Use of a Self-Fed, Small-Package Protein Supplement for Beef Cows Post-Weaning

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USE OF A SELF-FED, SMALL-PACKAGE PROTEIN SUPPLEMENT FOR BEEF COWS POST-WEANING[1]

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ABSTRACT: A 2-year supplementation study conducted at Miles City, MT from mid-October to mid-December in 2007 and 2008 evaluated responses of beef cows (n = 141 in 2007, n = 138 in 2008; avg BW = 546 ± 5.2 kg) grazing dormant native range (8.8% CP, 64% NDF, 71% IVDMD) to two different supplementation strategies. Each year, cows were stratified by age and weight at weaning and then assigned to one of two supplements: 1) self-fed loose mineral mix (**MIN**) or 2) self-fed mineral plus high-bypass protein sources (**MIN+PRO**; 50% mineral mix, 25% feather meal, 25% fish meal). Target intakes were 70 g/d for MIN and 140 g/d for MIN+PRO. Cows were weighed and hip height and girth measurements were taken at the beginning and end of the 60-d studies. Weight-to-height and weight-to-girth ratio changes were calculated. Data were analyzed with supplement, cow age (2, 3, and 4+), year, and their interactions in the model. In 2007, cows fed MIN consumed 28 g/d and MIN+PRO cows consumed 93 g/d, which was lower than the target amount for both supplements. In 2008, MIN cows again failed to consume the target amount (13 g/d), while MIN+PRO cows consumed just over target amount (160 g/d). Cows lost similar (P = 0.70) amounts of weight during the study regardless of supplement treatment (-22 and -25 ± 5 kg for MIN and MIN+PRO, respectively). Likewise, weight-to-height ratio change (-0.25 and -0.25 ± 0.04) and weight-to-girth ratio change (-0.10 and -0.12 ± 0.02) were similar ($P \geq$ 0.60) for MIN and MIN+PRO cows, respectively. Year × cow age interactions ($P \leq 0.08$) were observed for weight change and weight-to-height ratio change. Two- and 3-yr-old cows lost less weight in 2008 than in 2007, while mature cows lost similar amounts of weight in both years. All cows exhibited less change in weight-to-height ratio in 2008 compared to 2007, with the difference between years most pronounced in younger cows. Protein supplementation at this level did not impact cow performance; however, forage quality was higher than expected, which may have contributed to the lack of response to supplementation with the mineral-protein mix.

Key Words: Beef Cows, Post-Weaning, Protein Supplementation

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Introduction

Low amounts of supplemental protein, particularly from sources high in ruminally undegradable protein (**RUP**), may enhance nitrogen utilization efficiency (Sawyer et al., 1998; Coomer et al., 1993). Freetly and Nienaber (1998) suggested that nutrient restriction also increases the efficiency of nitrogen utilization in cows. A supplement composed of small quantities of high-RUP (> 70% of CP as RUP) ingredients combined with salt and minerals was demonstrated to maintain ruminal function with low quality forage diets (Sawyer et al., 2000) and was consumed in controlled and consistent patterns by cows grazing desert range (Stalker et al., 2002). In a 3-year field study in central New Mexico, gestating cows consuming a small-package, self-fed supplement (25% feather meal, 25% blood meal, and 50% mineral mix; < 250 g/d consumption) maintained BW and BCS during late fall and early winter, and had similar performance to cows hand-fed an oilseed-based supplement at > 454 g/d (Sawyer et al., 2005). The objective of this study was to evaluate the effectiveness of a self-fed small-package supplement for maintaining BW of post-weaning beef cows grazing native range in the Northern Great Plains.

Materials and Methods

A 2-yr supplementation study was conducted at the Fort Keogh Livestock and Range Research Laboratory near Miles City, MT from mid-October to mid-December in 2007 and 2008. At this location, the potential natural vegetation is a grama-needlegrass-wheatgrass (*Bouteloua-Hesperostipa-Pascopyron*) mixed grass dominant. Average annual rainfall is 343 mm, with the majority occurring during the mid-April to mid-September growing season. Average precipitation compared to 2007 and 2008 precipitation patterns by month is presented in Figure 1.

Each year, Hereford and Hereford-cross beef cows (n = 141 in 2007, n = 138 in 2008; avg BW = 546 ± 5.2 kg; ages 2 through 11 yr; ~135 d gestation) were stratified by age and BW at weaning and then randomly assigned to one of four pastures. Supplement treatments (n = 2) were then randomly assigned to each pasture resulting in 2 pastures per supplement treatment. Treatments consisted of: 1) self-fed loose mineral mix (**MIN**; Table 1) or 2) self-fed mineral plus high-bypass protein sources (**MIN+PRO**). The MIN+PRO supplement was formulated to contain 35% CP and was composed of 50% mineral mix, 25% feather meal, and 25% fish meal. The mineral portion of MIN+PRO was designed to provide the same level of mineral intake as cows receiving MIN. Target intakes were 70 g/d for MIN

and 140 g/d for MIN+PRO. Cows were weighed and hip height and girth measurements were taken at the beginning and end of the study. Weight-to-height and weight-to-girth ratio changes were calculated.

Diet quality was estimated from ruminal extrusa. Extrusa samples were collected via ruminal evacuation techniques (Lesperance et al., 1960) at the beginning (mid-October) and end (mid-December) of the experiment in each year. Mature ruminally-cannulated cows (n = 2 per pasture) that grazed in common with experimental cows were used for all diet sample collections. Collected extrusa samples were lyophilized, ground to pass a 1-mm screen and stored until analysis for DM, OM (AOAC, 1990), and NDF (Goering and Van Soest, 1970). For CP analysis, sub-samples of ground extrusa were placed in glass square-bottom jars with metal rod inserts and dried in a 60°C oven. Upon removal from a drying oven, jars were capped with lids and subsequently placed on a roller grinder for 24 h (Mortenson, 2003). Nitrogen was determined by combustion techniques using a C-N analyzer (CE Elantech, Inc., Lakewood, NJ). Nitrogen values were multiplied by 6.25 to obtain CP.

At 0700 on the day of in vitro analyses, rumen extrusa (1/3 solids and 2/3 liquor) were collected at the interface of the forage mat and liquid fraction from 2 ruminally-cannulated cows on alfalfa hay diets and placed into a Dewar flask (Nalgene 4150-200, StevenJo & Steph, Rochester, NY) that had been incubated to 39°C for 24 h. Rumen extrusa was immediately transported in the Dewar flask to the laboratory at Fort Keogh and forage (solids) were placed into a blender for 30 s. Once extrusa was blended, solids and remaining rumen liquor were strained through 4 layers of cheesecloth into a 6-L Erlenmeyer flask that had been pre-warmed in a 39°C water bath under continuous CO_2 flushing. Next, 500 mL of rumen liquor was measured out into a graduated cylinder and was then combined with 500 mL of pre-made phosphate buffer [70.8% Na_2HPO_4 and 29.2% KH_2PO_4; Menke et al., (1979)] and McDougal's buffer (Tilley and Terry, 1963) already in vessels of a DAISY^{II} apparatus (ANKOM Technology Corp., Fairport, NY) maintained at 39°C. Vessels also contained samples [250 mg of sample/bag (F57; 5 × 5.55 cm^2, ANKOM Technology Corp, Fairport, NY)]. Vessels were purged with CO_2 for 30 s and a lid was secured onto the jar and immediately placed back into the DAISY^{II} apparatus (process was repeated for each of two vessels). Samples were then subjected to in vitro incubation for 48 h at 39°C. At the end of 48 h, incubation bags containing samples were removed and rinsed under reverse-osmosis water until effluent was clear. In vitro dry matter disappearance (IVDMD) was calculated as the DM which disappeared from the initial DM weight inserted into the bag.

Data were analyzed as a completely randomized design by analysis of variance using the MIXED procedure of SAS (SAS Institute, Cary, NC) with pasture as the experimental unit. The model included cow age (2-yr-old, 3-yr-old, or 4-yr-old and older), supplement, and their interaction as fixed effects and pasture within year by treatment as the random effect.

Results and Discussion

In 2007, cows fed MIN consumed 28 g/d and MIN+PRO cows consumed 93 g/d, which was lower than the target amount for both supplements (70 and 140 g/d, respectively). In 2008, MIN cows again failed to consume the target amount (13 g/d), while MIN+PRO cows consumed just over target amount (160 g/d). Sawyer et al. (2005) fed a supplement similar to MIN+PRO (containing blood meal instead of fish meal) to prepartum cows, who consumed an average 230 g/d over a three-year study. Stalker et al. (2002) reported intake of 128 g/d of a self-fed supplement similar to MIN+PRO.

No supplement × year, supplement × cow age, or supplement × cow age × year interactions were observed. ($P \geq 0.21$). Improved intake of MIN+PRO in 2008 did not result in a change in animal performance, and cows lost similar amounts of weight during the study regardless of supplement treatment ($P = 0.67$; -22 and -25 ± 4 kg for MIN and MIN+PRO, respectively). Likewise, weight-to-height ratio change and weight-to-girth ratio change were similar for MIN and MIN+PRO cows ($P \geq 0.56$; weight-to-height: -0.25 and -0.25 ± 0.03; weight-to-girth: -0.10 and -0.12 ± 0.02 for MIN and MIN+PRO, respectively). Sawyer et al. (2005) reported that gestating cows fed a small-package (< 250 g/d) self-fed protein supplement maintained weight and body condition during late winter, while cows that were self-fed loose mineral supplement lost weight. These researchers reported that cows on the mineral-only treatment were also fed 454 g/d oilseed-based supplement during adverse weather.

Cow age × year interactions were observed for weight change and weight-to-height ratio change ($P \leq 0.08$; Table 3). Two- and 3-yr-old cows lost less weight in 2008 than in 2007, while mature cows lost similar amounts of weight in both years. A similar pattern was observed for weight to height ratio.

Forage quality and quantity are important factors that influence domestic rangeland livestock production. Extrusa CP concentrations were similar between mid-October and mid-December each year ($P = 0.68$; 8.6 and 8.9 ± 0.5% CP for October and December, respectively), but were higher overall in 2008 than 2007 ($P = 0.04$; 9.6 and 8.0 ± 0.5% CP for 2008 and 2007, respectively). Higher CP concentrations in 2008 may be due to higher-than-average fall precipitation during October 2008 (Figure 1), coupled with unusually warm average temperatures during October and November (NOAA, 2008; data not shown). Extrusa NDF concentrations and IVDMD were each similar ($P \geq 0.61$) regardless of year or sampling time. These results may have been influenced by low stocking rates used in the experiment, which allowed animals to select diets of higher quality throughout the 60-d study each year. Even though forage quality characteristics indicate adequate nutrient supply for maintenance of gestating cows, cows still lost weight during the experiment. This might be partially explained by rapid temperature changes and inclement weather near the end of the 60-d study in both years. Both 2007 and 2008 were characterized by unseasonably warm temperatures early in the study period, followed by a rapid change to unseasonably cold temperatures during the last 2 wk of each 60-d period

(NOAA, 2007, 2008; data not shown). Adams et al. (1986) found reduced grazing activity and forage intake of grazing beef cows as minimum daily temperatures decreased. Adverse weather conditions experienced by the cows near the end of each 60-d study may have resulted in decreased grazing activity, forage intake, and subsequent weight loss.

Implications

Strategic protein supplementation with a small-package, self-fed supplement did not impact cow performance. Target intakes of the mineral-protein mix were only achieved in 1 of 2 years, which may have contributed to the lack of response. Cows were able to select a high quality diet during both years due to low stocking rates. Cow body weight loss despite diet quality characteristics indicating adequate nutrient supply may be due to rapid temperature drops and inclement weather near the end of the experiment in both years. Further research identifying liming nutrients in range forages and the use of strategic small-package supplementation may be beneficial to optimize range livestock production.

Literature Cited

Adams, D. C., T. C. Nelson, W. L. Reynolds, and B. W. Knapp. 1986. Winter grazing activity and forage intake of range cows in the Northern Great Plains. J. Anim. Sci. 62:1240-1246.

Coomer, J. C., H. E. Amos, M. A. Froetschel, K. K. Ragland, and C. C. Williams. 1993. Effects of supplemental protein source on ruminal fermentation, protein degradation, and amino acid absorption in steers and on growth and efficiency in steers and heifers. J. Anim. Sci. 71:3078-3086.

Freetly, H. C. and J. A. Nienaber. 1998. Efficiency of energy and nitrogen loss and gain in mature cows. J. Anim. Sci. 76:896-905.

Goering, H. K. and P. J. Van Soest. 1970. Forage fiber analyses (apparatus, reagents, procedures and some applications). Agric. Handbook No. 379. USDA-ARS, Washington, DC.

Lesperance, A. L. V. R. Bohman, and D. W. Marble. 1960. Development of techniques for evaluating grazed forage. J. Dairy Sci. 43:682-689.

Menke, K. H., L. Raab, A. Salewski, H. Steingass, D. Fritz, and W. Schneider. 1979. The estimation of the digestibility and metabolizable energy content of ruminant feeding stuffs from the gas production when they are incubated with rumen liquor J. Agr. Sci. 93:217-222.

Mortensen, M. C. 2003. Effects of interseeded alfalfa (*Medicago sativa* spp. *falcata*) on forage production, forage quality, and carbon sequestration on a mixed-grass rangeland. MS Thesis, Univ. Wyoming, Laramie.

National Oceanic and Atmospheric Administration. 2007. 2007 Year in Review for Miles City. Available at: http://www.wrh.noaa.gov/byz/local_news/2008/MLSyearsum07.php. Accessed: 18 March 2008.

National Oceanic and Atmospheric Administration. 2008. 2008 Year in Review for Miles City. Available at: http://www.wrh.noaa.gov/byz/local_news/2009/MLSyearsum08.php. Accessed: 23 March 2009.

National Oceanic and Atmospheric Administration. 2008. Miles City Daily Climate by Month. Available at: http://www.wrh.noaa.gov/byz/unique_climate.php. Accessed 23 March 2009.

Sawyer, J. E., S. H. Cox, R. L. Endecott, M. R. Rubio, S. L. Ivey, and M. K. Petersen. 2005. Efficacy of a self-fed small supplement for prepartum cows grazing dormant pinon-juniper rangeland. Proc. West. Sec. Amer. Soc. Anim. Sci. 56:299-302.

Sawyer, J. E., C. C. Rasor, R. C. Waterman, and M. K. Petersen. 2000. Relative efficiency of 40 or 160 g of moderate or highly undegradable intake protein supplements with low quality forage diets. J. Anim. Sci. 78(Suppl. 1):254.

Sawyer, J. E., L. A. Knox, L. A. Richards, M. W. Salisbury, J. Richards, C. K. Krehbiel, and M. K. Petersen. 1998. Nitrogen utilization in thin cows consuming lovegrass straw supplemented with different amounts of non-protein nitrogen and true protein. Proc. West. Sec. Amer. Soc. Anim. Sci. 49:36-39.

Stalker, L. A., J. E. Sawyer, M. G. Thomas, M. D. Remmenga, C. Bailey, D. Wood, and M. K. Petersen. 2002. Influence of undegradable intake protein mixed with mineralized salt on intake and fermentation profiles of cows grazing dormant winter range. Proc. West. Sect. Amer. Soc. Anim. Sci. 53:73-76.

Tilley, J.M.A. and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassl. Soc. 18:104-111.

Table 1. Composition of self-fed loose mineral supplement

Item	%
Calcium	12.0
Phosphorus	12.0
Salt	27.0
Sodium	10.0
Magnesium	1.5
Potassium	0.1
	ppm
Copper	1,200
Manganese	4,000
Iodine	100
Selenium	25
Zinc	2,500
	IU/kg
Vitamin A	330,000
Vitamin D	39,600
Vitamin E	220

Table 2. Crude protein and neutral detergent fiber concentration and in vitro dry matter disappearance of rumen extrusa samples at the start (mid-October) and end (mid-December) of supplementation from experimental pastures.

	Extrusa Collection		
Item	Supplementation Start	Supplementation End	SE
CP %, DM basis			
2007	8.4	7.6	0.8
2008	8.9	10.3	0.8
NDF %, DM basis			
2007	63.3	63.7	1.5
2008	64.5	64.5	1.5
IVDMD, %			
2007	69.4	72.8	2.4
2008	72.2	67.7	2.4

Table 3. Cow age × year interactions for weight change, weight-to-height ratio change and weight-to-girth ratio change.

	Cow Age						
Item	2	SE	3	SE	≥ 4	SE	Interaction *P*-value
Weight change, kg							
2007	-29[ax]	5	-32[ax]	6	-27[ax]	4	0.03
2008	-15[ay]	5	-13[ay]	6	-26[bx]	4	
Weight-to-height ratio change							
2007	-0.32[ax]	0.04	-0.32[ax]	0.05	-0.32[ax]	0.03	0.08
2008	-0.17[ay]	0.04	-0.13[ay]	0.05	-0.25[bx]	0.03	

[a,b] Means in rows with different superscripts differ ($P < 0.10$).
[x,y] Means in columns with different superscripts differ ($P < 0.10$).

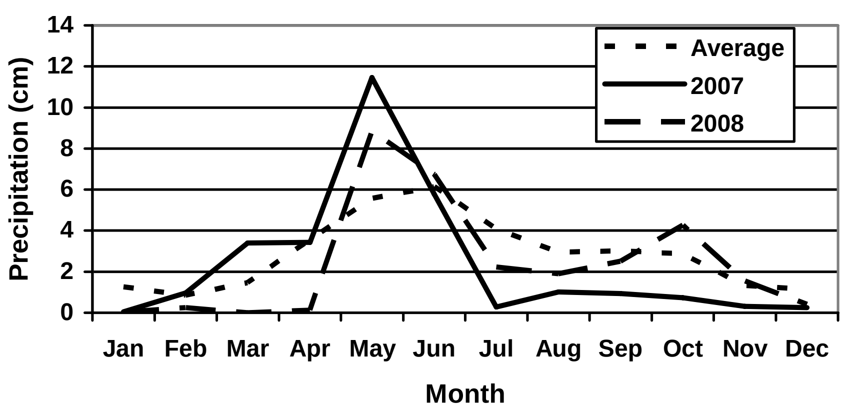

Figure 1. Average annual precipitation (30-yr), 2007, and 2008 precipitation by month for Miles City, MT (NOAA, 2007, 2008).