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Effects of an individual weight-adjusted feeding strategy in early lactation on milk production of Holstein cows during extended lactation

C. Gaillard,*[1] N. C. Friggens,† M. Taghipoor,‡ M. R. Weisbjerg,* J. O. Lehmann,§ and J. Sehested*
*Department of Animal Science, AU Foulum, Aarhus University, PO Box 50, 8830 Tjele, Denmark
†INRA UMR 0791, AgroParisTech UMR 079, Modélisation Systémique Appliquée aux Ruminants, 16 rue Claude Bernard, 75005 Paris, France
‡INRA-UMR 1348 PEGASE Physiologie, Environnement et Génétique pour l'Animal et les Systèmes d'Élevage, 35590 Saint-Gilles, France
§Department of Agroecology, AU Foulum, Aarhus University, PO Box 50, 8830 Tjele, Denmark

ABSTRACT

Extending lactation by voluntarily delaying rebreeding aims to improve fertility and milk production in the modern dairy cow. Previous studies have shown that increased energy concentrations in the ration induced greater total milk yield and lactation persistency defined by the duration and the shape of the lactation curve. In this paper, we hypothesized that increasing the supply of energy during the early lactation mobilization period would have a positive carryover effect on milk production during extended lactation. A total of 53 Holstein cows completed a 16-mo lactation, including 30% primiparous cows. The cows were divided into 2 feeding strategies: half of the cows received a high-energy density diet (HD) in early lactation followed by a lower-energy density diet (LD; strategy HD-LD). The change in diet was defined individually after 42 d of lactation, and when the live weight (LW) gain of the cow was $\geq$0 based on a 5-d average. The other half of the cows were fed the LD diet during the entire lactation (strategy LD-LD). Both groups received 3 kg of concentrates per day during milking. Weekly milk composition (fat, protein, lactose, and somatic cells), daily milk production, daily feed intake, daily LW, and body condition score every second week were recorded. The fda package of R was used to model the curves of these different variables for the 53 cows that had a lactation over 400 d. The fitted values of these curves and the associated slopes were then compared for parity and treatment effects using a linear mixed-effects model. The HD-LD and LD-LD cows had a similar length of lactation (461 ± 7 d). The HD diet reduced the intensity of the mobilization period and increased the milk production of the multiparous cows in early lactation compared with the cows fed the LD diet. The primiparous cows used the extra energy to grow and gain weight, but not to produce more milk. After the shift in diet, the treatment had little short-term carryover effect on milk yield or LW, but it affected the slopes of some curves. From 0 to 50 d from shift, milk fat content of the LD-LD cows decreased faster than that of the HD-LD cows whereas milk lactose increased. From 250 to 350 d from shift, the energy-corrected milk decreased faster for the HD-LD cows than for the LD-LD cows. The lactose content in milk decreased faster for the LD-LD cows than for the HD-LD cows, and the fat content in milk was significantly higher for the primiparous HD-LD than for the primiparous LD-LD cows. In conclusion, the supply of extra energy during the mobilization period had a 300-d negative carryover effect on lactation persistency.
Key words: extended lactation, energy balance, persistency, milk production

INTRODUCTION

The fertility of dairy cows is decreasing due to an intense in genetic selection for milk production, and the cows are often dried-off while they are still producing a high amount of milk per day (Knight, 2005). When rebreeding is voluntarily delayed, the lactation of the cows is extended beyond the traditional 10 mo, allowing a better exploitation of the capacity of the cow's production (Knight, 2005). This management also avoids the insemination occurring at the same time as the peak of production and the reconstitution of body reserves, which could improve pregnancy rates (Borman et al., 2004). The plasticity of the lactation curve offers the possibility of prolonging the lactation and increasing the persistency of the lactation (Grossman and Koops, 2003). Lactation persistency is defined as the slope of the decline in milk yield from peak lactation (Sorensen et al., 2008) and is affected by

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[1]Corresponding author: charlotte.gaillard@anis.au.dk

genetics, parity, stage of pregnancy (Nørgaard et al., 2005), milking frequency, and nutrition (Sorensen et al., 2006). Indeed, the energy density of the ration has to be adapted for each stage of the lactation, especially in early lactation, where diets with a high energy concentration can reduce the intensity of the mobilization period and lead to a higher milk production (Bossen et al., 2009). However, as cows respond individually to feeding strategies, an individual diet adjustment would improve milk production (Bossen and Weisbjerg, 2009). Even so, this individual adjustment requires a precise definition of when to adjust the diet for each cow. Our objectives in the present study were to examine the effects of an individually live weight-adjusted feeding strategy in early lactation, based on 5 consecutive daily weightings, aiming to reduce the intensity of the mobilization in early lactation, and thereby to sustain the mobilization for a longer period. It was hypothesized that an increased supply of energy during the mobilization period will have a positive carryover effect on milk production and consequently will support a planned 16-mo extended lactation.

MATERIALS AND METHODS

Experimental Facilities and Animals

The experiment was approved by The Animal Experiments Inspectorate under the Danish Veterinary and Food Administration and was carried out at the Danish Cattle Research Centre at Aarhus University, Foulum, Denmark. A total of 53 Danish Holstein cows (17 primiparous and 36 multiparous) entered the experiment 2 mo before calving from December 2012 to September 2013, and completed a 16-mo lactation and an 18-mo calving interval. Cows were housed in a loose housing system with slatted floors and cubicles with mattresses and sawdust as bedding. Cows had free access to water, automatic feed bins (RIC system, Insentec, Marknesse, the Netherlands), and an automatic milking unit (**AMU**; DeLaval AB, Tumba, Sweden). The AMU was equipped with a weighing platform (Danvaegt, Hinnerup, Denmark) to record the live weight (**LW**) of the animal at each milking and a device delivering and recording the amounts of concentrates and refusals.

Experimental Design

Before entering the experiment, cows with previous lactations were dried off 8 wk before expected calving date. Dry cows and heifers were housed on slatted floors with cubicles the first 5 wk of dry-off, on deep litter bedded with straw the next 3 wk, in a calving pen for the last 6 to 24 h before calving, and entered the experimental group pen immediately after calving. All cows were fed the same dry cow ration during this pre-experimental period (Table 1).

The experimental animals were blocked according to expected calving date and parity and randomly allocated to 1 of 2 feeding strategies (Table 2). In the high-low energy diet strategy (**HD-LD**) the cows received a partially mixed ration with a high energy density (**HD**), 50:50 forage:concentrate ratio, until they reached at least 42 d of lactation and a LW gain $\geq$0 kg/d over 5 d, on average. When these criteria were fulfilled, the cows were individually shifted to a diet with lower energy density (**LD**), with a 60:40 forage:concentrate ratio. The cows in the low-low energy diet strategy (**LD-LD**) were fed the LD diet during the whole lactation. Diets were formulated using the NORFOR model and standards (Volden, 2011). The composition of the diets is shown in Table 1. Both groups were fed the mixed part of the ration ad libitum and each cow was further offered 3 kg of concentrates per day in the milking robot. Weekly analyses of the dry matter content of forages were performed for adjustment of ration composition.

The cows were inseminated at the first heat observed after 220 DIM to achieve an 18-mo calving interval. Finally, the cows were dried off 8 wk before expected calving, or if the average milk production dropped below 12 kg of milk per cow per day in 2 subsequent weeks.

Data Recording

Feed Intake. Feed intake (kg) was recorded for each cow at each visit to the Insentec feeder. All cows were offered a maximum of 3 kg of concentrate per day in the AMU. If a cow ate less than the daily 3 kg concentrate allowed, the amount not eaten (up to 1.5 kg) was allowed on top of the 3-kg allowance for the next day. Individual daily DMI was calculated as the sum of the partially mixed ration ingested at the Insentec and the amount of concentrate ingested at the AMU within a day.

Daily Milk Yield and Milking Frequency. The milk yield was individually recorded at each visit to the AMU. The milk yields recorded at the first and last milking of a 24-h day were divided proportionally according to time from midnight, and allocated to the days, -1 or $+1$, to obtain the daily milk yield. The same adjustment was made to calculate the daily milking frequency. Individual milk samples were collected weekly by the AMU using a modified automatic sampler (XMS, DeLaval; Løvendahl and Bjerring, 2006). The milk samples were taken over a 48-h period start-