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Milk urea concentration as affected by the roughage type offered to dairy cattle

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Abstract

Milk urea content (MUC) is used to manage protein nutrition and predict nitrogen excretion of dairy cows. However, MUC might depend on the roughage type offered and hence, for comparable MUC values, different N-excretions might be found. To evaluate this, three diets were compared in a feeding trial with 18 lactating Holstein cows in a Latin square design with as roughages 100% maize silage (treatment 100 MS), 50%/50% maize silage/prewilted grass silage (treatment 50 MS) and 100% prewilted grass silage (treatment 100 PGS). For all treatments, cows were fed to supply 105% of their net energy and digestible protein requirements and to have a daily rumen degraded protein balance (RDPB) intake of 100 g. This was only possible by feeding soybean meal as a protein corrector to 100 MS and 50 MS and by feeding citruspulp as an energy corrector in 100 PGS. The same balanced concentrate was fed to all groups. In a separate trial, N-balance was determined for both 100% rations.

In the feeding trial, the MUC of 100 MS (230 mg/l) and 50 MS treatment (214 mg/l) were significantly ($P < 0.001$) different from that of 100 PGS (171 mg/l). Cows on treatments 50 MS and 100 PGS ingested the same amount of RDPB (71 and 73 g/day), but when fed 100 MS cows ingested −16 g/day. After correction for differences in energy and protein supply, MUC of the 100 MS was 71 mg/l higher than that of 100 PGS.

N-balances indicated that total N-excretion (faecal, urinary and milk) was almost identical for both treatments: 392 for 100 MS versus 389 g/day for 100 PGS, as was environmental N-excretion (faecal and urinary): 259 for 100 MS versus 272 g/day for 100 PGS. However, the MUC content for 100 MS was significantly higher: 248 mg/l versus 180 mg/l for 100 PGS. From a correction for differences in energy and protein supply, this difference increased up to 84 mg/l between 100 MS and 100 PGS.

These results suggest that MUC is roughage dependent and that a system to predict N-excretion should account for these differences. Therefore the exact mechanism behind the determined roughage influence should be investigated further.

Keywords: Milk urea content; N-excretion; N-balance

Abbreviations: DPI, true protein digested in the small intestine; FPCM, fat protein corrected milk; MUC, milk urea concentration; RDPB, rumen degraded protein balance; NEL, feed unit net energy lactation.

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1. Introduction

Determination of the milk urea content (MUC) is simple and cheap. As such, MUC has been evaluated to predict various factors. It is used to manage protein nutrition and monitor protein efficiency (Hof et al., 1997; Godden et al., 2001b; Nousiainen et al., 2004). It appeared to have only limited utility as a monitoring tool for reproductive performance or as a predictive parameter of conception (Godden et al., 2001a; Guo et al., 2004). Furthermore, several models have been developed to predict nitrogen (N) excretion of dairy cows from MUC. Such a model could be used to give farmers an incentive to produce milk with a lower N-excretion to the environment. For example from an observed yearly average MUC above or below a fixed value, farmers could be punished or rewarded financially. It remains unclear which parameters should be used for an adequate prediction of the total N-excretion. Jonker et al. (1998) published a model to predict N-excretion from MUC, milk N and dietary crude protein (CP) percentage. Kohn et al. (2002) adapted this model slightly, partly by using body weight (BW) as an additional parameter to estimate urinary excretion. Nousiainen (2004) also derived a model to predict urinary N-excretion from MUC.

The accuracy of the above models is affected by nutritional factors, such as feed protein intake and the ratio of protein to energy in the diet, which have been reported frequently (Oltner and Wiktorsson, 1983; Oltner et al., 1985; Carroll et al., 1988; Roseler et al., 1993; Baker et al., 1995; Hof et al., 1997; Schepers and Meijer, 1998; Westwood et al., 1998; Trevaskis and Fulkerson, 1999; Steinwidder and Gruber, 2000; Van Duinkerken et al., 2005). Apart from the latter, none of the above researchers investigated a specific effect of the roughage type on the MUC at comparable energy and protein intakes. Van Duinkerken et al. (2005) compared the same forage combinations as we did (grass silage grass/maize silages and maize silage), but in a factorial design with 3 RDPB levels (0, 500 and 1000 g/day). They found forage type to be an explanatory factor (together with RDPB-level) of the NH_3 emission. However, they assumed that the forage type itself was not the causing agent, but rather the chemical or nutrient composition of it (Van Duinkerken et al., 2005).

At our institute, a model (De Brabander et al., 1999; more details see discussion) was derived to predict the MUC content of a maize silage/prewilted grass silage-based diet. This model was based on trials involving different roughage diets. From the statistical analysis of the total data set, an important influence of the roughage type on the MUC was found. However, the absence of a comparison of different roughages within the same trial includes that the roughage effect, deduced from the pooled data set, may have been confounded with other effects (e.g. trial or year effects). In literature, very little information exists on the influence of diet composition, at comparable protein and energy contents, on MUC. As such, this study was designed to examine that specific roughage type influence.

2. Materials and methods

2.1. Feeding trial

2.1.1. Experimental design and diet composition

The experiment was a 3 × 3 Latin square arrangement. Eight primiparous and 10 multiparous Holstein–Friesian cows, yielding between 22.5 and 38.7 kg milk/day at the beginning of the experiment, were blocked into three groups of six, based upon parity, body weight (on average 611 kg at start), milk production, fat and protein content of the milk, calving date (on average 145 DIM at start) and gestation stage.

The three rations were formulated to provide similar energy (NEL), and protein (CP, DPI and RDPB) levels. The roughages were offered ad libitum, consisted of 100% maize silage, 50% maize silage/50% prewilted grass silage and 100% prewilted grass silage in treatment 100 MS, 50 MS and 100 PGS, respectively, and were completed with balanced concentrate (same concentrate for all groups) and soybean meal (diets 100 MS and 50 MS) or citruspulp (diet 100 PGS) until 105% of the net energy for lactation (NEL; Van Es, 1978) and DPI (true protein digested in the small intestine; Tamminga et al., 1994) requirements. If necessary, urea was added to achieve a RDPB (rumen degraded protein balance; Tamminga et al., 1994) intake of 100 g daily. Roughages and concentrates were each given in two equal meals: concentrates were fed before milking in two daily