INFLUENCE OF HIGH DIETARY PROTEIN ON REPRODUCTIVE FUNCTION IN DAIRY CATTLE: A PROGRESS REPORT

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Story in Brief

In the first year of a 2 year study, 82 dairy cows were fed moderate (15%) and high (20%) crude protein diets from 10 ± 4 to 145 days postpartum. High protein increased milk production by 4 lbs per day over the entire experiment. Nutritional stress as indicated by body weight and body condition change appeared similar between the two groups during early lactation. Plasma urea was elevated 12 mg/100 ml in cows fed the high crude protein diet. Interval to first estrus, interval from calving to conception, services per conception and percent pregnant were similar between cows on the high versus moderate levels of crude protein.

(Key Words: Dietary protein, fertility, days open, body condition)

Introduction

Average milk prodution has increased by over two times for all United States dairy herds and by over one and one-half times in DHIA dairy herds in the past thirty years. In order to realize the milk producing potential of these high producing cows, quality and quantity of diet have increased substantially. Since peak dry matter intake usually lags behind peak milk production by some four to eight weeks, the protein and energy components in the diet must be higher initially in hopes of meeting the cows requirements during early lactation.

Of primary concern in this study is the effect of high dietary protein on rebreeding performance. Recent reports have indicated crude protein percentages above 16% may be detrimental to reproduction (Folman et al., 1981; Jordan and Swanson, 1979). It has been suggested that diets high in protein may alter the uterine environment in such a way that fertilization failure and/or early embryonic mortality are enhanced (Jordan et al., 1983). According to National Research Council recommendations, a 1300 lb cow in her second lactation, milking 60 lbs per day with a milk fat % of 3.5 would require a diet of 15% crude protein to meet her requirements (NRC, 1978). However, if that same cow was milking at 100 lbs per day, a diet containing 19% crude protein would be necessary. This is well within the range of dietary concentrations of crude protein thought to be detrimental for reproductive performance.

The objective of this study was to compare two levels of dietary crude protein on: 1) fertility, 2) onset of estrus and ovarian activity, 3) concentration of plasma metabolites as indicators of nutritional status, 4) feed consumption, 5) body weight and body condition score changes as indicators of nutritional stress and 6) milk production over the first 145 days postpartum.

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Materials and Methods

Sixty Holstein and 22 Ayrshire cows of second lactation or greater were randomly assigned to receive either moderate (15%) or high (20%) levels of crude protein in the diet, beginning 10 ± 4 days from calving. Cows were allotted to diets according to breed, lactation number and date of calving. They were fed a complete mixed ration formulated for the level of crude protein desired, consisting of 45% sorghum silage and 55% grain concentrate on a dry matter basis. Protein levels were varied by modifying the amount of corn and soybean meal in the concentrate. Cows were individually fed three times daily to the limit of consumption for the first 145 days postpartum. Daily feed intake and feed refusals were recorded. Dietary dry matter and protein intake were determined on a weekly average basis. Weight and body condition scores were recorded every two weeks through the duration of the study to follow any changes in nutritional stress that may occur. The body condition scoring system was as described by Aalseth et al. (1983), using a 1 to 9 scale (1 = extremely thin, 9 = over-conditioned). Weekly average milk production was caclulated from daily milk production. Average milk fat and milk protein were determined from samples taken from four consecutive milkings during each week. Plasma urea-nitrogen and B-hydroxybutyrate concentrations were measured on a weekly basis to determine metabolic status.

To monitor reproductive performance, cows were: 1) palpated weekly to follow uterine involution, ovarian function, and later to diagnose pregnancy, 2) bled once weekly for progesterone analysis to determine onset of ovarian activity, 3) observed twice daily for behavioral estrus and bred on the first and subsequent heats 55 or more days postpartum.

Results and Discussion

Data presented represent the initial year of a two year study. The data were averaged over lactation number and breed for each diet. Cows fed the high protein diet produced 7 lbs more milk per day at the peak of lactation, and had 4 lbs more milk per day averaged over the whole experiment (Table 1). Percent milk fat and protein were not altered by level of crude protein in the diet.

Table 1. Dietary intake and productive characteristics of dairy cattle fed two levels of crude protein.

	% Crude Protein	
	15	20
Cows per treatment	43	39
Crude protein (% of dry matter)[a]	14.6 ± .03[b]	19.5 ± .03
Dry matter intake (lbs/day)[a]	48.8 ± .3	49.8 ± .3
Actual milk (lbs/day)[a]	59.5 ± .4	64.4 ± .5
4% fat corrected milk (lbs/day)[a]	58.9 ± .4	62.8 ± .5
Milk fat %[a]	3.97 ± .02	3.87 ± .02
Milk protein %[a]	3.3 ± .01	3.3 ± .01

[a] Weekly average over the experiment.
[b] ± Standard Error

Losses in body weight and condition were similar for cows on both diets, thus cows on either diet appeared to experience the same magnitude of nutritional stress during early lactation. The high protein cows had an initial average weight of 1385 lbs and an initial condition score of 5.4 that decreased to 1373 lbs and 5.0 by weeks 5 and 7, respectively. The moderate protein group had an initial average weight of 1354 lbs and initial average condition score of 5.3 that decreased to 1339 lbs and 4.8 by weeks 5 and 7, respectively. Both groups of cows regained initial body condition by the end of the experiment.

Protein intake on a dry matter basis was calculated as a percentage of NRC requirements based on body weight, milk production, percent milk fat and lactation number. At week 5 of the experiment moderate protein cows were consuming 100% of NRC requirements for protein and high protein cows were consuming 120%. Protein intake, as a percentage of requirements increased linearly over the experiment reaching levels of 123% and 167% by completion of the experiment for cows on medium and high protein diets, respectively. The influence of different levels of crude protein on its metabolism was apparent after 1 week on the diets based on plasma urea levels. Further increases in plasma urea were small. By week 5 cows on high protein diets averaged 27 mg urea/100 ml, about 12 mg/100 ml above cows fed moderate protein.

Reproductive performance did not appear to be affected by different levels of dietary crude protein (Table 2). Onset of estrous behavior, interval from calving to conception and percent pregnant while on experiment were similar for cows on both diets. While the high protein group had an apparent advantage of .3 services per conception, limited cow numbers per treatment prevent any definite conclusions.

Table 2. Reproductive performance for dairy cattle fed two levels of crude protein.

	% Crude Protein	
	15	20
Cows per treatment [a]	42	35
Interval to first estrus (days)	41.1 ± 3.3 [b]	36.3 ± 2.7
Interval from calving to conception (days)	85.3 ± 4.2	81.3 ± 4.0
% Pregnant	81.8	88.6
Services/conception (cows conceiving)	1.6 ± .2	1.3 ± .1
Services/conception (total services/total cows)	2.0	1.7

[a] Cows with abnormal uterine involution were eliminated from the reproductive data.

[b] ± Standard Error

In summary, there may not be a conflict between a dairy cow's dietary requirements for protein needed for lactation and reproductive performance. However, these conclusions are based on a limited number of observations. Completion of the second year of this controlled experiment should provide a confident answer concerning the effect of high dietary protein on reproduction in dairy cattle.

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