

# Effect of Energy and Protein Density in the Diet and Milking Frequency on Milk Production in Early Lactation Dairy Cows

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## Introduction

A priority for the dairy industry is to optimize milk production while improving animal welfare, and more frequent milking is of interest for the dairy industries aiming to maximize milk production by technologies such as automatic milking systems to meet domestic demands for milk products. Cows in early lactation, especially when milked more than twice daily, will benefit from increased dietary energy density, thus reducing metabolic imbalances resulting in over-mobilized body tissues to sustain increased milk production. The purpose of the present study was to examine the effects of increasing dietary energy, protein density, and milking frequency (6x vs 3x) on performance of fresh lactating dairy cows.

## Materials and Methods

Twenty fresh lactating cows (two primiparous and three multiparous cows assigned to each treatment) were arranged in a 2x2 factorial block design from d 3 to d 25 postpartum and were housed in a freestall system and milked with Westfalia METATRON 21 milking system. Cows milked three times per d (3x) were milked at hours of 2, 10, and 18. Cows milked six times per d (6x) were milked at hours of 2, 6, 10, 14, 18, and 22. The distance of the milking house to the freestall was 70 m. Cows were on the same diet from 2 wk prepartum until 2 d postpartum. The treatment included either a higher (H) or a lower (L) dietary energy density with either 3x or 6x milking frequency: L3, L6, H3, and H6. The net energy for lactation and crude protein percentage values were 0.74 Mcal/lb (1.63 Mcal/kg) and 18% for the L diet, and 0.74 Mcal/lb (1.78 Mcal/kg) and 20% for the H diet. The nonfiber carbohydrates (37.2 and 37.5), neutral detergent fiber (32.5 and 27.7) and dietary cation-anion difference (360 and 345), respectively, for low and high diet density. Cows were group fed three times daily a total mixed ration based on alfalfa hay (20, 15), corn silage (20, 18), soybean meal (13.71, 15.9) and cottonseed meal (5, 10), cottonseed (5, 6), barley grain (8.19, 12), corn grain (8, 10.4), fish meal (3.52, 3.76), beet pulp (10.52, 0), Megalac® (1.19, 4), calcium carbonate (0.71, 0.73), salt (0.58, 0.58), sodium bicarbonate (1.78, 1.78),

mineral-vitamin mixture (1.48, 1.48), magnesium oxide (0.32, 0.32), and zinc oxide (0.05, 0.05), respectively, for low and high density diets. Body condition was scored at the beginning and the end of the experiment by three people. Blood samples were obtained from a jugular vein approximately 5 h after the morning feeding on days 1 and 25 after calving. 3.5% fat corrected and energy corrected milk yields and milk components were analyzed as repeated measures using PROC MIXED of SAS (2003). Cow nested within treatment by parity, and all other effects in the model were considered fixed. Significant treatment differences were declared at  $P < 0.05$ .

## Results

The effect of milking frequency on dry matter intake (DMI) ( $P < 0.05$ ), milk production ( $P < 0.002$ ), and yield of milk fat ( $P < 0.003$ ) and milk protein ( $P < 0.002$ ) were significantly higher for 6x cows, but differences were not significant for percentage of milk fat, milk protein, solids-not-fat (SNF), and blood metabolites. The nonesterified fatty acids concentration was affected by milking frequency ( $P < 0.01$ ). The effect of diet density on DMI, percentage of milk fat, milk protein, blood metabolites, and SNF was not significant, but the effect on milk production ( $P < 0.035$ ), yield of milk fat ( $P < 0.02$ ), and milk protein ( $P < 0.01$ ) was significant and was higher for high density diet. DMI were 37.5, 37.3, 42.0, and 43.4 lb/d (17.01, 16.9, 19.07, and 19.69 kg/d) for L3, H3, L6, and H6, respectively, with cows being milked 6x having greater DMI, but this difference couldn't be analyzed because cows were group fed.

## Significance

More frequent milking (6x vs 3x) with enriched early lactation dietary energy and protein improved milk production. Cows with greater milk yield, achieved by increased milking frequency, benefit from greater dietary energy and protein density in early lactation. Such a dense diet alongside more frequent milking when lactation curve peaks may help to reduce negative energy and protein balances, likely in part by improving hepatic energy turnover. Results provide information for improving periparturient cow health.