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Effects of shortening the close-up period length coupled with increased supply of metabolizable protein on performance and metabolic status of multiparous Holstein cows

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ABSTRACT

This experiment was conducted to compare conventional (CON; 21 d) and shortened (SH; 10 d) close-up period, and evaluate the effect of shortened close-up period combined with feeding different metabolizable protein (MP) levels on dry matter (DM) intake, metabolic status, and performance of dairy cows. Forty-eight multiparous Holstein cows with similar parity, body weight (BW), and previous lactation milk yield were divided into 2 groups. The first group (n = 24) received the far-off diet from −60 to −21 d (CON), and the second group (n = 24) received same far-off diet from −60 to −10 d (SH) relative to expected parturition. Cows were then moved to individual stalls and randomly allocated to 1 of 3 close-up diets: low MP diet (LMP; MP = 79 g/kg of DM), medium MP diet (MMP; MP = 101 g/kg of DM), or high MP diet (HMP; MP = 118 g/kg of DM). Treatments were used in a 2 × 3 factorial arrangement with 2 lengths of close-up period (CON and SH) and 3 levels of MP (LMP, MMP, and HMP). All diets were fed for ad libitum intake during the close-up period. After calving, all cows received the same fresh cow diet. We found no interaction between close-up period length and MP levels for traits, except for postpartum serum fatty acids and β-hydroxybutyrate (BHB). The concentrations of postpartum serum fatty acids and BHB were higher on LMP than MMP and HMP diets in SH group. The cows of the SH group tended to produce less colostrum in the first milking than cows in CON group. The length of close-up period did not affect pre- and postpartum DM intake or energy balance of cows during the last week of prepartum, but cows of the CON group had greater BW changes during the last 3 wk before parturition than cows in SH group. Cows fed MMP and HMP diets consumed 1.2 and 1 kg more DM than for those fed LMP prepartum, respectively. The concentrations of prepartum BHB and Ca were higher for SH cows than CON group cows. Except for blood urea N concentration, no other blood metabolite in prepartum was affected by dietary MP. We found no effects of close-up period length or MP levels in the close-up diet on urinary pH, purine derivative excretion, and microbial N flow. Postpartum, milk yield was not affected by close-up period length, but cows in CON group tended to have higher 4% fat-corrected milk yield, had higher milk fat content and yield, had greater BW and body condition score loss, and higher energy negative balance than cows in the SH group. Cows fed MMP diet ate 1.8 kg more DM and yielded 3.37 kg more milk than those fed the LMP diet. Milk fat, protein, and lactose content, milk urea N, and somatic cell count were not affected by MP levels, but the yield of milk protein and lactose were higher on MMP diet than on LMP diet. Concentrations of postpartum serum fatty acids and BHB were decreased by shortening the close-up period length, but glucose, cholesterol, and triglyceride were similar between close-up groups. During the postpartum period, serum fatty acids, BHB, aminotransferase, and Ca concentrations were decreased by increasing the MP levels in the close-up diet. It appears from this data set that multiparous cows will benefit from a shortened close-up period, and feeding a moderate MP diet could improve DM intake, milk yield, and metabolic status of periparturient dairy cows.

Key words: shortened close-up, metabolizable protein, metabolic status, periparturient cow

INTRODUCTION

The transition period is an extremely challenging period in the cow's productive cycle, where careful formulation of the diet can improve subsequent performance and health status (Lean et al., 2013). One of the tremendous challenges to successful adaptation in dairy cows is reduced DMI during the transition period (Lean et al., 2013). Feed intake is usually decreased 30

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to 35% during the last 3 wk before parturition (Grummer, 1995; Richards, 2011), and 89% of this decline happens in the last 7 d before calving (Hayirli et al., 2002). Grummer (1995) stated that prefresh feed intake was positively correlated with postcalving feed intake, and improving DMI during the prefresh period may have a significant effect on health and productivity after calving; therefore, strategies to maximize DMI should be initiated precalving (Grummer, 1995). These strategies included increasing the energy density of the diet during the entire dry period (Rabelo et al., 2003; Vickers et al., 2013; Mann et al., 2015) or the close-up period (Roche et al., 2015; Zhang et al., 2015), or limiting energy intake by restricted feeding in dry period (Dann et al., 2006; Douglas et al., 2006) or different days of exposure to close-up diet (Mashek and Beede, 2001; Robinson et al., 2001; DeGaris et al., 2008, 2010). Although, most studies conducted on increasing dietary energy density in the dry or close-up period reported an increase in prepartum DMI (Mann et al., 2015; Roche et al., 2015; Zhang et al., 2015), cows fed high-energy diets experienced an impaired metabolic status after calving. Despite the beneficial effects reported from limited feeding in prepartum cows on DMI and energy status during postpartum period (Dann et al., 2006; Douglas et al., 2006), restriction of feed intake is not recommended on commercial dairy farms with group housing systems because of increased competition at the feed bunk, which intensifies the decrease in feed intake (Overton and Waldron, 2004; Dann et al., 2006; Mann et al., 2015).

In studies with varied days of close-up period, feeding a close-up diet for greater than 3 wk increased the incidence of displaced abomasum and did not improve any productive parameters (Contreras et al., 2004). Mashek and Beede (2001) reported cows fed the close-up diet for an average of 37 d lost less BCS during the first 3 wk postpartum than cows fed for an average of 18 d prepartum, but tended to produce less milk during the first 180 DIM. Also, Robinson et al. (2001) found no benefit on productive and reproductive performance when feeding a close-up diet to multiparous cows. In addition, in a study with 13,000 cows that compared a close-up period >21 d with <7 d, first test-day milk yield and peak milk yield were similar between the 2 groups (Corbett, 2002). However, none of aforementioned studies evaluated the effects of feeding duration of close-up diets on DMI and fluctuation of feed intake during the last week prepartum. Richards (2011) compared single- and 2-stage feeding strategies over the dry period. An interesting finding in Richards (2011) was the marked increase in DMI, with increased insulin and decreased serum fatty acid concentrations in the 2-stage cows when animals were switched from the far-off to close-up diet. However, these increases in DMI and energy balance only were maintained during the first week after the change. Therefore, it appears shortening the length of close-up period might be a beneficial strategy to increase DMI during the final days before calving due to the switching of a far-off to close-up diet.

Higher demands for AA and glucose by gravid uterus and mammary gland combined with decreased DMI immediately before calving compromise nutrient balance and predispose the cow to periparturient disorders (Marquardt et al., 1977; Bell, 1995). Therefore, nutrient density of the diet must be increased to offset decreased DMI immediately before calving (Vandehaar et al., 1999).

A considerable volume of studies have evaluated the effect of prepartum protein feeding on performance and health of transition dairy cows (Vandehaar et al., 1999; Greenfield et al., 2000; Hartwell et al., 2000; Phillips et al., 2003; Adachi et al., 2006). However, most of these studies failed to obtain significant results from higher dietary protein prepartum on postpartum performance (Greenfield et al., 2000; Hartwell et al., 2000; Robinson et al., 2001; Doepel et al., 2002; Park et al., 2002). The primary reason for unsuccessful postpartum responses to prepartum protein is likely the use of CP to express the protein requirements (Bell et al., 2000), increasing RUP at the expense of RDP, which reduces the microbial protein yield and results in no improvement in intestinally delivered MP (Santos et al., 1998), feeding high-protein diets to cows during postpartum period covering the effect of protein inadequacy of prepartum diets (Bell et al., 2000), or some combination. Although most published articles did not report any positive response with higher prepartum dietary protein, field observations suggest that protein requirements of the cows during the close-up period exceed those recommended by NRC (2001). Given the variation of DMI in close-up cows, increasing MP content in excess of NRC (2001) recommendations may improve health status and performance of transition cows. The objective of our study was to evaluate different MP content in close-up diets on DMI, milk production, and blood metabolites in peripartum cows during conventional (**CON**) and shortened (**SH**) close-up periods.

MATERIALS AND METHODS

Feeding, Experimental Design, and Management of Cows

The present study was conducted on a commercial dairy farm in Isfahan, Iran, from April to June 2015. The average ambient temperature was 18.6°C and aver-