2 general categories. Seven had low mean urinary Mg levels during early spring and subsequently followed the expected

seasonal pattern. The remaining 4 had high urinary Mg levels throughout spring and at the time of last sampling only 1 of these herds had shown any marked increase in urine Mg levels with the approach of summer.

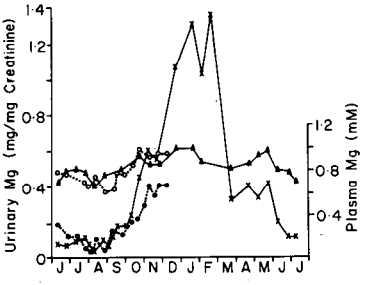

FIG. 1 Seasonal changes in the herd means for urine and plasma Mg concentrations. Samples (n > 25) from an unsupplemented herd.
Urine, x — x, 1980/1; ● . . . ●, 1981/2
Plasma, • — •, 1980/1; o . . . o, 1981/2

For these seasonal changes to be useful diagnostically we must be able to define predictive criteria allowing interpretation of test results. We have approached this indirectly by examining the relationship between urine and plasma Mg concentrations on the assumption that plasma Mg provides reliable information on Mg status and the likelihood of production responses, a premise that not all workers in the field would support (Anon., 1980).

The relationship between the herd means for urinary Mg levels (Y, mg Mg/mg creatinine) and plasma Mg (X, mM) in samples collected weekly from supplemented and unsupplemented herds at No. 4 Dairy is given by:

$$\ln Y = -7.5 + 6.24X, \quad R^2 = 0.61$$

A similar relationship

$$\ln = -7.9 + 6.98X, \quad R^2 = 0.5$$

was found in a commercial herd monitored weekly over the same period. Individual animals with plasma Mg concentrations less than 0.7 mM generally had low urinary Mg levels, while those with severe hypomagnesaemia (plasma Mg less than 0.4 mM) almost invariably had low urinary Mg outputs, although the converse was not always true.

Predictive criteria derived from the No. 4 herd have been applied to data collected from the monitored commercial farms with mixed success, due in part to the very wide range of plasma Mg concentrations found in any one herd. While herds with a major hypomagnesaemia problem were readily identified, a number of the surveyed herds using some form of Mg supplementation had high mean urinary Mg concentrations. They would be expected to have a satisfactory Mg status but were found to have a relatively high incidence of hypomagnesaemic cows and a lower than expected mean Mg level. This apparent discrepancy will have to be resolved before urinary Mg levels can be considered a reliable guide to herd management.

Such discrepancies may well lie in the particular feeding and supplementation practices used on these farms. Gross dry matter intake has a major influence on urinary Mg concentration. Preliminary studies show changes in Mg intake rapidly affect urinary Mg concentrations. Changes in diet, introduction or removal of Mg supplements are all apparent in the Mg concentrations of urine samples collected at the next milking, while maintenance or submaintenance rations offered as a single feed either night or morning result in marked differences in the Mg content of a.m. or p.m. urine collections.

In summary, our work to date supports the European studies suggesting that urinary Mg determination has promise as an indicator of Mg status in so far as it reflects Mg intake. This is especially so since urinary Mg levels can quite readily be measured by semiqualitative colorimetric methods suitable for "on farm" use by farmer, adviser or veterinarian. However a greater understanding of the factors influencing urinary Mg concentration and thus of biasing decisions based on the test results will be necessary before this promise can be realised.

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