J. Dairy Sci. 99:8779–8789
http://dx.doi.org/10.3168/jds.2016-11023
© American Dairy Science Association®, 2016.

Digestive response of dairy cows fed diets combining fresh forage with a total mixed ration

A. Mendoza,*[1] C. Cajarville,† and J. L. Repetto*[2]
*Departamento de Producción de Bovinos, and
†Departamento de Nutrición Animal, Instituto de Producción Animal, Facultad de Veterinaria, Universidad de la República, Ruta 1 km 42.5, 80100, San José, Uruguay

ABSTRACT

The objective of this experiment was to quantify the response of dairy cows fed a total mixed ration (TMR) to increasing access to high-quality temperate fresh forage with respect to energy intake, rumen fermentation, microbial protein flow, passage rate, nutrient digestion and utilization, and metabolic and endocrine profiles. Nine Holstein cows fed a TMR were assigned to the following treatments according to a 3 × 3 Latin square replicated 3 times with 20-d periods and sampling on the last 10 d of each period: 0 (T0), 4 (T4), or 8 (T8) h of daily access to fresh forage. The forage (*Lolium multiflorum*; 17.1% crude protein, 26.5% acid detergent fiber) was cut daily and offered ad libitum beginning at 0800 h, and a TMR (16.1% crude protein, 22.9% acid detergent fiber) was offered ad libitum during the remaining time. Energy intake and balance were higher in T0 than in T8, which was reflected in higher blood glucose and insulin concentrations in T0. Total volatile fatty acid concentrations in the rumen were higher in T0 and T4 than in T8, pH was lower in T4 than in T8, and ammonia-N was higher in T0 than in T8. No differences among treatments were detected in microbial protein flow to the duodenum, digestibility of nutrients, apparent efficiency of energy, or N utilization for milk production, but the total mean retention time of feed in the digestive tract was higher in T8 than in T0. It is concluded that more than 4 h of daily access to high-quality fresh forage in the diet of dairy cows fed a TMR reduced energy intake and balance but had no effects on nutrient digestion or utilization.
Key words: total mixed ration, fresh forage, rumen fermentation, digestibility

INTRODUCTION

Recently, interest has been renewed in the utilization of fresh forage (**FF**) for dairy cows. Where dairying relies on the sole use of a TMR for feeding dairy cows, this interest in FF may be justified when feed costs increase, as well as a greater volatility in the price of conventional feeds. Additionally, inclusion of FF in the diet of cows increases the proportion of certain milk components (e.g., rumenic and vaccenic FA) that may have nutritional benefits for human health (Elgersma et al., 2006). On the other hand, in countries where dairying relies on direct grazing of forage, utilization of FF in combination with a TMR may improve milk yields when compared with the more traditional supplementation of grazing cows with concentrates in the milking parlor or conserved forage on a feed pad (Bargo et al., 2002a; Wales et al., 2013).

Part of the observed differences in milk yield between these feeding systems may be related to differences in nutrient intake, which has been reported to be higher in TMR-fed cows than in grazing cows (Bargo et al., 2003). For example, we have recently reported that cows with 4 h of access to high-quality FF had similar DMI levels and milk yields as cows fed only with TMR, but more than 4 h of access reduced DMI and performance, although milk fat had higher content of beneficial fatty acids (Mendoza et al., 2016). Although animal performance is also explained by how nutrients are digested in the gastrointestinal tract and how they are used in different tissues, the effect of feeding diets that combine a TMR and FF on the digestion and metabolism of nutrients in dairy cows remains largely unknown. In an in vitro study, Vibart et al. (2010) reported no differences in rumen pH or NH_3-N concentrations, but observed linear increases in total diet digestibility with a greater proportion of fresh annual ryegrass in a TMR-based diet, whereas Soder et al. (2013) reported reduced pH, NH_3-N concentration and apparent NDF digestibility, and true OM digestibility in fermentors fed only a TMR compared with only fresh orchardgrass. However, considerable differences exist in VFA concentrations and

Received February 11, 2016.
Accepted May 11, 2016.
[1]Current address: Programa de Producción de Leche, Instituto Nacional de Investigación Agropecuaria, Ruta 50 km 11, 70002, Colonia, Uruguay.
[2]Corresponding author: joselorepetto@gmail.com

nutrient digestion data obtained by rumen simulation techniques or in vivo trials (Hristov et al., 2012). For example, Bargo et al. (2002b) reported no differences in the rumen pH or NH_3-N concentration but lower NDF digestibility when dairy cows were fed a TMR compared with TMR plus a grass-based FF (Bargo et al., 2002a). Santana et al. (2011, 2012) reported a higher rumen pH in beef heifers fed a legume-based FF compared with only TMR or a TMR plus 6 h of access to the FF, but no differences were detected in DM digestibility. These discrepancies among experiments may be related to the particular experimental approach chosen in each study (in vitro or in vivo), the nutritional quality of the TMR and FF used, the type of FF, or the proportion of FF in the diet, but the relative contribution of each factor is unknown.

The design of optimal feeding strategies requires a better understanding of the digestive and metabolic responses of cows when offered diets that combine a TMR and FF. However, to date there is a paucity of published information on key aspects that affect in vivo nutrient digestion such as the dynamics of rumen fermentation, digesta passage rate, and microbial protein flow to the duodenum, as well as on associated metabolic indices of energy and protein status. Therefore, to gain insight on the formulation of diets that combine FF and TMR and maximize nutrient availability to the animal, the objective of this experiment was to determine the changes in energy intake, rumen fermentation, nutrient digestion and utilization, and metabolic and endocrine profiles of TMR-fed lactating cows with varying degrees of access to high-quality FF.

MATERIALS AND METHODS

Animals, Treatments, and Experimental Design

The experiment complied with regulations set by the Bioethics Committee of the Veterinary Faculty (Universidad de la República, Uruguay). Nine multiparous Holstein cows fitted with permanent rumen catheters, and with a milk yield record during the previous 305 d of lactation of 7,079 kg (SD = 1,226), were selected from the herd at Experimental Station of the Veterinary Faculty (Universidad de la República, Uruguay) in San José, Uruguay (34°40′ S, 56°32′ W). Cows were blocked into 3 squares balanced for BW, previous milk yield, DIM, and parity, and within each square were randomly assigned to treatment sequences according to a replicated 3 × 3 Latin square design. At the start of period 1, cows had an average BW of 572 kg (SD = 76), 100 DIM (SD = 25), and a parity of 4.3 (SD = 1.2). Each period lasted 20 d and consisted of 10 d for adaptation followed by 10 d of data and sample collection. The treatments evaluated were 0 h of access to FF plus 24 h of access to a TMR (**T0**), 4 h of access to FF plus 20 h of access to a TMR (**T4**), or 8 h of access to FF plus 16 h of access to a TMR (**T8**).

Cows were housed in individual tie stalls (2.0 × 1.3 m) with ad libitum access to water and were milked at 0700 and 1800 h. A pastureland of Italian ryegrass (*Lolium multiflorum*; var. INIA Bakarat) was seeded (15 kg per ha) on March 3, 2011, and was fertilized with 27 kg of N per ha and 69 kg of P per ha as diammonium phosphate and was used throughout the experimental period. The pastureland was divided into 3 paddocks with 1 paddock used during each period. Average herbage mass for the 3 periods was 2,413 ± 552 kg of DM per ha, with a height between 20 and 25 cm; all forage used was in a vegetative stage. Herbage was harvested daily at 0700 h with a mower, leaving a residual height of 10 cm. The FF was immediately collected, stored under a roof, and offered unchopped in individual feed troughs from 0800 to 1200 h, or from 0800 to 1600 h, to T4 and T8 cows, respectively. To ensure that amount of feed was not limiting at any time, the feed trough was observed every 30 min, and if necessary, more feed was added. Cows in T4 and T8 had access to the TMR from 1200 to 0700 h, and from 1700 to 0700 h, respectively, which was delivered as described above for the FF. Cows in T0 had ad libitum access to the TMR all day. Every day at 0800 h, which will herein be referred to as h 0, orts from the previous 24 h were removed from the feed trough, and new feed was offered.

Feed Analysis

Samples of TMR and FF were taken at 0800, 1200, and 1600 h on d 13 to 20 of each period and composited to obtain one sample per day, whereas approximately 20% of feed orts were sampled from each cow. Particle size distributions of the TMR were assessed using the modified Penn State Particle Size Separator (Kononoff et al., 2003). All samples were kept frozen at −20°C until analysis. Feed samples were dried in a forced-air oven at 60°C and ground to pass through a 1-mm Wiley mill screen (Arthur H. Thomas Co., Philadelphia, PA). Feed samples were analyzed for DM, ash, total N, and ether extract (AOAC, 1990; methods 934.01, 942.05, 955.04, and 920.39, respectively); NDF using heat-stable α-amylase and sodium sulfite; ADF and ADL (Van Soest et al., 1991), expressed exclusive of residual ash; and NDIN and ADIN (Licitra et al., 1996). Organic matter was determined as the difference between DM and ash content. The concentration of NFC was estimated as 100 − (% NDF + % CP + % ether extract + % ash) (NRC, 2001). The concentration of NE_L was calculated from chemical composition analyses, actual

Download English Version:

https://daneshyari.com/en/article/5542653

Download Persian Version:

https://daneshyari.com/article/5542653

Daneshyari.com