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NitroShure™

Precision Release Nitrogen

Balchem Research Summary

Response of Holstein cows to replacing urea with a slow rumen release urea in a diet high in soluble crude protein.

A summary of a study conducted by A. Highstreet, et al. “Response of Holstein cows to replacing urea with a slowly released urea in a diet high in soluble crude protein. Livestock Science 129 (2010) 179-198.

Background

Rumen bacteria are able to utilize ammonia and available fermentable carbohydrates to produce high-quality microbial protein. In fact, some bacterial species have a requirement for ammonia to maximize microbial growth and optimally digest feed to produce protein and energy for the cow. Ammonia is derived primarily from dietary non-protein nitrogen, recycled urea and the degradation and deamination of dietary rumen degradable proteins (RDP). The level of ammonia in the rumen is affected by many factors including level and source of RDP, level and fermentability of carbohydrate sources, the balance between rates of fermentation of protein and carbohydrate, rumen pH and rate of passage. Inadequate levels of fermentable carbohydrate can also lead to elevated levels of rumen ammonia because without available energy, bacteria cannot convert peptides, amino acids and ammonia to microbial protein. As rumen ammonia levels rise, increasing amounts are absorbed from the rumen. Ammonia in the blood is transported to the liver where it is converted to urea (this process requires energy). Some of this urea will be excreted either in milk (milk urea nitrogen, MUN) or in urine. Both of these pathways of excretion are undesirable and represent lost efficiency of protein utilization. Alternatively some of the urea produced by the liver will be recycled back to the rumen via saliva or direct transfer from the blood to the rumen across the epithelial tissues. The proportion excreted vs. recycled increases as blood urea increases.

Urea is an inexpensive source of protein. It is very soluble and is rapidly hydrolyzed to ammonia in the rumen. This can be beneficial when there are rapidly fermentable sources of carbohydrates in the diet such as sugars and fast starch. However, over-feeding urea can cause a rapid spike in rumen ammonia levels. If bacteria are unable to capture the released ammonia it is absorbed and processed as described above. It is possible to slow the rate of release of urea by lipid encapsulation. By doing so it may reduce spiking of ammonia levels and allow bacteria to better capture the ammonia as it is released more slowly. This can result in increased microbial growth and thus high quality metabolizable protein for the cow, increased carbohydrate digestibility (more energy) and lower MUN and urea nitrogen excretion (more efficient protein utilization). The purpose of this trial was to determine if replacing urea with NitroShure™ *Precision Release Nitrogen*, a slow-release nitrogen source, could enhance performance of early and mid-lactation cows.

Materials and Methods

The trial was conducted on a commercial dairy. Approximately 360 cows were grouped based on milk production and days in milk (DIM). The early lactation groups averaged 79+/- 3.1 DIM (48.6 kg milk/day) and the mid-lactation groups averaged 258 +/- 6.5 days (41.9 kg milk/day) at the start of the experiments. The early and mid-lactation groups were analyzed as separate experiments but ran concurrently. The experimental diets consisted of a control diet containing urea and the NitroShure diet in which urea was replaced with NitroShure. The experiments were a switch back design and consisted of two four-week periods. Treatments were reversed within pens. Cows were milked 3 times daily and were fed a TMR twice daily. Pen intakes were monitored using Feed Watch (Valley Agricultural Software, Tulare, CA, USA). Feed and TMR samples were taken at the beginning and middle of the last week of each period. Milk production was monitored using meters and milk was sampled on day 27/28 of each period. Urine samples were collected on day 25 from 22 to 25 random cows from each treatment group. Only cows that remained in their initial respective pens throughout the entire study were used in the analysis.

Results and Discussion

The treatments' TMR ingredient compositions only varied in that urea was replaced by NitroShure *(Table 1)*. The chemical composition of the TMRs is shown in Table 2. Nutrient compositions were very similar. The NitroShure TMR tended to have slightly lower NDF and ADF and had higher sugar content. The NitroShure diet was also lower in soluble protein, which probably reflects the inclusion of slow-release NitroShure. Soluble protein levels in both TMRs were relatively high at approximately 42%.

Milk production was not significantly increased in either early or mid-lactation cows due to replacing urea with NitroShure (Table 3). Milk production values were numerically higher, 0.8 and 0.7 kg, for early and mid-lactation cows, respectively. In early lactation cows, milk fat and milk protein, yield and percentages, were significantly increased with NitroShure. In the mid-lactation cows, milk components were not different between treatments. MUN levels tended to be high for NitroShure-fed cows in early lactation and were significantly higher in the mid-lactation cows. This seems counterintuitive to the concept of slower release of nitrogen. However, urinary nitrogen and urea were not different between treatments.

The authors suggested that since the diets had high soluble protein levels, peak rumen ammonia levels would be expected to be high as well (not measured). Studies in which rumen ammonia levels have been elevated through the infusion of ammonium salts have shown decreased acetate to propionate ratios (Grummer et al., 1984; Song and Kennelly, 1989; Song and Kennelly, 1990). The authors speculated that adding NitroShure may have reduced peak ammonia levels resulting in an increase in the acetate to propionate ratio and that this may explain the increased milk fat synthesis.

Table 1. Ingredient Composition of Diets.

Ingredient (kg/ton DM)	Urea	NitroShure
Alfalfa hay	150	150
Rolled corn grain	160	159
Cottonseed, whole linted	96	97
Soy hulls	53	53
Canola meal, solvent	136	134
Almond hulls	83	83
Yeast culture	4	4
Urea mineral	18	0
NitroShure mineral	0	17
Rumen inert fat	20	19
Alfalfa haylage	65	67
Corn silage	217	217

Table 2. Nutrient Composition of Diets

Nutrient Composition, g/kg	Urea	NitroShure	P
Dry Matter	587	588	1.00
Organic Matter	918	918	0.96
aNDF	340	334	0.07[a]
ADF	253	249	0.13
Lignin	57	57	0.94
Starch	155	157	0.75
Sugars	31	36	0.02
Crude protein	180	178	0.76
Soluble protein	434	416	0.05
Total fatty acids	55	56	0.50

Table 3. Effects of Diet on Productive Performance of Cows

	Urea	NitroShure	P
Early Lactation Group (79 DIM)			
Yield			
Milk (kg/d)	46.9	47.6	0.14
Fat (kg/d)	1.66	1.73	0.01
True protein	1.30	1.34	0.01
Lactose	2.21	2.25	0.10
Components, (mg/kg)			
Fat	35.7	36.6	0.01
True protein	27.8	28.2	0.01
Lactose	47.1	47.2	0.63
MUN	13.3	13.6	0.11

Mid-Lactation Group (258 DIM)			
Yield			
Milk (kg/d)	38.9	39.6	0.22
Fat (kg/d)	1.48	1.52	0.11
True protein	1.21	1.22	0.43
Lactose	1.84	1.87	0.20
Components, (mg/kg)			
Fat	38.5	38.7	0.49
True protein	31.4	31.2	0.09
Lactose	47.1	47.2	0.74
MUN	12.0	12.2	0.04

Conclusion

1. Replacing urea with NitroShure in high soluble protein diets resulted in significantly increased milk component content and yield in early lactation cows while milk yield tended to be higher. Increasing milk fat and protein could be explained by improved fiber digestibility and microbial protein yield resulting from better utilization of ammonia with NitroShure vs. urea by rumen bacteria.

2. Similar trends were seen in mid-lactation cows but the numbers were not significant. This may be related to the later stage of lactation (258 vs. 79 DIM) of this group of cows.

3. MUN was not different between treatments.

References

Grummer, R.R., Clark, J.H., Davis, C.L., Murphy, M.M. 1984. Effects of ruminal ammonia-Nitrogen concentration on protein degradation in situ. J. Dairy Sci. 67, 2294-2301

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Balchem Corporation
5 Paragon Drive, Montvale, NJ 07645 USA
Tel: 845-326-5600
Email: ANH.Marketing@balchem.com
Website: **Balchem.com**

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