# Monensin and Extruded Urea-Grain for Range Beef Cows

**R. P. Lemenager, F. N. Owens, W. E. Sharp, Merwin Compton and Robert Totusek**

## Story in Brief

Two trials were conducted to evaluate the supplemental value of monensin and extruded urea-grain in comparison to natural protein (30 and 15%) supplements for beef cows grazing low quality dry winter range grass. The extruded urea-grain supplement (30% protein) contained one-half of its protein equivalent from urea.

Cow weight change was not consistently affected by monensin. Cows wintered on 30% natural protein supplement lost less weight than cows receiving 15% natural protein supplement or a supplement containing extruded urea-grain. Calculations indicated the urea in extruded urea-grain was utilized about 43% as well as natural protein. Condition score loss of cattle followed the same trend as weight loss, with cattle losing the most weight also losing the most condition.

Monensin supplemented cows did not differ appreciably from cows receiving control supplements in ruminal total nitrogen, ammonia, non-ammonia nitrogen or sodium. However, addition of monensin to supplements decreased ruminal molar percent of acetate and butyrate, and increased ruminal propionate and ruminal potassium.

This experiment indicated that (1) urea from extruded urea-grain is not utilized as well as natural protein by cows on dry grass, and (2) monensin did not decrease winter weight loss of range cows. The possibility that monensin decreases the intake of forage by range cows is now being researched.

## Introduction

Altering ruminal fermentation to favor propionic acid production by the microorganisms should increase feed efficiency. Improved feed efficiency would be expected since previous research has indicated that (1) propionic acid fermentation is energetically more efficient, (2) propionic acid is utilized by the host animal more efficiently, and (3) propionic acid may have a protein sparing effect as a precursor of glucose.

Monensin has been shown to increase the molar proportion of rumen propionic acid both in the laboratory and in the rumen of cattle fed a high grain ration and to increase feed efficiency of cattle fed finishing rations. Cattle on pasture have shown increased molar proportions of rumen propionate and improved average daily gains when fed monensin. Laboratory experiments indicated that 200 mg/head/day is optimal for cattle fed high roughage diets.

The purpose of this study was (1) to evaluate the addition of monensin to supplements for pregnant and lactating cows, and (2) to determine the utilization of extruded urea-grain in a supplement containing alfalfa for cows. All cows grazed dry winter range grass during the experiments.

## Procedure

Two winter trials were conducted in Central Oklahoma on native tall-grass range with climax vegetation of little bluestem, big bluestem, Indian grass and switch grass. Ingredient makeup of experimental supplements is shown in Table 1. The nitrogen:sulfur ratio for all supplements was approximately 12:1. Initial and final weights, and visually appraised condition scores were obtained after a 12-hour shrink. A condition score of 1 to 9 was placed on each individual cow with 1 being the thinnest and 9 the fattest rating.

### Trial 1.

Seventy-eight mature Angus and Hereford cows were randomly allotted, after blocking by breed and breeding date, to six treatments for a 107-day wintering trial. The six supplemental treatments were 1 through 6 in Table 1. Treatments were: 30% natural protein supplements with and without monensin, 15% natural protein supplements with and without monensin and 30% protein supplements with one-half of the protein equivalent from extruded urea-grain, with and without monensin. Supplement was fed at a rate of 2.50 lb/head/day six days per week initially and increased to 3.25 lb/head/day for the remainder of the trial. Monensin was fed at a calculated level of 200 mg/head/day.

The 30% and 15% natural protein supplements served as positive and negative controls, respectively. All cows were allowed to graze in a common pasture and fed their respective supplement in individual stalls six mornings per week. Feed refusals were recorded daily and minor intake adjustments were made by periodically providing an extra feeding on the seventh day to equalize supplement intake across all treatments. Cows calved from September 5th to February 1st, with a mean calving

**Table 1. Ingredient Makeup of Protein Supplements**

| | Protein source and monensin level, mg/head/day | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | Natural | 30% | Natural | 15% | Extruded grain-urea | 30% | Natural | 30% |
| Item | 0 | 200 | 1 | 200 | 0 | 200 | 0 | 200 |
| Crude protein, %[1] | 30.69 | 32.07 | 15.21 | 18.24 | 31.32 | 32.66 | 29.59 | 29.64 |
| Dry matter, % | 87.82 | 88.47 | 88.05 | 88.36 | 85.96 | 88.26 | 91.79 | 92.01 |
| Corn, % | 22.77 | 27.77 | 68.75 | 68.75 | ---- | ---- | 27.77 | 27.77 |
| Soybean meal (44%), % | 58.25 | 58.25 | 17.25 | 17.25 | 12.40 | 12.40 | 58.25 | 58.25 |
| Ground alfalfa hay, % | 5.00 | 5.00 | 5.00 | 5.00 | 32.80 | 32.80 | 5.00 | 5.00 |
| Sugarcane molasses, % | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Sodium phosphate, % | 2.50 | 2.50 | 2.75 | 2.75 | 4.35 | 4.35 | 2.50 | 2.50 |
| Dicalcium phosphate, % | 0.75 | 0.75 | 1.20 | 1.20 | --- | --- | 0.75 | 0.75 |
| Sodium sulfate[2], % | 0.68 | 0.68 | --- | --- | 1.40 | 1.40 | 0.68 | 0.68 |
| Trace mineral mix, % | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Vitamin A palmitate[3] | + | + | + | + | + | + | + | + |
| Extruded urea-grain[4], % | --- | --- | --- | --- | 44.00 | 44.00 | --- | --- |

[1]Crude protein as determined by Kjeldahl procedure on dry matter basis.
[2]Formulated to supply 12:1 nitrogen:sulfur ratio.
[3]22,000 IU per kg of supplement.
[4]Starea 44: 4.5% moisture, 46.1% protein, 12.5% urea, 97% starch damage determined by alpha-amylase procedure.

date of October 26th. Calving commenced before the trial began and was completed before the trial ended.

Rumen samples were obtained from five randomly selected cows per treatment, 4½ hours post-supplement feeding, on day 84 of the trial for volatile fatty acid determinations. Rumen fluid was sampled a second time from eight randomly selected cows per treatment on day 98 of the trial for determination of certain mineral and nitrogen parameters. Cows on day 98 were fed supplement and allowed to graze 3½ hours before sampling.

### Trial 2.

Seventy-six mature Hereford cows were used in a 140-day trial. Cows were blocked by weight and expected calving date and randomly allotted to two treatment groups with two replications per treatment. Cows were placed on four pastures and rotated among pastures at 14-day intervals to minimize pasture and location effects. The two treatments consisted of supplements 7 and 8 in Table 1. Cows were fed 3.0 lb/head/day of range cubes six days per week consisting of 30% natural protein supplement with or without added monensin at a calculated level of 200 mg/head/day.

Rumen samples were taken on days 84 and 97 of the trial to determine the effect of monensin on molar proportions of acetate, propionate and butyrate. Rumen samples on day 84 were taken an average of 4½ hours post supplement feeding and those on day 97 were obtained immediately preceding daily supplementation.

## Results and Discussion

### Trial 1.

Cow performance results are shown in Table 2. Average daily supplement intakes were approximately equal on all treatments. Palatability of supplements containing extruded urea-grain was lower than the natural protein supplements. There were no apparent palatability problems with the natural protein supplements containing monensin.

Cows consuming the 30% natural supplements, with and without monensin lost about 18% less weight than cows receiving extruded urea-grain with or without monensin, and about 28% less weight than cows fed the 15% natural protein supplements, with and without monensin. Cows on extruded urea-grain supplements were intermediate in weight loss between cows on 30% natural and 15% natural supplements when averaged over monensin treatments, and calculations suggested that the urea nitrogen from extruded urea-grain was utilized about 43% as well

**Table 2. Performance of Cows During Winter Supplementation in Trial 1**

| | Protein source and monensin level mg/head/day | | | | | |
|---|---|---|---|---|---|---|
| | Natural 30% | | Natural 15% | | Starea[1] 30% | |
| | 0 | 200 | 0 | 200 | 0 | 200 |
| No. of cows | 13 | 13 | 13 | 13 | 13 | 13 |
| Daily supplement, lb | 2.30 | 2.30 | 2.30 | 2.30 | 2.25 | 2.27 |
| Calving date | Oct. 27 | Oct. 28 | Oct. 23 | Oct. 27 | Oct. 20 | Oct. 28 |
| Initial cow wt., lb | 990.9 | 991.5 | 991.1 | 991.1 | 991.1 | 991.5 |
| Adjusted cow wt. loss, lb | $215.4^{2}$ | $232.3^{2}$ | $324.3^{4}$ | $297.2^{3,4}$ | $257.6^{3}$ | $288.9^{3}$ |
| Initial cow condition score[7] | 5.69 | 5.62 | 6.08 | 5.62 | 5.69 | 5.85 |
| Condition score change[8] | $-2.08^{2}$ | $-1.92^{2}$ | $-3.69^{6}$ | $-2.92^{4}$ | $-2.38^{3}$ | $-3.31^{5}$ |

[1]Extruded urea-grain to furnish 50% of total crude protein equivalent.
[2,3,4,5,6]Values with different superscripts are significantly different ($P < .05$).
[7]Based on a scale of 1 to 9, 1 the thinnest and 9 the fattest.
[8]Difference in initial and final condition.

as natural protein. This generally agrees with previous research work here. Cow weight losses were about 3% greater with monensin supplementation averaged over nitrogen levels. A difference this small suggests that monensin had little affect on cow weight loss.

Cows fed 30% natural protein supplements lost less condition than cows on the other supplements. Condition score loss followed the order of extruded urea-grain, 15% natural + monensin, extruded urea-grain + monensin and 15% natural supplements. A protein source by monensin interaction was apparent in which monensin depressed condition with extruded urea-grain but improved condition with 15% natural protein. In general, condition loss paralleled weight losses.

Total and molar percentages of volatile fatty acids are shown in Table 3. Averaged over supplements, monensin decreased molar percentage of propionate. Total molar concentration was similar across all treatments and was not influenced by protein source.

Ruminal sodium, potassium and nitrogen parameters are shown in

**Table 3. Total Molar Percentages of Volatile Fatty Acids In Rumen Fluid of Cows In Trial 1**

| | Protein source and monensin level, mg/head/day | | | | | |
|---|---|---|---|---|---|---|
| | Natural, 30% | | Natural, 15% | | Starea, 30% | |
| Item | 0 | 200 | 0 | 200 | 0 | 200 |
| Acetate[4], molar % | $72.48^{1,2}$ | $70.14^{2,3}$ | 73.04 | $67.69^{3}$ | $75.19^{1}$ | $66.17^{3}$ |
| Propionate[4], molar % | $20.12^{2,3}$ | $23.89^{1,2}$ | $19.76^{2,3}$ | $25.45^{1}$ | $18.48^{3}$ | $28.38^{1}$ |
| Butyrate[5], molar % | $7.41^{1}$ | $5.97^{1,2}$ | $7.20^{1}$ | $6.85^{1,2}$ | $6.34^{1,2}$ | $5.45^{2}$ |
| Total conc., mM/1 | 35.14 | 49.59 | 32.52 | 28.56 | 46.09 | 43.83 |

[1,2,3]Values with different superscripts are significantly different ($P < .05$).
[4]Main effect of monensin statistically significant ($P < .005$).
[5]Main effect of monensin statistically significant ($P < .05$).

**Table 4. Ruminal Mineral and Nitrogen Parameters of Cows in Trial 1**

| | Protein source and monensin level, mg/head/day | | | | | |
|---|---|---|---|---|---|---|
| | Natural, 30% | | Natural, 15% | | Starea, 30% | |
| | 0 | 200 | 0 | 200 | 0 | 200 |
| Dry matter, % | $1.96^{3}$ | $2.42^{1}$ | $2.02^{2,3}$ | $2.29^{1,2}$ | $2.18^{1,2,3}$ | $2.40^{1,2}$ |
| Total nitrogen, mg N/100/ml | $58.6^{1,2,3}$ | $64.8^{1}$ | $52.2^{2,3}$ | $49.6^{3}$ | $58.4^{1,2,3}$ | $61.7^{1,2}$ |
| Rumen ammonia, mg $NH_3$/100 ml | $6.3^{2,3}$ | $8.1^{1,2}$ | $3.2^{3}$ | $3.8^{3}$ | $11.2^{1}$ | $8.0^{1,2}$ |
| Non-ammonia nitrogen, mg NPN/100 ml | 52.3 | 56.7 | 49.0 | 45.8 | 47.2 | 53.7 |
| Sodium, ppm | 3000 | 2843 | 2878 | 2640 | 2547.38 | 3318 |
| Potassium, ppm | $464^{2,3,4}$ | $595^{1}$ | $444^{2,3,4}$ | $502^{2,3}$ | $4.3^{4}$ | $508^{2}$ |

[1,2,3,4]Values with different superscripts are significantly different ($P<.05$).

Table 4. Dry matter of ruminal contents was higher for monensin supplemented cows than for control cows.

Total nitrogen content of rumen fluid did not differ consistently across protein sources or with monensin addition. Rumen ammonia concentrations were higher for cows fed extruded urea-grain and 30% natural supplements than for cows fed 15% natural supplements. Reduced rumen ammonia concentrations with monensin feeding have been reported from other research. Supplement treatment did not influence non-ammonia nitrogen or sodium in rumen fluid.

Potassium in rumen contents was similar for protein supplements. However, averaged over nitrogen sources, monensin was associated with approximately a 10% increase in ruminal potassium. Potassium represents an important fraction of the rumen fluid essential in maintaining a desirable medium for bacterial fermentation. Previous research has shown that potassium is essential for laboratory cellulose digestion and maintaining a desirable moisture content of the rumen fluid. Therefore, it is possible that cows receiving monensin may have an increased bacterial fermentation efficiency as shown by the decreased molar percent of acetate and butyrate and increased molar percent propionate. The higher dry matter content of rumen fluid from cows supplemented with monensin could also be due to increased fermentation and slower turnover rate of rumen contents. The results indicate that total rumenal nitrogen and ruminal potassium are strongly correlated, again suggesting that bacterial fermentation increases as ruminal potassium level increases. The VFA's, potassium, total nitrogen and dry matter of rumen fluid reported here support the theory that monensin causes a shift in microbial population.

## Trial 2.

Response of cows in Trial 2 was similar to that of Trial 1 (Table 5). Changes in weight or condition of cows receiving the 30% natural supplement were similar to those of cows fed the 30% natural + monensin supplement. VFA samples collected on cows prior to supplement feeding (Table 6) suggested that monensin had little affect on molar percent of acetate, propionate or butyrate. When sampled 4½ hours post-supplement feeding, cows fed monensin had lower molar percent acetate and butyrate and higher propionate than cows without monensin, but sampled prior to supplement feeding (or 22 hours post-supplement feeding) no difference was apparent. Whether energy supply or amount of residual monensin is responsible for this difference is unknown.

Since rumen VFA's indicted monensin improved rumen fermentation in range cows but weight loss of cows was not benefitted, it is possible that the rumen-fed cows consumed less forage. Research to answer this question is now in progress.

**Table 5. Performance of Cows During Winter Supplementation In Trial 2**

| Item | Monensin, mg/head/day 0 | 200 |
|---|---|---|
| Cows, number | 38 | 38 |
| Ave. daily supplement, lb[1] | 2.75 | 2.75 |
| Ave. calving date | Mar. 25 | Mar. 22 |
| Initial cow wt., lb | 978.8 | 985.1 |
| Adjusted cow wt. loss, lb | 195.0 | 196.2 |
| Initial cow condition score[2] | 5.66 | 5.45 |
| Condition score change[3] | —1.76 | —1.90 |

[1]Dry matter basis.
[2]Based on scale of 1 to 9, 1 the thinnest and 9 the fattest.
[3]Difference in initial and final condition.

**Table 6. Total Molar Percentages of Volatile Fatty Acids In Rumen Fluid of Cows in Trial 2**

| Item | Monensin, mg/head/day 0 | 200 |
|---|---|---|
| Sampled 22 hr post-supplement feeding | | |
| Acetate, molar % | 73.44 | 73.38 |
| Propionate, molar % | 20.40 | 21.09 |
| Butyrate, molar % | 6.16 | 5.53 |
| Total conc., mM/1 | 42.28 | 39.92 |
| Sampled 4½ hr post-supplement feeding | | |
| Acetate, molar % | 76.26[1] | 68.46[2] |
| Propionate, molar % | 16.08[2] | 25.68[1] |
| Butyrate, molar % | 7.65[1] | 5.86[2] |
| Total conc., mM/1 | 38.66 | 36.04 |

[1,2]Values with different superscripts are significantly different ($P < .05$).