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Effect of dry period length and dietary energy source on energy balance, milk yield, and milk composition of dairy cows

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ABSTRACT

The objective of this study was to evaluate the effects of dry period length and dietary energy source in early lactation on milk production, feed intake, and energy balance (EB) of dairy cows. Holstein-Friesian dairy cows (60 primiparous and 108 multiparous) were randomly assigned to dry period lengths (0, 30, or 60 d) and early lactation ration (glucogenic or lipogenic), resulting in a 3 × 2 factorial design. Rations were isocaloric and equal in intestinal digestible protein. The experimental period lasted from 8 wk prepartum to 14 wk postpartum and cows were monitored for milk yield, milk composition, dry matter intake (DMI), energy balance, and milk fat composition. Prepartum average milk yield for 60 d precalving was 13.8 and 7.7 ± 0.5 kg/d for cows with a 0- and 30-d dry period, respectively. Prepartum DMI and energy intake were greater for cows without a dry period and 30-d dry period, compared with cows with a 60-d dry period. Prepartum EB was greater for cows with a 60-d dry period. Postpartum average milk yield until wk 14 was lower for cows without a dry period and a 30-d dry period, compared with cows with a 60-d dry period (32.7, 38.7, and 43.3 ± 0.7 kg/d for 0-, 30-, and 60-d dry period, respectively). Postpartum DMI did not differ among treatments. Postpartum EB was greater for cows without a dry period and a 30-d dry period, compared with cows with a 60-d dry period. Young cows (parity 2) showed a stronger effect of omission of the dry period, compared with a 60-d dry period, on additional milk precalving (young cows: 15.1 kg/d; older cows: 12.0 kg/d), reduction in milk yield postcalving (young cows: 28.6 vs. 34.8 kg/d; older cows: 41.8 vs. 44.1 kg/d), and improvement of the EB postcalving (young cows: 120 vs. −93 kJ/kg$^{0.75}$·d; older cows: −2 vs. −150 kJ/kg$^{0.75}$·d. Ration did not affect milk yield and DMI, but a glucogenic ration tended to reduce milk fat content and increased EB, compared with a more lipogenic ration. Reduced dry period length (0 and 30 d) increased the proportion of short- and medium-chain fatty acids in milk fat and omitting the dry period decreased the proportion of long-chain fatty acids in milk fat. In conclusion, shortening and omitting the dry period shifts milk yield from the postpartum to the prepartum period; this results in an improvement of the EB in early lactation. An increased energy status after a short dry period can be further improved by feeding a more glucogenic ration in early lactation.
Key words: dry period length, lipogenic nutrients, glucogenic nutrients, negative energy balance

INTRODUCTION

The advice to dry-off dairy cows at 6 to 8 wk before calving dates back to the early nineteenth century (Dix Arnold and Becker, 1936) and is well known to maximize milk production in the next lactation (e.g., Kuhn et al., 2005). Recently, the long tradition of a dry period for dairy cows was discussed (Collier et al., 2004). Shortening or omitting the dry period of dairy cows seems to shift milk production from the critical period shortly after calving to the weeks before calving, when the energy demands for milk production can be matched by feed intake easily (Grummer et al., 2010). This partial shift in milk production from post- to precalving can be hypothesized to improve the energy balance (**EB**) of dairy cows in early lactation. Indeed, shortening the dry period resulted in a significant improvement in EB in early lactation [−1.0 vs. −1.7 MJ/d ($P < 0.05$); Rastani et al., 2005], whereas omitting the dry period resulted in absence of a negative EB during the first 56 d [0.2 vs. −1.7 MJ/d ($P < 0.01$); Rastani et al., 2005] or first 4 wk in lactation [0.38 vs. −0.46 Mcal/d ($P < 0.01$); de Feu et al., 2009], compared with a conventional dry period of 56 d. These improvements in EB were realized by a reduction in milk production postcalving (Gulay et al., 2003; Rastani et al., 2005; de Feu et al., 2009).

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Although the number of studies that reported the EB of dairy cows after no or a short dry period is limited, some more studies reported consequences for metabolic health, disease incidence, and fertility. No or a short dry period reduced plasma concentrations of NEFA (Andersen et al., 2005; Klusmeyer et al., 2009) and BHBA (Schlamberger et al., 2010), and tended to increase plasma insulin concentration (Andersen et al., 2005; Mantovani et al., 2010) in early lactation, indicating reduced mobilization of body reserves and improved metabolic health. In addition, the incidence of ketosis was reduced when the dry period was omitted or shortened, whereas effects on other diseases in early lactation, such as mastitis and metritis, were more variable (Pezeshki et al., 2007; Schlamberger et al., 2010; Santschi et al., 2011a). Furthermore, several studies have indicated that shortening or omitting the dry period has potential to improve cow fertility (Gümen et al., 2005; Pezeshki et al., 2008; Watters et al., 2009).

Considering the potential beneficial effects for EB, metabolic health, and fertility, shortening or omitting the dry period can be argued to be a viable approach to manage health and fertility of high-producing dairy cows. Currently, however, application in practice is limited, possibly because of several questions and uncertainties concerning management of cows with a short or no dry period. First, because only a few studies are available (Rastani et al., 2005; de Feu et al., 2009), effects of omission of the dry period on EB need to be confirmed. Second, it can be hypothesized that complete adaptation of peripartum cow management, with adjustments in feeding and insemination strategies, may be essential for proper utilization of the concept of reducing the length of the dry period. For example, an earlier resumption of ovarian cyclicity related to a shorter dry period (Gümen et al., 2005) could have implications for the voluntary waiting period for breeding. Moreover, optimizing feeding strategies could potentially reduce milk yield losses or further improve the EB due to a short or no dry period.

Similar to reducing the dry period length, specific feeding strategies also are known to improve the EB by reducing milk energy output in early lactation. Earlier, we showed that glucogenic rations, compared with lipogenic rations, could reduce milk energy output and herewith improve the EB of dairy cows in early lactation (van Knegsel et al., 2007a), which was related to an increased plasma insulin concentration (van Knegsel et al., 2007b). Moreover, an improvement of EB was only observed when cows had relatively low plasma insulin concentration postpartum (i.e., primiparous cows with higher postpartum insulin concentration did not improve the EB or alter the insulin concentration as a result of a glucogenic ration). It can be hypothesized that when the EB in early lactation is positive due to omission of the dry period, plasma insulin concentration is increased and beneficial effects of glucogenic rations for dairy cow health are reduced because cows have less shortage in early lactation for glucogenic precursors, compared with cows with a conventional dry period and a more negative EB. In contrast, it can be hypothesized that when the EB is improved, but still negative, after a short dry period, a glucogenic ration can further improve the EB of dairy cows in early lactation. Therefore, the objective of this study was to evaluate the effects of dry period length (0, 30, or 60 d dry) and dietary energy source (lipogenic and glucogenic) on milk production, feed intake, and EB of dairy cows in early lactation.

MATERIALS AND METHODS

Experimental Design, Animals, and Housing

The Institutional Animal Care and Use Committee of Wageningen University and Research Centre (Wageningen, the Netherlands) approved the experimental protocol. Holstein-Friesian dairy cows (n = 168) were selected from the Dairy Campus Research dairy herd (Wageningen University and Research Centre Livestock Research, Lelystad, the Netherlands) for this experiment. The experiment started 9 wk before the expected calving date and lasted until 14 wk postcalving. The experiment started with 60 primiparous cows, and 108 multiparous cows. Cows were blocked for parity (primiparous or multiparous), expected calving date, milk production in the previous lactation, and BCS and randomly assigned to treatments. Treatments consisted of dry period length (0, 30, or 60 d) and early lactation ration (glucogenic or lipogenic), resulting in a 3 × 2 factorial arrangement of treatments. One cow (30 d dry and fed a lipogenic ration) was excluded from the experiment because of a mistake in the drying-off protocol. Cows were housed in a freestall with slatted floor and cubicles. During lactation, cows were milked twice daily (0500 and 1630 h). The drying-off protocol for cows with the 30- and 60-d dry period consisted of a transition to the far-off ration at d 7 before drying-off, and milking once daily at d 4 before drying-off cows. At drying-off, cows were treated with an intramammary antibiotic (Supermastidol; Virbac Animal Health, Barneveld, the Netherlands).

Rations

Prepartum, dry cows received a dry cow ration and lactating cows received a lactating cow ration supporting 25 kg of milk. From 3 wk prepartum onwards, all