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Effects of feeding wheat straw or orchardgrass at ad libitum or restricted intake during the dry period on postpartum performance and lipid metabolism[1]

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ABSTRACT

The objectives of this study were to investigate the effects of forage source [wheat straw (WS) or orchardgrass hay (OG)] and total amount of diet dry matter fed [ad libitum or restricted to 70% of predicted dry matter intake (DMI)] prepartum on postpartum performance. The study design was a 2 × 2 factorial design with 10 cows per treatment. Treatments were WS total mixed ration (TMR) ad libitum, OG TMR ad libitum, WS TMR restricted, and OG TMR restricted. The WS TMR (dry matter basis) contained 30% WS, 20.7% corn silage, 10.0% alfalfa hay, 18.2% ground corn, 16.8% soybean meal, and 4.3% molasses mineral mix (14.7% CP, 1.5 Mcal/kg of net energy for lactation, 37.0% neutral detergent fiber). The OG TMR contained 30% OG, 46.2% corn silage, 10.0% alfalfa hay, 9.5% soybean meal, and 4.3% molasses (14.2% CP, 1.5 Mcal/kg of net energy for lactation, 41.0% neutral detergent fiber). Cows received 1 lactation diet after calving (17.7% CP, 1.6 Mcal/kg of net energy for lactation, 27.3% neutral detergent fiber). Total diet DMI prepartum was higher for ad libitum than for restricted as designed, but forage source had no effect on DMI. Total tract apparent digestibilities of DM and NDF were greater for OG than for WS. Postpartum DMI expressed as a percentage of body weight for the first week of lactation was higher for ad libitum than for restricted diets. Postpartum DMI during the first 30 d of lactation was higher for OG than for WS, but no effect was observed for the amount fed prepartum. Milk yield during the first week of lactation was higher for OG than for WS; however, during the first 30 d, 3.5% fat-corrected milk yield and yield of milk fat were highest for OG TMR restricted and WS TMR ad libitum. Prepartum treatments had a limited effect on pre- and postpartum lipid metabolism; however, cows fed WS TMR ad libitum had the highest postpartum β-hydroxybutyrate. Eating behavior was observed by 10-min video scans of 24-h video surveillance for 5 d pre- and postpartum. Prepartum eating time and eating bouts tended to be greater by WS than for OG, and postpartum eating time per kilogram of neutral detergent fiber intake tended to be greater for WS than for OG. Results indicate that forage source and amount of DM fed prepartum affected postpartum performance and tended to alter the behavior of cows in tie-stall barns.

Key words: forage, ad libitum, restricted, transition cow

INTRODUCTION

Nutrition and management strategies to prevent the decrease in DMI before calving are not clearly defined. Maintaining DMI in periparturient dairy cattle is important to minimize the disruption in energy balance, which is known to affect lipid mobilization and the performance of dairy cattle after parturition. Minimizing the extent and duration of the negative energy balance will help reduce lipid mobilization, which is linked to liver lipid accumulation (Hammon et al., 2009; McCarthy et al., 2010) and impaired immune function (Wathes et al., 2009). The concept of prepartum limit feeding has received some interest from researchers. Grum et al. (1996) was the first to report that a lower energy intake prepartum (with lower DMI because of fat supplementation) was associated with a lower liver lipid accumulation without a significant detriment to milk production. Subsequently, Douglas et al. (2006) limit-fed cows prepartum and observed higher DMI and NE_L intake during the first 21 d postpartum compared with cows fed ad libitum. The authors concluded that the amount of prepartum energy intake had an effect on metabolism because lower prepartum energy intake resulted in improvements in key metabolic indicators. Other researchers have demonstrated that limit feeding prepartum to maintain a consistent energy balance (Kunz et al., 1985; Holcomb et al., 2001) or a slightly

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negative energy balance prepartum (Holtenius et al., 2003) results in higher postpartum DMI. More recently, Dann et al. (2006) demonstrated that cows with a lower energy balance [either limit fed or using wheat straw (**WS**) to dilute the dietary energy density] during the far-off dry period had higher postpartum DMI and a higher energy balance and lower serum NEFA and BHBA during the first 10 DIM.

Reasons for the improvements in postpartum DMI from limiting energy intake prepartum by restricted feeding remain unclear. The published data suggest that higher DMI postpartum reduces lipid mobilization and prevents the suppression of DMI by NEFA (Overton and Waldron, 2004). Limit-fed cows therefore have lower energy intake and are potentially at lower risk for excessive lipid mobilization compared with ad libitum-fed cows, which often consume energy in excess of requirements (Dann et al., 2006; Winkelman et al., 2008). Limit feeding also prevents BCS gain during the dry period (Dann et al., 2006), reduces feed costs, and reduces the amount of nutrients excreted into the environment (Hoffman et al., 2007; Zanton and Heinrichs, 2007). Perhaps restricted-fed cows have less rumen fill and a greater appetite drive immediately postpartum compared with ad libitum-fed cows. The effect of prepartum rumen fill on feed intake would likely be only transient unless limit feeding had carryover effects on postpartum feeding behavior. The digestibility of limit-fed diets and mean retention time in the rumen are likely also important factors contributing to DMI in the first week postpartum. Sheep fed in restricted amounts spent more time ruminating per gram of DMI (Galvani et al., 2010), and cattle fed in restricted amounts increased the chewing rate when eating and ruminating (Dias et al., 2011). To our knowledge, no studies have examined the effect of prepartum restricted feeding on postpartum feeding behavior.

In addition to restricted feeding, we wanted to compare the effect of feeding 2 dry forages that varied greatly in physical and chemical properties, WS or orchardgrass hay (**OG**), to determine the effect of forage type on periparturient performance. Wheat straw tends to be lower in potassium than grasses, which accumulate potassium within plant tissues. Minerals from forages are thought to be readily digestible and contribute to the DCAD. A positive DCAD increases the risk for hypocalcemia and related periparturient disorders (Lean et al., 2006). Additionally, the rate of digestion is likely an important factor in the selection of forages for dry cow diets. Wheat straw has a slower ruminal disappearance rate compared with OG, resulting in greater rumen fill that maintains a more stable rumen fiber mat, reducing the risk for displaced abomasum after freshening (Douglas et al., 2006; Janovick et al., 2011), but perhaps also limits feed intake in the first days after parturition. The amount and rate of digestion of NDF on the periparturient dairy cow is unknown. The rate and extent of NDF digestion affects ruminants by altering DMI, microbial ecology, VFA production, and rumination behavior and influencing the rate of passage through the gastrointestinal tract.

The objectives of this study were to determine whether limit feeding during the dry period would prevent the decline in intake at parturition, and to determine whether the forage source would alter prepartum energy intake, postpartum performance, and metabolism. We hypothesized that limit feeding would result in more consistent DMI through parturition and that OG would result in greater prepartum energy intake compared with WS.

MATERIALS AND METHODS

Animals and Treatments

All procedures involving animals were approved before the onset of the experiment by the University of Minnesota Institutional Animal Care and Use Committee (No. 0706A09601). The experiment began in September 2008 and ended in March 2009. Holstein and Holstein crosses with Jersey, Montbéliard, and Swedish Red dairy cattle (n = 40) entering their second or later lactation were selected from the University of Minnesota Dairy Teaching and Research Center. Treatments were balanced for BW at dry off, parity, breed, and previous-lactation 305-d mature-equivalent milk yield. At the day of dry off (45 d before expected calving) cows were assigned to 1 of 4 treatments: (1) WS ad libitum (**AWS**), (2) OG ad libitum (**AOG**), (3) WS restricted (**RWS**), and (4) OG restricted (**ROG**). The restricted diets were fed at 70% of NRC (2001)-predicted DMI for dry cows. Dietary treatments are described in Tables 1 and 2. Prepartum diets fed ad libitum (**A**-fed) were formulated for 13.6 kg/d of DMI and those fed restricted were formulated for 9.5 kg/d of DMI. To ensure the nutrient requirements were met for restricted-fed (**R**-fed) cows, the diets were formulated to supply greater than 100% of nutrient requirements for multiparous dry cows averaging 635 kg at 270 d of gestation when fed ad libitum. All nutrient requirements were met except for MP, which was calculated as106 ± 6.0 g/d less than required for R-fed cows; however, requirements for the amino acids lysine and methionine were met. Wheat straw and OG were chopped in a vertical mixer to reduce particle size to a uniform consistency between forages. Cows were fed a common lactation diet (Table