To determine the effect of Dietary Crude Protein (DCP) on milk production and protein metabolism, a two group pre/post experimental design was used. The CP level in the ration fed to the two groups (high, low) of lactating dairy cows was increased by 2% for a period of 21 days. Data from each group was collected regarding manure scores, milk fat, milk protein, Milk Urea Nitrogen (MUN) and overall milk production. It was hypothesized that increasing the dietary crude protein would result in increased milk components, higher MUN and lower manure scores. Analysis of data indicated mean milk production decreased by 8 #/day in the low producing group, but the decrease was not significant (P=0.06). In the high producing group significant differences were observed in a Milk Urea Nitrogen increase (P=0.001), milk fat decrease (P=0.025), and a decrease in manure scores (P=0.042) when DCP was increased.

**Introduction**

Lower milk prices and higher operating expenses have dairy producers across the nation searching for ways to increase profits. Protein supplements are said to be the most expensive portion of the dairy cattle ration (Espe and Smith, 1952). Some producers are feeding higher levels of dietary crude protein in order to obtain higher levels of milk solids (protein and fat), since premiums are paid for milk with higher milk solids content. Research suggests that 17% to 19% dietary crude protein should be provided to the lactating cow to meet required nutritional needs. As a cow progresses through lactation a 16% crude protein diet is recommended. However, excess dietary crude protein (EDCP) may result in negative health impacts.

Excess Dietary Crude Protein is converted to ammonia in the rumen. Ammonia that is not utilized in the rumen is transferred to the small intestines and absorbed into the blood stream. The blood stream conveys ammonia to the liver where it is converted to urea, a non-toxic form of nitrogen. In this way, the liver is protecting the animal, since ammonia is toxic to the animal. Excess urea is then excreted in urine or reused by the
rumen through saliva or the passage through the rumen wall (Roessler et al., 1993). In addition, urea synthesis due to EDCP requires more energy to support, which causes an overall depression of blood sugar (energy) in the animal (Harris, 2003) and may lead to decreased fertility and milk solids production.

Gould (1969) expressed concerns that a high dietary protein intake during an early lactation could have a negative effect on the fertility of the cattle. Researchers theorize that reduced fertility is due to 1) an imbalance of protein and energy that leads to reduced concentration of blood progesterone, 2) altering pH and progesterone production which leads to poor uterine environment for embryo survival, and 3) by-products of nitrogen metabolism from the rumen (ammonia) and liver may impair sperm, ova, or early embryo survival due to the change in uterine secretions (Hamaker, 2004).

Furthermore, the EDCP requires extra energy to convert ammonia to urea. Often, the energy source is obtained from fat breakdown that limits the amount of fat available for milk production. The reductions in fat concentrations may eliminate or reduce milk premiums paid to producers.

There are numerous ways of determining if dairy cattle diets contain excess crude protein. For example, the milk urea nitrogen (MUN) is a cost effective and accurate way to test for excess urea nitrogen. A MUN level 12 – 18 mg/dl is considered optimal. Samples that exceed 19 mg/dl have been associated with decreased fertility, and would indicate EDCP (Espe and Smith, 1952, Myers, et al., 2000). Alternatively, EDCP can be assessed by either measuring urea concentration in blood, plasma, and urine or by manure scoring.
Previous research conducted by the University of Wisconsin-Platteville in cooperation with UW-Madison, evaluated the effect of dietary crude protein in dairy cattle on ammonia losses. The diets consisted of two different levels of crude protein, 17% and 20%. During and after the study it became apparent to the herdsmen that the change in crude protein had varied effects on the milk components and fertility of the dairy cattle. The Pioneer Farm Dairy Herd manager observed that increased crude protein in dairy diets resulted in: 1) increased day to first estrus, causing a longer period of average days open; 2) increase in overall fat and protein produced in the milk; and 3) higher incidence of displaced abomasums in the herd.

Based on previous research and observations it was still not apparent how increased dietary crude protein affected low producing and high producing lactating dairy cattle. In the present study, the hypothesis was tested that apparently feeding higher percent crude protein in dairy diets has an increased negative effect on those cattle that were previously fed an optimal crude protein diet in respect to milk urea nitrogen and manure scores. Areas of prime interest were those factors that cause the most influence on potential income and animal health indication including: milk fat, milk yield, milk protein, MUN and manure scores.

**Materials and Methods**

The study was conducted at the University of Wisconsin-Platteville Pioneer Farm Dairy Center located seven miles outside of Platteville. The cattle included in this study were lactating Holstein cows and were split into two groups, high producing and low producing. Equal representation was presented by the high producing and low producing dairy cattle groups. Cattle (n=6) were randomly selected from each producing group.
These lactating cows were then tested on the basis of milk fat, milk protein, milk urea nitrogen, milk yield and manure scores. The milk samples and yield measurements were obtained and analyzed by the Dairy Herd Improvement Agency (DHIA). Manure scores were taken on the day of milk sample collection and were administered according to University of Minnesota diagnostic toolbox guidelines.

The 21 day feed trial started after the first collection of data. The dietary crude protein was increased by 2% in the low and high producing groups’ diets. The high and low producing groups’ diets now contain 19% and 17% dietary crude protein respectively. Dairy diets in this study contain the following roughages, forages and feed additives: corn silage, haylage, mineral mixes, high moisture corn and etc. The samples were collected and analyzed for crude protein content by the University of Wisconsin-Madison feed analysis laboratory to ensure appropriate levels of protein.

To obtain a comprehensive report on all dairy cattle of interest the milk samples were sent to Lafayette county Ag-source laboratories in cooperation with the Dairy Herd Improvement Agency (DHIA). The milk testing was done before and after the feed trial treatment period. The milk was analyzed using the Foss 6000 machine, which analyzed the MUN using the new management summary approach. The new management summary takes into consideration different protein metabolism based on a number of different factors. It is also designed for cows being fed Total Mixed Rations (TMRs) and can be used for groups.

Results

There was a significant increase in MUN levels (P<0.001) for the high producing cattle group. This cattle group also saw a decrease in milk fat production, figure 1,
(P<0.025) and an overall depression in manure scores (P<0.042), as shown in figure 2. However, milk protein levels and milk production did not seem to be affected by increased DCP in the high producing dairy rations.

According to figure 2, the low producing group did not see any significant changes regarding to milk protein, milk fat, milk urea nitrogen, and manure scores. However, the low producing group did see a drop in milk production, but it was not significant (P<0.062) on a 95% confidence interval.

**Discussion**

The results that we saw from this study did support previous work performed by Roessler et al. (1993) and Harris (2003), in which excess urea in the animal caused a depression in milk fat and an increased amount of urea excreted into the environment. However, we did not observe health issues that were recognized by the dairy herd manager in the first feed trial at the UW-Platteville Pioneer Farm. These previous health issues included increased day to first estrus, causing a longer period of average days open; increase in overall fat and protein produced in the milk; and higher incidence of displaced abomasums in the herd.

The duration of only 21 days for the feed trial may be the reason the effects of the previous study were not observed. The previous study’s feed trial ran for twelve months, allowing for a full year for the adverse affects of the change in dietary crude protein to prevail. The experiment conducted was a systems research pre and post experimental design. Systems research means that an initial observation is taken followed by the implementation of the variable and then another observation follows. Due to this design
there was a sacrifice of having no control group, which left the only option of using previous observations to compare the study results.

**Conclusion**

This study demonstrated that a two percent increase in dietary crude protein had variable results on the high and low producing cattle groups. The high producing group did experience a significant decrease in manure scores and increase in MUN levels; this demonstrates that the increase of dietary crude protein at optimal levels seems to produce measurable negative impacts. It also seemed to decrease the milk fat, which causes a loss of profits for milk components, and did not affect the overall milk yield.

The low producing group did not see any significant changes regarding to milk protein, milk fat, milk urea nitrogen, and manure scores. However, the low producing group did see a decrease in milk production, although it was not significant. The increase of the dietary crude protein by two percent, in this study, conveyed to us that there were no strong negative effects, possibly due to the increase to a recommended level of dietary crude protein in the dairy diet.
**Figure 1.** Milk Fat and Milk Protein Pre and Post Interval Plot Comparison

**Figure 2.** Boxplot Comparison of Pre and Post Milk Components, Milk Urea Nitrogen and Manure Scores.
References


