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Effects of feed restriction and prolactin-release inhibition at drying-off on susceptibility to new intramammary infection in cows

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ABSTRACT

A cow's risk of acquiring a new intramammary infection during the dry period increases with milk production at drying-off. A method commonly used to reduce milk production is a drastic reduction in feed supply in the days that precede drying-off. Milk production can also be reduced by inhibiting the lactogenic signal driven by prolactin (PRL). This study aimed to compare the effects of these 2 drying-off procedures on milk production, metabolism, and susceptibility to intramammary infection in cows. A total of 21 Holstein cows in late lactation were assigned to 1 of 3 treatments based on milk yield, somatic cell count, and parity. The cows were fed a lactation diet until drying-off (control), only dry hay during the last 5 d before drying-off (DH), or the same diet as the control cows but with twice-daily i.m. injections of 4 mg of quinagolide, a specific inhibitor of PRL release, from 5 d before drying-off until 13 d after (QN). On d 1 to 7 after the last milking, the cows were challenged by daily teat dipping in a solution containing *Streptococcus agalactiae* at 5×10^7 cfu/mL. Quinagolide induced a decrease in PRL concentration in blood on all the injection days. Blood PRL was also depressed in the hay-fed cows before drying-off. Both the QN and DH treatments induced a decrease in milk production, which at drying-off averaged 12.0, 10.0, and 21.7 kg/d for the QN, DH, and control cows, respectively. The DH treatment decreased blood concentration of glucose and increased blood concentrations of β-hydroxybutyrate and nonesterified fatty acids before drying-off. Somatic cell count at drying-off was greater in the milk of the QN cows than in that of the control cows but after drying-off was greater in the mammary secretions of the control cows than in those of the QN cows. The number of *S. agalactiae* colonies found in mammary secretions on d 8 and 14 after the last milking was lower for the QN cows than for the control cows. The percentage of *S. agalactiae*-infected quarters was also lower in the QN cows than in the control cows and on d 14 averaged 17.2, 33.7, and 57.5% in the QN, DH, and control cows, respectively. No differences between the DH and control groups were observed for either bacterial count or infection rate. In conclusion, this experiment shows that PRL-release inhibition could be an alternative for reducing milk production and improving resistance to intramammary infection at drying-off.

Key words: quinagolide, dry period, dairy cow

INTRODUCTION

The lactation cycle of the dairy cow requires a dry period for optimal milk production in the subsequent lactation. However, the susceptibility to new IMI is high during the first 3 wk of the dry period (Eberhart, 1986). Even though milk is no longer removed, the mammary gland temporarily continues to synthesize milk, causing milk accumulation and leakage via the teats and thereby facilitating the entry of microorganisms into the mammary gland (Oliver and Sordillo, 1989). Consequently, the risk of acquiring a new infection during the dry period increases rapidly with the level of milk production (Rajala-Schultz et al., 2005). As it is now common to dry off cows that are still producing 25 to 30 kg/d of milk, it is important to develop strategies that reduce milk production before drying-off.

A common drying-off practice among farmers involves a drastic short-term reduction in feed supply in the days that precede drying-off. Although effective for rapidly reducing milk yield, this method creates a state of negative energy balance, especially in high-yielding cows. Accordingly, feeding only straw (Odensten et al., 2005) or hay (Bernier-Dodier et al., 2011) at drying-off caused metabolic stress, as indicated by an increase in plasma NEFA concentration comparable with the increase that can be observed in early lactation (Loiselle et al., 2009). The linkage between metabolic stress in early lactation and health disorders such as mastitis is well documented (Pryce et al., 1998; Ingvartsen et al., 2003). Carbonneau et al. (2012) and Ster et al. (2012) reported that immune functions such as periph-

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eral blood mononuclear cell (**PBMC**) proliferation and cytokine release were inhibited by serum obtained from periparturient cows and that this inhibition was related directly to NEFA concentration in the serum. Accordingly, the present authors reported in a previous paper that serum harvested from feed-restricted cows in late lactation reduced PBMC proliferation and IL-4 production (Ollier et al., 2014). It is therefore possible that part of the gain in disease resistance obtained by reducing milk production at drying-off by means of feed restriction is lost as the result of immunosuppression.

Milk production can also be reduced by decreasing the lactogenic signals driving milk production. Lacasse et al. (2011) recently showed that inhibiting prolactin (**PRL**) secretion using the dopamine agonist quinagolide gradually decreased milk production in cows at peak lactation. When applied to cows in late lactation, the same approach induced a sharp decrease in milk production within 24 h, and several indicators suggested that involution had been hastened (Ollier et al., 2013, 2014). This approach did not affect NEFA concentration or PBMC proliferation. The results of that experiment suggest that inhibiting PRL secretion could be a valuable alternative for reducing milk production before drying-off without disturbing the metabolism and immune functions of the cow, but the protective effect of PRL-release inhibition against IMI has not been yet assessed. The present study aimed to compare the effects of PRL-release inhibition as a drying-off procedure with those of a drastic reduction in feed supply in the days preceding drying-off on mammary gland susceptibility to new infection in cows.

MATERIALS AND METHODS

Animals and Experimental Design

The experiment was conducted in accordance with the guidelines of the Canadian Council on Animal Care (1993). A total of 21 Holstein cows in late lactation (329 ± 12 DIM at drying-off) housed at Agriculture and Agri-Food Canada's Dairy and Swine Research and Development Centre (Sherbrooke, QC, Canada) were assigned to 1 of 3 treatments according to their milk yield, SCC, and parity (1 primiparous and 6 multiparous cows per treatment). The cows were housed in individual tie stalls and were fed ad libitum 1) a late-lactation diet (containing grass silage, corn silage, dry hay, corn grain, soybean meal, and nonmineral and mineral supplements) until drying-off (control; n = 7), 2) only dry hay during the last 5 d before drying-off (**DH**; n = 7), or 3) the same late-lactation diet as the control cows but with twice-daily (at 0930 and 2130 h) i.m. injections of 4 mg of quinagolide (Ferring, Wallisellen, Switzerland) from 5 d before drying-off until 13 d after (**QN**; n = 7). The control and DH cows received injections of the solvent (water). After drying-off, all 21 cows were fed ad libitum a dry-period diet containing (on a DM basis) 69.9% dry hay and 30.1% TMR (containing corn silage, soybean meal, and mineral supplement). The compositions of the late-lactation TMR, dry hay, and dry-period TMR are presented in Table 1. Feed intake was recorded daily for each cow throughout the experiment, and each cow's BW was determined at the start and at the end of the experiment. The cows were milked twice daily, at 0800 and 2000 h, and milk yield was recorded at each milking during the last 2 wk before drying-off. Any given experimental day started after the a.m. milking or sampling and ended at the next a.m. milking or sampling. Accordingly, the last milking was performed on the morning of d −1 and the sampling of the next morning was called d 1. A summary of the experimental design and sampling is presented in Supplemental Figure S1 (http://dx.doi.org/10.3168/jds.2014-8426).

Bacterial Challenge

No antibiotic dry-cow therapy was administered at drying-off. On d 1 to 7 after the last milking, the cows were challenged by daily dipping each teat in a suspension containing *Streptococcus agalactiae* (strain ATCC 27956, American Type Culture Collection, Manassas, VA) at 5 × 10^7 cfu/mL. Challenge suspension was

Table 1. Composition of diets

Item	Late-lactation TMR	Dry hay	Dry-period TMR
Chemical composition, % of DM			
CP	13.9	10.4	21.3
ADF	19.8	42.6	17.5
NDF	31.9	70.2	29.7
P	0.41	0.24	0.54
K	1.51	2.26	1.39
Ca	0.76	0.24	0.78
NE_L, Mcal/kg of DM	1.57	1.20	1.64