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Short communication: Feeding red clover cut in the afternoon or morning to late-lactation dairy cows

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ABSTRACT

Forages cut in the afternoon (p.m.) generally yield a higher concentration of nonstructural carbohydrates (NSC) than those cut in the morning (a.m.). We aimed to compare the effects of p.m.-cut red clover baleage (p.m.-RC) versus a.m.-cut RC baleage (a.m.-RC) on milk yield, concentrations and yields of milk components, and apparent total-tract digestibility of nutrients in late-lactation Holstein cows. Twelve multiparous and 2 primiparous Holstein cows received a total mixed ration containing, on a dry matter (DM) basis, 65% p.m.-RC or a.m.-RC plus 35% concentrate in a crossover design with 14 d for diet adaptation and 7 d for data and sample collection. One RC field was split in 2 with the first half cut in the afternoon (1600 h) and the second half in the following morning (0600 h). The p.m.-RC and a.m.-RC contained (% of DM): 12.6 versus 9.43% NSC in samples collected before the beginning of the experiment and 7.49 versus 7.79% NSC in samples collected during the sampling periods (i.e., d 14 to 21). The total mixed rations averaged 18.2 and 17.5% NSC for the p.m.-RC and a.m.-RC, respectively. Feeding p.m.-RC or a.m.-RC did not improve feed intake or milk yield and composition in late-lactation dairy cows. However, milk urea N and plasma urea N were both lowest in cows offered p.m.-RC. With the exception of the apparent total-tract digestibility of DM, which was highest in cows fed p.m.-RC, no other changes in nutrient digestibility were observed. Similarly, no treatment effect was observed for the urinary excretion of N and purine derivatives. Further research is needed to better understand NSC losses during storage and the associated effects on baleage quality and animal performance.
Key words: baleage, dairy cow, diurnal cutting management, red clover

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In general, forage sources are rich in RDP but poor in NSC [defined herein as total ethanol-soluble carbohydrates (**TESC**) or water-soluble carbohydrates plus starch] leading to unbalanced supplies of NH_3 and fermentable energy in the rumen. Plant C fixation occurs at a greater rate than C exportation during daylight resulting in accumulation of NSC in tissues of grass and legume species as the day progresses (Bowden et al., 1968; Lechtenberg et al., 1971; Gordon, 1996). Pelletier et al. (2010a) compared the NSC concentration of 8 cool-season forage crops cut at a.m. versus p.m. and reported that red clover (**RC**; *Trifolium pratense* L.) and tall fescue [*Schedonorus phoenix* (Scop.) Holub] showed the greatest concentrations of NSC across cutting times and growth periods. We reported previously that p.m.-cut alfalfa (*Medicago sativa* L.) baleage fed as the sole feed source to late-lactation Holstein cows significantly increased milk yield, milk N efficiency, and omasal flow of microbial NAN compared with a.m.-cut alfalfa baleage (Brito et al., 2008, 2009). Although research-based information about the use of alfalfa with enhanced concentration of NSC offered as baleage (Brito et al., 2008, 2009, 2014) or hay (Yari et al., 2014) to lactating dairy cows is growing, we are not aware of studies in which the effects of p.m.-cut RC baleage on milk yield and nutrient utilization have been investigated. We hypothesized that, compared with a TMR containing a.m.-cut RC baleage (**a.m.-RC**), a TMR with p.m.-cut RC baleage (**p.m.-RC**) would improve milk yield and N utilization in late-lactation dairy cows due to the enhanced supply of ruminal fermentable energy. The objectives of this study were to compare the effects of daytime cutting management (p.m.-RC versus a.m.-RC baleage) on milk yield, concentrations and yields of milk components, and apparent total-tract digestibilities of nutrients in late-lactation Holstein cows.

Care and handling of the animals used in the current study were conducted as outlined in the guidelines of the University of New Hampshire Institutional Animal Care and Use Committee (Institutional Animal Care

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and Use Committee protocol no. 100702). The 42-d-long experiment was conducted at the University of New Hampshire Fairchild Dairy Teaching and Research Center (Durham, NH; 43°14′N, 70°95′W) from March 9 to April 18, 2011. Cows were housed in a naturally ventilated tie stall barn and had access to water throughout the experiment.

The red clover (second cutting at 50% flowering stage) used in the current study was grown in 1 field [4 ha; 75% red clover stand and 25% others (i.e., grass and weeds)] at the Agriculture and Agri-Food Canada, Dairy and Swine Research and Development Centre located in Sherbrooke, QC, Canada (45°24′N, 71°54′W). The first summer regrowth of half of the field (74% RC herbage) was cut in the afternoon on July 26, 2010 (1600 h; p.m.-RC), which was a sunny day (maximum, minimum, and mean temperature of 24.4, 15.1, and 19.8°C, respectively) with a global radiation of 24 MJ/m^2. Forage was racked and baled at 1300 and 1715 h, respectively, on July 27, 2010. The second half of the field (75.2% RC herbage) was cut on July 27, 2010, in the morning (0600 h; a.m.-RC), and racked and baled at 1700 and 1745 h, respectively, on the same day. The concentrations of NSC in the RC herbage averaged 9.40% (p.m.-RC) and 7.22% (a.m.-RC) at cutting, and 9.09% (p.m.-RC) and 7.94% (a.m.-RC) at baling. A total of 53 bales (27 p.m. and 26 a.m. = 12,900 kg of DM) were made and later transported to the University of New Hampshire. The time elapsed between red clover baling and feeding (d 1 of the study) was 267 d. The ranking and paring procedures, as well as the sampling methodology used for RC bales, were similar to those reported for alfalfa bales (Brito et al., 2008, 2014). Bales fed during the sampling period (i.e., d 14 to 21) period were chopped before feeding with representative samples collected and processed according to Pelletier et al. (2010b). In brief, samples were pretreated (i.e., heated in a microwave oven for 1 min at maximum intensity to reach approximately 70°C) and then oven-dried at 55°C for 48 h before TESC and starch analyses.

Twelve multiparous and 2 primiparous Holstein cows averaging (mean ± SD) 238 ± 23.3 DIM and 693 ± 67.1 kg of BW at the beginning of the experiment were blocked by DIM, parity, and milk yield. Within each block, cows were randomly assigned to 1 out of 2 TMR (65:35 forage-to-concentrate ratio) containing either p.m.-RC or a.m.-RC baleage in a crossover design. Each experimental period lasted 21 d with 14 d for diet adaptation and 7 d for data and sample collection. The TMR was offered to cows individually in tie stalls twice a day (0500 and 1400 h) with the amount of feed adjusted daily to yield refusals equal to approximately 5 to 10% of intake. Cows were milked twice daily (0430 and 1600 h) with milk yield recorded throughout the duration of the study. Body weight was recorded after the afternoon milking for 3 consecutive days at the beginning of the experiment and during the last 3 d of each period to compute ADG.

During each sampling period, samples of TMR and refusals were collected daily, pooled by period, and stored at −20°C until analyses. Samples were then thawed at room temperature, dried (55°C, 48 h; forced-air oven), and ground to pass through a 1-mm screen (Wiley mill, Arthur H. Thomas, Philadelphia, PA). Samples of TMR and baleage were analyzed for absolute DM (105°C), ash, total N, NDF, ADF, and lignin following the methods reported by Brito et al. (2015), starch and TESC (Brito et al., 2014), and indigestible ADF (Brito and Broderick, 2006). In addition, TMR was analyzed for crude fat, NDIN, and ADIN (Brito et al., 2015).

Milk samples were collected for 4 consecutive milkings (d 18, 19, and 20) beginning in the afternoon milking of d 18 and were preserved, pooled, and analyzed for fat, protein, lactose, and MUN according to Brito et al. (2015). Blood samples were collected for 2 consecutive days (d 20 and 21) approximately 5 h after the morning feeding and processed and analyzed for plasma urea N (**PUN**) as described elsewhere (Brito et al., 2015). Fecal grab samples and spot urinary samples were collected for 4 consecutive days (d 15 to 18) at approximately 6-h intervals, yielding a total of 12 sampling points. Feces and urine were processed following the methodology reported previously (Brito et al., 2015). Pooled fecal samples were analyzed for DM, ash, total N, NDF, ADF, and indigestible ADF according to the methods reported earlier (Brito and Broderick, 2006; Brito et al., 2015). Pooled urine samples were analyzed for creatinine and urea N using colorimetric methods (Brito et al., 2015), and for uric acid and allantoin by HPLC (Beckman Instruments, San Ramon, CA; Balcells et al., 1992). Fecal output of DM (indigestible ADF as the internal marker) was determined according to Cochran et al. (1986). Urinary volume was estimated assuming a constant creatinine excretion rate of 29 mg/kg of BW (Valadares et al., 1999).

Data were analyzed using the MIXED procedure of SAS (version 9.4, SAS Institute, Inc., Cary, NC) according to a crossover design. The following model was fitted for all variables:

$$Y_{ijkl} = \mu + S_i + C_j(S)_i + P_k + T_l + E_{ijkl},$$

where Y_{ijkl} = dependent variable, μ = overall mean, S_i = mean effect of the ith crossover sequence group, $C_j(S)_i$ = mean effect of jth cow nested within ith sequence, P_k = mean effect of kth period, T_l = mean effect