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Priming the cow for lactation by rapeseed supplementation in the dry period

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ABSTRACT

High-producing dairy cows experience a sudden and significant increase in energy requirements due to the onset of milk production in early lactation. They mobilize body reserves, mainly adipose tissue, resulting in an increased risk of production decline and the development of health disorders. The objective of the present study was to investigate the effects of feeding oilseeds (rapeseed) during the dry period, thereby priming dairy cows for metabolism of body fat in early lactation. Forty-three Holstein dairy cows were used, 14 were primiparous and 29 were multiparous (≥2nd lactation). In the dry period, 8 wk before expected calving until calving, the cows were fed either a diet with a high content of rapeseed in the total mixed ration (HF) or a standard total mixed ration with a low content of fat (CON). During the first 5 wk after calving, all the cows were fed a standard low fat lactation ration. The treatments were evaluated by performance and metabolic variables in blood and liver. The dry period diet had no effects on body weight and body condition score of the cows during the dry period and in early lactation. The daily yield of milk, protein, and lactose did not differ among treatments. However, the milk fat concentration was lower and the daily milk fat production tended to be lower for the cows fed the HF diet in the dry period compared with the cows fed the CON diet. The plasma content of nonesterified fatty acids, cholesterol, and phospholipids in the dry period was increased in the HF dry period diet compared with the CON diet. The lower plasma concentration of uric acid obtained prepartum for the cows fed the HF diet may indicate a lower rumen microbial protein synthesis. Postpartum, the plasma concentration of β-hydroxybutyric acid tended to be lower for the cows fed the HF dry period diet. The liver content of triglycerides was lower and the liver content of glycogen was higher in early lactation among the cows fed the HF dry period diet compared with the cows fed the CON diet. Based on liver glycogen, triglyceride content, and blood β-hydroxybutyric acid concentration, it could be argued that intake of oilseeds during the dry period is a positive strategy for priming dairy cows for fat metabolism in the following early lactation.

Key words: cow, metabolite, hepatic fat infiltration, oilseed

INTRODUCTION

High-producing dairy cows experience massive metabolic changes during the transition period, from the dry period in late gestation to early lactation, due to a sudden and significant increase in the energy requirements for milk production (Bell, 1995). This period is critically important to health and production, as most health disorders occur during this time (Drackley, 1999). It is generally accepted that nutritional management in the dry period influences the metabolic status in the subsequent lactation period. Cows decline in feed intake and start to mobilize body reserves toward the end of the dry period (Grummer et al., 1995; Vandehaar et al., 1999). According to Friggens (2003), this mobilization of adipose tissue is a natural phenomenon among mammals around parturition. Mobilization of body lipid reserves results in an increased plasma level of NEFA.

Previously, Friggens et al. (2004) presented the hypothesis that feeding a high-fat ration in the dry period could prime the cow to adapt to body fat mobilization in the following lactation period. This strategy is based on the principle that feeding a high-fat ration in the dry period increases the circulating concentration of NEFA, thereby increasing NEFA uptake into the liver for preadaptation of hepatic long-chain FA metabolism (Grum et al., 1996; Friggens et al., 2004).

Previous studies in dairy cows indicated that supplementing dry cows with an SFA source was a positive strategy for priming dairy cows for body fat mobilization in the subsequent early lactation (Andersen et al., 2008). Dry cows supplemented with a source of highly saturated FA, in the form of vegetable fat powder, were compared with cows supplemented with a highly unsaturated FA, based on linseed, or cows fed a low-fat diet without fat supplementation. The cows supplemented with the highly saturated FA source revealed the lowest plasma NEFA concentration and the lowest liver triacylglycerol (**TAG**) concentration in the first

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2 wk of lactation compared with cows fed the highly unsaturated fat diet or the control diet. Conversely, unsaturated fat did not result in any positive effects in early lactation. However, it could be interesting to investigate the effect of moderately unsaturated fat fed to cows in the dry period.

Primiparous cows are still growing in the period before first parturition, and therefore have higher energy requirements before parturition than multiparous cows (Friggens et al., 2004). Consequently, the effect of feed supplements in the period before parturition may be different in primiparous and multiparous cows. The hypothesis behind the present study was that a high-fat (rapeseed) diet in the dry period could prime the dairy cow for body fat mobilization in the following lactation period. Therefore, the aim of the study was to investigate the effects of feeding rapeseed in the dry period on the metabolism of body fat in the periparturient period of dairy cows. Changes in BW, BCS, several blood variables, and liver concentrations of fat and glycogen were followed as indicators of metabolic status and adaptive changes in the periparturient period.

MATERIALS AND METHODS

Cows and Housing

The experimental procedures involving animals were evaluated and approved by the Danish Animal Experiments Inspectorate and complied with the Danish Laws concerning animal experimentation and care of experimental animals. The experiment was carried out at the Danish Cattle Research Centre (Tjele, Denmark) during 2009. A total of 43 Danish Holstein dairy cows (14 primiparous and 29 multiparous) were included in the experiment. The cows were kept in a loose-housing system with slatted floors and cubicles with mats of hard rubber material and sawdust as bedding. A free cow-traffic system was applied for access to an automatic milking system from DeLaval AB (Tumba, Sweden). Within the dairy unit, the cows were organized in 2 groups, and each group had access to 1 automatic milking unit (**AMU**) equipped with a device for automatic measurement of milk yield and milk sampling. Additionally, the AMU were equipped with a device for concentrate feeding and weighing of concentrate refusals at the end of each cow visit. Below each AMU, a platform scale from Danvaegt (Hinnerup, Denmark) was installed for automatic recording of cow BW. For automatic recording of mixed ration intake, the Insentec RIC system (Marknesse, the Netherlands) was used. The facilities and management procedures at the Danish Cattle Research Centre are described in detail by Bossen et al. (2009) and Bossen and Weisbjerg (2009).

Experimental Design and Diets

The experimental period covered the last 8 wk before expected calving and the first 5 wk after calving. The cows were dried off at the start of the experimental period. At the day of drying off the cows were allocated to different treatments according to lactation number (1st and later) and expected calving date. The cows were allocated to 2 different diets: (1) a high content of rapeseed (high-fat; **HF**) in a TMR or (2) a normal dry cow diet without fat supplementation (control; **CON**). During wk 0 to 5 of lactation all the cows were fed a standard low-fat dairy ration. The diets were all TMR based on corn silage, grass-clover silage, and barley straw. The HF diet was further supplied with ground rapeseed on a DM basis as shown in Table 1, where the chemical composition of the diets is also shown.

Data Collection and Analyses

Information on TMR intake, concentrate intake, milk yield, milk composition, BW, and BCS was obtained as described by Bossen et al. (2009) and Bossen and Weisbjerg (2009). Energy-corrected milk was calculated as described by Sjaunja et al. (1991). Chemical analyses of individual feedstuffs and adjustment of feed rations during the study were carried out as described by Bossen et al. (2009). Feed free FA composition was analyzed as described by Palmquist and Jenkins (2003). One cow fed the HF diet developed displaced abomasum and ketosis postpartum and was omitted from the experiment.

Sampling and Analysis of Blood

Blood samples were collected weekly between 0900 and 1200 h from wk 5 before to wk 4 after calving. The blood samples were collected by venipuncture of a tail vein using vacutainer tubes containing sodium heparin (Vacutainer, Becton Dickinson Vacutainer Systems, Plymouth, UK), then stored on ice and centrifuged within 90 min at 2,000 $\times$ g for 20 min at 4°C. The plasma was collected and stored at −20°C until further analysis.

Albumin, total protein, glucose, cholesterol, calcium, alkaline phosphatase, aspartate aminotransferase (**AST**), γ-glutamyl transferase (**GGT**), uric acid (**UA**), and plasma urea nitrogen (**PUN**) were analyzed according to standard colorimetric procedures (Siemens Diagnostics Clinical Methods for ADVIA 1650; Siemens Medical Solutions Diagnostics, Tarrytown, NY). β-Hydroxybutyrate was determined according to Nielsen et al. (2005). Nonesterified FA were determined using the Wako, NEFA C ACS-ACOD assay method