

Oregon State University



Beef Cattle Sciences

Oregon Beef Council Report

Influence of Supplement Type and Monensin Addition on Utilization of Low-quality, Cool-season Forage by Beef Cattle¹

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Synopsis

Monensin addition, irrespective of supplement type, reduced forage intake while maintaining performance of beef cattle consuming low-quality forage.

Summary

Two studies were conducted to evaluate the influence of supplement composition and monensin addition on intake and digestibility of a low-quality (< 6% CP), cool-season forage, as well as cow performance. Treatments included a non-supplemented control (CON), approximately 30% CP supplements consisting of corn and urea (CU), CU + monensin (200 mg/day; CU+M), dried distillers grains (DDGS), or DDGS + monensin (200 mg/day; DDGS+M). In Experiment 1, 5 steers (avg. 992 ± 56 lb) were used in an incomplete 5 x 4 Latin square with four 28-d periods to compare the effects of monensin and supplement type on forage intake, digestibility and ruminal fermentation characteristics. Forage intake tended to be greater with supplementation ($P = 0.06$), was greater with DDGS compared with CU ($P = 0.03$), and was decreased 5.5% with monensin addition ($P = 0.04$). Ruminal pH was increased with monensin; however, it was increased more with monensin addition to the DDGS supplement compared with the CU supplement ($P < 0.01$). In Experiment 2, 80 late gestation cows (avg. 1,173 ± 175 lb) were stratified by age, BCS, and BW

and randomly allotted to treatments (20 pens; 4 cows/pen; 4 pens/treatment). Pre-calving and post-calving body condition score (BCS) change were more positive with supplementation ($P < 0.01$) and monensin addition to the supplements benefited pre-calving ($P = 0.02$) and post-calving ($P = 0.02$) BCS change a greater amount with the CU supplement compared with the DDGS supplement.

Introduction

Beef cattle producers have taken advantage of ionophores, such as monensin and lasalocid, since the 1970's. The principle advantages associated with incorporating ionophores into beef cattle diets are improved feed efficiency and amelioration of digestive upsets. In addition, ionophores have proven useful in helping control certain health disorders such as liver abscesses and coccidiosis. As a result, ionophores improve the cost of production in the growing/feedlot by almost \$12/head, with approximately 93% of all feedlots currently using ionophores (Lawrence and Ibarburu, 2007). Another benefit of using ionophores in ruminant diets is a reduction in greenhouse gas emissions. Research has noted that methane production by cattle (21 times more powerful than carbon dioxide as a greenhouse gas) can be decreased almost 40% when monensin is included in the diet (Neto et al., 2009). It should be noted that the vast majority of the aforementioned research was conducted with

1. This document is part of the Oregon State University – 2015 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at <http://beefcattle.ans.oregonstate.edu>.
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growing cattle consuming high-concentrate diets or high quality pasture. In contrast, there is little data available related to feeding ionophores to mature cattle consuming low-quality, forage-based diets (Bretschneider et al.; 2008). Also, there is a paucity of research evaluating the effect of supplement type and ionophore addition on beef cattle consuming poor-quality forages.

The majority of research that has documented improved feed efficiency with ruminants consuming low-quality forage has demonstrated maintained performance when provided approximately 10% less total forage (Bretschneider et al.; 2008). Nevertheless, Lemenager et al. (1978) suggested that forage intake was reduced from 15 to 20% by beef cows grazing winter range in Oklahoma and supplemented with monensin compared with those not receiving monensin. If cattle producers that use low-quality forages for a significant period of the year can reduce the quantity of forage utilized while maintaining or improving animal performance, simply by supplementing with an ionophore, they can reduce required winter feed resources, decrease winter feed costs, and reduce the environmental impact of their operation. We hypothesize that providing supplemental monensin to beef cattle will decrease intake of low-quality forage while maintaining performance; thereby improving feed efficiency, energy status, and ruminal fermentation compared with no monensin. In addition, we hypothesize that the beneficial effects of monensin will be independent of supplement type.

Materials and Methods

All experimental procedures used in this study were approved by the Oregon State University Institutional Animal Care and Use Committee.

Experiment 1. Influence of Supplement type and Monensin Addition on Forage Intake and Digestibility in Steers

Five ruminally cannulated Angus x Hereford steers (avg. 992 ± 56 lb) were used in an incomplete 5 x 4 Latin square and housed in individual pens within an enclosed barn with continuous lighting. Treatments included a non-supplemented control (CON), approximately 30% CP supplements consisting of either corn and urea (CU; 0.29% BW), CU + monensin (200 mg/day; CU+M), dried distillers grains (DDGS; 0.27% BW), or DDGS + monensin (200 mg/day; DDGS+M). All supplemented

treatments were formulated to be provide similar caloric and nitrogen intakes. Supplements and a mineral-salt mix (Cattleman's Choice; Performix Nutrition Systems, Nampa, ID) containing 14% Ca, 10% P, 16% NaCl, 1.5% Mg, 6000 mg/kg Zn, 3200 mg/kg Cu, 65 mg/kg I, 900 mg/kg Mn, 140 mg/kg Se, 136 IU/g of vitamin A, 13 IU/g of vitamin D3, and 0.05 IU/g of vitamin E were placed directly into the rumen via ruminal cannula daily. Steers had continuous access to fresh water and chopped fine fescue grass seed straw (approximately 5% CP).

The 4 experimental periods were 28 d each with 20 d of diet adaptation and 8 d of sampling. Forage intake was measured d 21 through d 26 and blood samples were collected into commercial blood collection tubes via coccygeal venipuncture 4 h after feeding on d 23 through d 28. Also, on d 28 ruminal fluid was collected immediately before feeding and at 2, 4, 6, 8, 12, 18, and 24 h after feeding. Ruminal fluid pH was measured immediately after collection.

Experiment 2. Influence of Supplement type and Monensin Addition on Cow Performance

Eighty late gestation (approximately 190 d pregnant) Angus x Hereford cows (avg. $1,173 \pm 175$ lb) were stratified by age, BCS, and BW. Cows were then randomly assigned to 1 of 5 treatments. The same treatments as described in Exp. 1 were used. Water and a mineral-salt mix was available free choice (same composition as previously described; Cattleman's Choice; Performix Nutrition Systems, Nampa, ID). Cows were provided ad libitum access to low-quality (approximately 5.0% CP) fine fescue grass seed straw. Also, the supplements offered to cows are provided in Table 1.

Cow BW and BCS were measured every 14 d until calving and within 24 h post-calving. Calf BW was also obtained within 24 h post-calving. Blood samples were via jugular venipuncture at trial onset and within 24 h post-calving.

Statistical Analysis

Exp. 1. Intake and digestibility data were analyzed as a 5 x 4 incomplete Latin square with the MIXED procedure of SAS. The model included period and treatment and steer was used as the random variable. Contrasts used to partition specific treatment effects consisted of: 1) supplemented vs non-supplemented; 2) monensin addition; 3) supplement type; and 4) the monensin addition by supplement type interaction.

Ruminal pH was analyzed using the REPEATED statement with the MIXED procedure of SAS. The model included period, treatment, hour and treatment x hour. Steer was used as the RANDOM statement to specify variation and steer(period) was used as the subject. The specific term for the repeated statement was hour. Autoregression (AR1) was determined to be the most appropriate covariance structure based on the Akaike information criterion. The same contrasts as previously noted were used to partition specific treatment effects.

Blood samples were analyzed using the REPEATED statement with the MIXED procedure of SAS. The model included period, treatment, day and treatment x day. Steer was used as the random variable and steer(period) was used as the subject. The specific term for the repeated statement was day. Autoregression (AR1) was determined to be the most appropriate covariance structure based on the Akaike information criterion. The same contrasts as previously noted were used to partition specific treatment effects. If no treatment x time interactions were detected ($P > 0.05$), overall treatment means were compared.

Exp. 2. Cow performance data was analyzed as a randomized block design using the MIXED procedure of SAS. The model included block, treatment and treatment x block. Blood samples were analyzed using the REPEATED statement with the MIXED procedure of SAS. Model included block, treatment, day and all resulting interactions. Initial blood values were used as a covariate. Cow(pen) and pen(treatment) were used as the repeated variables, the subject was cow(pen). The same contrasts as previously described were used to partition specific treatment effects.

Results

Exp. 1 Forage intake, digestibility and ruminal fermentation characteristics in steers

Intake. Forage intake was not altered by supplementation (Table 1; $P > 0.05$); however, DDGS increased forage intake 6% compared with the CU supplement ($P = 0.03$). Also, monensin addition to supplements reduced forage intake by greater than 5% ($P = 0.04$). Total dry matter intake was increased with supplementation ($P < 0.01$), but decreased with monensin addition ($P = 0.04$).

Ruminal Fermentation. Ruminal pH was not altered with supplementation ($P = 0.58$); however, we did note that monensin addition to the DDGS supplement increased average ruminal pH 0.3 units

compared with only 0.1 units with the CU ($P < 0.01$; Table 1).

Blood Variables. Insulin was not affected by treatments ($P \geq 0.019$) but glucose was greater with the CU compared with the DDGS supplements (63 vs 57 ng/mL; $P = 0.01$), probably due to the greater starch content of the corn compared with distillers grains. Protein supplementation has been shown to increase plasma urea nitrogen (BUN) and IGF-I in beef cattle. Our data supports this as plasma IGF-I and BUN concentrations were increased with supplementation ($P < 0.01$; Table 1). Furthermore, IGF-I has been shown to increase with greater DMI (Rausch et al., 2002), suggesting that our increase in IGF-I with supplementation may have been due to greater energy and DM intake resulting from supplementation. Also, due to the greater ruminal degradability of protein in the CU supplement, BUN was almost 100% greater with the CU compared with DDGS ($P < 0.01$; 24 vs 13 mg/dL).

Exp. 2 Cow Performance

Protein supplementation of beef cows consuming low-quality forage typically improves weight and BCS change compared with not providing a supplement (Bohnert et al., 2002; Currier et al. 2004). This was observed in the current study for pre- and post-calving weight and BCS change ($P < 0.01$; Table 2). Also, we observed an increase in pre- and post-calving weight change due to supplement type, with DDGS increasing weight gain compared with CU supplementation. Interestingly, monensin supplementation improved pre-calving cow BCS 0.4 units with the CU supplement compared with a loss of 0.2 units with the DDGS supplement ($P = 0.02$). Similarly, post-calving BCS change was improved 0.4 units with monensin addition to CU compared with a 0.1 increase with DDGS ($P = 0.02$). This suggests monensin was more advantageous when incorporated into the CU supplement compared with DDGS.

As with the steers in Exp. 1, plasma insulin was not altered by the treatment regime ($P \geq 0.32$; Table 2) but glucose was increased ($P = 0.05$) with the CU supplements compared with DDGS. Plasma IGF-1, an indicator of overall nutritional status, increased with supplementation ($P < 0.01$) but was not affected by supplement type or monensin addition ($P \geq 0.12$). Also, as noted in Exp. 1, BUN was greater with supplementation compared with the non-supplemented control ($P < 0.01$) and for the CU compared with DDGS supplements ($P = 0.02$).

Influence of Supplement Type and Monensin Addition on Utilization of Low-quality Forages

Table 1. Effects of supplement type and monensin addition on intake, ruminal pH, and blood variables in steers consuming low-quality, cool-season forage (Exp. 1).

	Treatment ^a					SEM ^b	Contrasts ^c , P =			
	Con	CU	CU+M	DDGS	DDGS+M		Con vs Supp	M	Supp Type	M vs Type
Intake, % of BW										
Forage	1.41	1.51	1.39	1.56	1.52	0.52	0.06	0.04	0.03	0.25
Supplement	0.0	0.29	0.29	0.27	0.27					
Total	1.41	1.80	1.68	1.83	1.79	0.52	<0.01	0.04	0.07	0.25
Ruminal pH	6.75	6.68	6.76	6.59	6.88	0.048	0.58	<0.01	0.65	<0.01
Insulin, ng/mL	4.07	3.60	3.75	3.29	3.26	0.89	0.19	0.88	0.31	0.82
Glucose, mg/dL	58.7	63.9	62.4	59.8	54.3	2.41	0.57	0.12	0.01	0.36
IGF-I, ng/mL	107	165	175	174	178	17.7	<0.01	0.27	0.31	0.66
BUN, mg/dL ^d	9.6	24.0	23.6	12.4	14.5	2.02	<0.01	0.47	<0.01	0.30

^a Con = control; CU = corn/urea; CU+M = CU + 200 mg of monensin; DDGS = dried distillers grains with solubles; DDGS+M = DDGS + 200 mg of monensin.

^b n = 5

^c Con vs Supp = control vs supplemented treatments; M = effect of monensin addition; Supp Type = effect of supplement type; M vs Type = Interaction of monensin addition and supplement type.

^d Plasma urea nitrogen

Table 2. Effects of supplement type and monensin addition on cow performance, calf birth weight, and blood variables (Exp. 2).

	Treatment ^a					SEM ^b	Contrasts ^c , P =			
	Con	CU	CU+M	DDGS	DDGS+M		Con vs Supp	M	Supp Type	M vs Type
Initial Wt., lb	1149	1155	1206	1175	1200	75.2	0.68	0.62	0.93	0.86
Initial BCS	4.8	5.2	4.8	4.9	4.8	0.16	0.38	0.17	0.49	0.22
Weight change, lb										
Pecalving	9	100	126	185	164	21.0	<0.01	0.89	<0.01	0.26
Postcalving	-92	10	14	79	50	24.7	<0.01	0.60	0.04	0.50
BCS change										
Pecalving	-0.8	-0.3	0.1	0.2	0.0	0.14	<0.01	0.41	0.10	0.02
Postcalving	-0.9	-0.6	-0.2	-0.1	0.0	0.17	<0.01	0.08	0.06	0.02
Calf Birth Wt., lb	78.4	81.4	84.7	91.0	82.8	4.0	0.15	0.53	0.34	0.16
Insulin, ng/mL	6.2	4.0	5.5	3.8	4.1	1.65	0.32	0.57	0.61	0.73
Glucose, mg/dL	77.8	80.3	85.8	76.6	74.5	3.95	0.71	0.66	0.05	0.32
IGF-I, ng/mL	25.9	44.8	47.4	53.3	60.2	6.51	<0.01	0.46	0.12	0.74
BUN, mg/dL ^d	10.9	20.3	19.6	13.6	18.0	1.64	<0.01	0.27	0.02	0.13
NEFA, mEq/L ^e	0.51	0.53	0.52	0.59	0.60	0.060	0.45	0.96	0.28	0.81

^a Con = control; CU = corn/urea; CU+M = CU + 200 mg of monensin; DDGS = dried distillers grains with solubles; DDGS+M = DDGS + 200 mg of monensin.

^b n = 5

^c Con vs Supp = control vs supplemented treatments; M = effect of monensin addition; Supp Type = effect of supplement type; M vs Type = Interaction of monensin addition and supplement type.

^d Plasma urea nitrogen

^e Non-esterified fatty acids

Conclusions

This research supports our hypothesis that, independent of supplement type, supplemental monensin would decrease intake of low-quality, cool season forage while maintaining performance compared with no monensin. We did observe monensin addition to CU resulted in improved cow BCS change (pre- and post-calving) compared to no change when monensin was added to the DDGS supplement. Therefore, inclusion of monensin into supplements for beef cattle consuming low-quality, cool season forages, can be a management strategy to reduce forage intake while maintaining performance. Also, based on cow BCS change, starch-based supplements (e.g. corn, barley, wheat, etc.) may benefit more from monensin addition than non-starch-based supplements.

Acknowledgements

This research study is financially supported by the Oregon Beef Council.

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