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Effect of altering the type of dietary carbohydrate early postpartum on reproductive performance and milk production in pasture-grazed dairy cows

S. McDougall,*[1] S. Leane,† S. T. Butler,† J. R. Roche,‡ and C. R. Burke‡
*Cognosco, Anexa FVC, Morrinsville, New Zealand, 3300
†Animal and Grassland Research and Innovation Centre, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland, P61 C996
‡DairyNZ Limited, Hamilton, New Zealand 3240

ABSTRACT

The objective of this study was to assess the effect of increasing dietary starch for approximately 30 d postpartum on reproduction outcomes in pasture-grazed, seasonal-calving dairy cows. Cows (n = 948) from 3 commercial herds were blocked by age (2, 3, and >3 yr), breed, and expected calving date and randomly assigned to 1 of 2 postpartum treatment groups: high starch (34.7 ± 1.9% nonstructural carbohydrate; mean ± SD) or low starch (22.5 ± 0.4% nonstructural carbohydrate). The high-starch group in all 3 farms received 4.0 to 4.5 kg/d of a 75:25 cracked corn:barley grain mixture in the dairy parlor, split evenly between the morning and afternoon milkings. The low-starch cows received 5.0 to 5.5 kg/d of a 50:50 mixture of palm kernel meal:soy hulls (herds 1 and 3) fed in the parlor; low-starch cows in the remaining herd (herd 2) did not receive a concentrate feed. Cows were cograzed on ryegrass–white clover dominant pastures and were offered corn silage (herds 1 and 3) and canola, corn distillers grain, and palm kernel meal (herd 1) throughout the study. At 1 mo before the start of the seasonal breeding period, the high-starch supplement was removed, and within each herd treatment groups were managed similarly through breeding. Presence of purulent vaginal discharge was assessed at 28 DIM, and tail paint was assessed weekly from 2 to 6 wk postpartum for signs of estrus. The interval to first observed estrus was unaffected by treatment (32.7 vs. 33.5 ± 2 d for high and low starch, respectively), but there were tendencies for a herd × treatment interaction for proportion of cows pregnant to first service and for pregnancy within 6 wk. This interaction was significant for the proportion of cows finally pregnant; a lower proportion of high-starch cows were pregnant to first service, pregnant by 6 wk, and pregnant by the end of the seasonal breeding period in herd 1, but diet did not affect these outcomes in the other herds. Our results do not support a positive effect on reproduction from increasing dietary starch in seasonally bred grazing dairy cows. However, the interactions indicate variability in the herd response to dietary starch early postpartum and imply that pregnancy rate could potentially be compromised through the provision of starch to grazing dairy cows in early lactation (i.e., prebreeding). The experiment was not designed to define the reasons for these interactions, but differences should be considered in future research on the subject.
Key words: nonstructural carbohydrate, fertility, grazing dairy cow

INTRODUCTION

Following parturition, there is a substantial increase in nutrient requirements for milk production; nutrient intake does not meet these requirements, and cows enter a period of negative energy balance (Bauman and Currie, 1980; Bell, 1995). This negative energy balance has been implicated in reduced pregnancy success (Buckley et al., 2003; Roche et al., 2007, 2009); it is therefore plausible that providing grazing dairy cows with supplementary feeds in early lactation would improve reproductive success. However, increasing cow DMI through allocating a greater pasture allowance per cow or supplementing grazing cows with pasture silage (McDougall et al., 1995; Burke and Roche, 2007) or cereal grains, beet pulp, or corn gluten feed (Kennedy et al., 2002, 2003; Horan et al., 2005; Cutullic et al., 2011) has not improved reproductive performance when cows were grazed to optimize pasture management. A breed × energy intake interaction on BCS was reported when Swedish Reds and Holsteins were fed a high- or low-energy ration postpartum, wherein the high-energy diet was associated with higher BCS compared with the low-energy diet in the Swedish reds, whereas no

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[1]Corresponding author: smcdougall@anexafvc.co.nz

difference in BCS was noted between the 2 diets in Holstein-Friesians (Ntallaris et al., 2017). A similar finding was reported in Holstein-Friesian strains from different selection indices, wherein selecting primarily for milk production reduced the effect of environment and nutrition on BCS compared with strains also selected for functional traits (Roche et al., 2006; McCarthy et al., 2007).

Instead of increasing feed allocation and DMI, however, it has been hypothesized that altering the ratio of structural to NSC in the diet without altering intake of ME could reduce the duration of postpartum anestrus (i.e., the postpartum anestrous period) and improve fertility outcomes through increasing circulating concentrations of insulin in dairy cows early postpartum. Consistent with this hypothesis, Gong et al. (2002) and Garnsworthy et al. (2009) reported greater conception rates and a higher proportion of cows pregnant by 120 d postcalving when they consumed a high-NSC diet from calving to first ovulation and a low-NSC diet subsequently. In another study in which cows were fed isoenergetic diets, higher NSC was associated with greater insulin concentrations, more small (<5 mm) ovarian follicles, and a tendency for greater progesterone concentrations and a larger corpus luteum diameter after ovulation (Garnsworthy et al., 2008). The greatest dietary NSC content, however, resulted in cows having lower progesterone and a smaller corpus luteum, possibly indicating a threshold level of dietary NSC, above which there are detrimental effects (Garnsworthy et al., 2008). Other postpartum dietary manipulation, such as increasing dietary fat in some forms, has also been demonstrated to improve pregnancy rates (Rodney et al., 2015).

Grazing dairy cows consume diets low in NSC and high in fermentable NDF and yet, to maintain seasonal milk production, are required to cycle early postcalving and have high first service conception rates (Roche et al., 2011). Therefore, it is hypothesized that grazing cows would benefit from supplementation with NSC postcalving. In support of this hypothesis, Burke et al. (2010) reported an 8-d shorter postpartum anestrous period and a 23% increase in first service conception rate in grazing dairy cows when diet NSC content was increased from 18 to 38% during the first 35 DIM. However, the experiment involved only 16 animals per group and was undertaken at 1 research facility; therefore, although the results were statistically significant and consistent with the previous reports from TMR feeding systems, the study requires validation on a larger scale and across varying farm systems to allow generalization of the findings. Accordingly, the objective of this current study was to assess whether increasing dietary starch content would improve reproduction in seasonally bred, pasture-grazed dairy cattle on commercially operated dairy farms.

MATERIALS AND METHODS

The study was conducted on 3 commercial spring-calving dairy herds in New Zealand between July and October 2014. All herds had rotary milking parlors with automatic cow identification and in-parlor feeding systems that allowed cows to be individually offered a specific concentrate feed. Cows were managed on pasture and were allocated fresh pasture twice daily as part of an intensively managed rotational grazing system (Roche et al., 2017). All procedures and animal events had the prior approval of AgResearch Ruakura Animal Ethics Committee (Hamilton, New Zealand).

Experimental Design

Cows (n = 948) were randomly assigned within herd to a high-NSC (high starch) or low-NSC (low starch) diet following blocking by age (2, 3, >3 yr), breed (>11/16th defined as either Holstein-Friesian or Jersey; the remainder defined as crossbreeds), and expected week of calving based on pregnancy diagnosis. A general description of the herds and cows enrolled in the study is provided in Tables 1 and 2, respectively.

Nutritional Management

A nutritional management program was developed for each herd in consultation with a nutritionist and the herd owner. The objective of the program was to

Table 1. Descriptive information of the 3 herds enrolled to examine the effects of feeding cows with a pasture-based diet designed to be high or low in NSC during the first 4 to 5 wk of lactation on indicators of metabolism, health, and resumption of estrus

	Herd		
Item	1	2	3
Cows (no.)			
Total herd size	329	740	627
Enrolled	137	527	284
High-starch group	72	260	139
Low-starch group	65	267	146
Farm area (ha)	73	250	157
Stocking rate (cows/ha)	4.5	3.0	4.0
Breeding			
Planned start of calving	Aug. 1	Jul. 25	Jul. 12
Start breeding	Oct. 20	Oct. 16	Sep. 30
End breeding	Dec. 28	Jan. 5	Dec. 20
Length (d)	69	81	81
Feed treatment period			
Start	Aug. 7	Jul. 29	Jul. 23
End	Sep. 19	Sep. 14	Aug. 30
Duration (d)	43	47	38