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Effect of protein supplementation on milk production and metabolism of dairy cows grazing tropical grass

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ABSTRACT

The objectives of this study were to determine if midlactation dairy cows (*Bos taurus* L.) grazing intensively managed elephantgrass would have their protein requirement met exclusively with the pasture and an energy concentrate, making the use of protein ingredients unnecessary, as well as to determine the dietary crude protein (CP) content that would optimize the efficiency of N utilization (ENU). Thirty-three Holstein and crossbred (Holstein × Jersey) midlactation dairy cows, producing approximately 20 kg/d, were grouped within breed into 11 blocks according to milk yield and days in milk. Within blocks, cows were randomly assigned to 1 of 3 treatments and remained in the study for 11 wk. The control treatment contained only finely ground corn, minerals, and vitamins, and it was formulated to be 8.7% CP. Two higher levels of CP (formulated to be 13.4 and 18.1%) were achieved by replacing corn with solvent-extracted soybean meal (SSBM). Pasture was fertilized with 50 kg of N/ha after each grazing cycle and averaged 18.5% CP (dry matter basis). No differences were observed in milk yield or milk fat, protein, and casein content or casein yield. In addition, pasture intake was not different among treatments. Milk urea N increased linearly as the concentrate CP content increased. Cows fed the 8.7% CP concentrate had higher ENU. In another experiment, 4 ruminally cannulated Holstein dry cows were used in a metabolism trial designed in a 4 × 4 Latin square. Cows were fed the same treatments described as well as a fourth treatment with 13.4% CP in the concentrate, in which urea replaced SSBM as the main N source. Ruminal volatile fatty acid concentration and microbial synthesis were not affected by levels or sources of N in the concentrate. Ruminal NH_3N content increased as the concentrate CP content increased. Inclusion of SSBM in the concentrate did not increase production and decreased the ENU of midlactation dairy cows grazing on tropical forage. Supplementation of an 8.7% CP concentrate, resulting in a diet with CP levels between 15.3 and 15.7% of dry matter, was sufficient to meet the protein requirements of such milk production, with the highest ENU (18.4%).

Key words: tropical pasture, protein supplementation, nitrogen metabolism

INTRODUCTION

During the last 10 yr, grazing management techniques have been implemented to improve the nutritive value and intake of tropical forage consumed by grazing dairy cows in Brazil (Pedreira et al., 2005; Da Silva and Nascimento Junior, 2007; Voltolini et al., 2008). High doses of N fertilization, between 200 and 500 kg/ha, are required to allow stocking rates of 6 to 10 cows/ha during the 6- to 7-mo rainy season (Santos et al., 2005). As a result of N fertilization, not only does the pasture CP content increase, but this increase is also accompanied by a decrease in NDF content (Johnson et al., 2001). A recent study concluded at the University of Wisconsin evaluated the nutrient composition and fiber digestibility of intensively managed tropical grasses collected in Brazil (Lopes, 2011). The 106 samples (from 6 different species) came from areas fertilized with 200 to 400 kg of N/ha with fewer than 30 d of regrowth, and CP and NDF content ranged from 14 to 21% and 60 to 63%, respectively. Those results showed that tropical grasses can present adequate nutritive value when well managed.

Additionally, N fertilizer accelerates plant growth; therefore, an adjustment in grazing management is necessary to avoid offering the animal old forage with a high fibrous content. The optimal physiological stage of utilization of grass pastures, from both the plant and animal standpoint, has been shown to be the point at which the canopy intercepts 95% of the incident light (Parsons et al., 1988; Carnevalli et al., 2006), and this stage seems to be well correlated with a specific canopy height for each grass species (Carnevalli et al., 2006; Giacomini et al., 2009; Voltolini et al., 2010). Those findings led to a new rotational grazing management

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approach, in which grazing intervals are variable and dependent on sward height, rather than the traditional method of a fixed number of days. In fertilized areas during the rainy season, the variable interval is usually shorter than the fixed number of days traditionally recommended, leading to a less mature plant being offered to the animal, with better nutritive value.

When the chemical composition of intensively managed tropical grasses (CP levels ranging from 15 to 21% DM) was used in the NRC (2001) and Cornell Net Carbohydrate and Protein System (**CNCPS**, version 6.1; Cornell University, Ithaca, NY) models, both suggested that only energy supplementation was needed to meet the nutritional requirements of grazing dairy cows producing 20 kg/d of milk. According to the NRC (2001) model, more than 18% CP in the forage already leads to an excess supply of MP, even for dairy cows supplemented with energy ingredients only in the concentrate.

However, regardless of the evidence provided by the models, resistance exists among the dairy farmers about reducing the CP of the diet. Concentrate mixtures sold commercially for grazing dairy cows in Brazil usually contain 17 to 25% CP, even when cows graze pasture that is intensively managed. Likewise, in Louisiana and Mississippi, a survey with 40 grazing dairy farms reported that 75% of the locations were overfeeding CP, using concentrates with more than 18% CP (McCormick et al., 2001). Overfeeding CP not only increases feed cost, but also increases the energy required to eliminate the excess N (NRC, 1989) and reduces the efficiency of N utilization (**ENU**). Moreover, N excretion may potentially result in environmental problems, such as N volatilization or leaching into the groundwater (Tamminga, 1992).

The resistance in reducing dietary CP for grazing cows fed tropical grasses might be related to concerns about the accuracy of model predictions of pasture DMI and the maintenance requirements of grazing cows because the equations were developed mainly for confinement animals and are associated with the limited availability of studies on the optimal protein level in diets for dairy cows grazing intensively managed tropical grasses. Voltolini et al. (2008) evaluated 3 levels of CP (17.3, 21.2, and 25% of DM) in the concentrate for cows grazing elephantgrass with 12% CP and found no treatment effect on milk or milk solids yield. In another study, Pereira et al. (2009) tested 3 levels of CP (15.2, 18.2, and 21.1% of DM) in the concentrate for cows grazing elephantgrass with 13.9% CP and did not find any advantage in DMI or milk yield of increased levels of CP in the diet. However, both studies still used protein ingredients in the concentrates, leading to higher levels of CP than an exclusively energy concentrate, which was suggested to be sufficient by the model simulation. Additionally, the forage CP observed in both studies was lower than was achievable with intensively managed rotational grazing.

Therefore, the objective of this study was to determine whether midlactation dairy cows grazing intensively managed tropical grasses (high N fertilizer doses and variable grazing intervals) would have their protein requirements met only by the forage plus a concentrate with energy ingredients, confirming what the model simulations have been showing as adequate and making the use of protein ingredients unnecessary in the concentrate of those cows. This study also aimed to estimate the optimal dietary CP to improve ENU in an intensively managed tropical grazing system.

MATERIALS AND METHODS

Grazing Management and Pasture Measurements

The 6.5 ha of pasture used in the study was composed of elephantgrass (*Pennisetum purpureum*), cv. Cameroon (70% of the paddocks) and cv. Napier (30% of the paddocks), and it was fertilized with 50 kg of N/ha after each grazing cycle. All cows from the lactation and ruminal metabolism trials grazed together, and a new paddock (2,000 m^2) was allotted for the animals every day, after the evening milking, with free access to natural shade and fresh water. The rotational grazing management was based on canopy height, with 103 cm as the entrance height for Cameroon and 90 cm for Napier, both previously determined as the point at which the canopy intercepted 95% of incident light (Voltolini et al., 2010; Da Silva, University of São Paulo, Piracicaba, São Paulo, Brazil, personal communication).

Experimental cows grazed the paddock as the first group, and they were kept in the paddock for 1 d only, grazing the canopy down to an average of 64.2 cm (Table 1) throughout the trial. A group of animals with a lower requirement (dry cows and pregnant heifers) was used to graze the pasture down to its residual postgrazing sward height [52 ± 5 cm (mean ± SD)]. The average interval between grazing cycles was 28 d, and the average stocking rate, considering only the experimental animals (i.e., not including the second group that grazed down the paddocks to the final residual height), was 5 cows/ha.

Sward height measurements were taken every day before the experimental animals entered the paddock, after they left, and also after the second group of animals was removed, for an average of 20 randomized points in each measurement. Forage mass and morphological composition were determined weekly on 3 consecutive

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