Proceedings, Western Section, American Society of Animal Science

Vol. 54, 2003

EFFECT OF FIELD PEA-BASED CREEP FEED ON INTAKE AND DIGESTIBILITY BY NURSING CALVES GRAZING NATIVE RANGE IN WESTERN NORTH DAKOTA

A. A. Gelvin[1], G. P. Lardy[1], D. G. Landblom[2], and J. S. Caton[1]

[1]Animal and Range Sciences Department, North Dakota State University, Fargo

[2]Dickinson Research and Extension Center

ABSTRACT: Eight Angus x Hereford nursing steer calves (145 ± 44 kg initial BW) fitted with ruminal cannulas were used to evaluate effects of field pea-based supplement and advancing season on dietary composition, intake, digestion, and ruminal characteristics. Treatments were control and field pea-based creep (19.1% CP, DM basis) fed at 0.45% BW (DM basis) daily. Calves grazed native pasture with their dams from late June through early November. Collection periods were 10-d long and occurred in July, August, September, and October. Masticate samples from supplemented calves tended to be lower in ADF ($P = 0.09$) and higher in CP ($P = 0.07$) compared with controls. Dietary CP and ADIN decreased linearly with advancing season ($P \leq 0.03$). In vitro organic matter digestibility decreased from July to October ($P < 0.01$; 58.5% to 41.3%). Forage intake was not different ($P = 0.89$) between treatments, but increased linearly with advancing season (1.67, 1.90, 3.12, 3.38 kg/d for July, Aug, Sept, and Oct, respectively; $P = 0.03$). Milk intake (% BW) was similar ($P = 0.55$) between control and supplemented calves, but decreased linearly ($P = 0.001$) with advancing season. Supplemented calves had greater total intake (forage + milk + creep; $P = 0.05$). Grazed forage OM and CP digestibilities were higher ($P = 0.004$) in supplemented calves. With advancing season, NDF, ADF, and OM digestibilities decreased linearly ($P < 0.01$). No treatment effects were observed for in situ DM disappearance rate of forage or creep ($P > 0.10$). Creep DM disappearance decreased linearly ($P = 0.02$) and forage DM disappearance decreased quadratically ($P = 0.03$) with advancing season. Supplementation reduced ($P < 0.01$) ruminal pH at several times measured. Ruminal ammonia was higher ($P < 0.01$) in supplemented compared with control calves. These data indicate supplementation increases total intake but has no effect on forage or milk consumption by nursing calves.

Keywords: Nursing, Calves, Intake, Digestion, Forage

Introduction

Supplemental creep feed can increase weaning weights of nursing calves (Faulkner et al., 1994; Lardy et al., 2001; Loy et al., 2002). For spring born calves grazing native sub-irrigated meadow, Lardy et al. (2001) found metabolizable protein was the first limiting nutrient, whereas Loy et al. (2002) found energy to be first limiting, when grazing native range. These differences could be due to differences in the forage quality. Forage diet samples from Lardy et al. (2001) averaged 12.5% CP and 54.8% in vitro organic matter digestibility (IVOMD). Loy et al. (2002) had forage that averaged 10.2% CP and 53.0% IVOMD.

Potential value of creep feed in a cow-calf operation is dependent upon increased weaning weight, ability to stretch tight forage supplies, improved feed intakes at weaning, and the price differential between light and heavyweight calves. Lardy et al. (2001) reported that forage intake tended ($P = 0.09$) to be higher in non-supplemented calves compared with calves receiving supplemental undegraded intake protein (UIP) in the form of sulfite liquor-treated soybean meal and feather meal. However, Loy et al. (2002) found no differences in forage intake between non-supplemented and supplemented calves. Treatments were non-supplemented control, energy supplement, degradable intake protein supplement, and degradable plus undegradable intake protein supplement. Milk intake did not differ between non-supplemented and supplemented calves in either study. Krysl et al. (1989) found that 0.5 kg of soybean meal or steam-flaked sorghum grain had little effect on forage intake, but both supplements increased total tract OM digestion in steers. However, increased cereal grain intake (> 30% OM intake) may lead to depression of forage digestibility (Uden, 1984; Hart, 1987).

Anderson (1998) varied proportions of field peas and wheat middlings in a creep feed for nursing calves. They observed feed intake and average daily gain increases with increased field peas in the diet. Our objectives were to determine effects of field pea/wheat middling-based creep feed and advancing season on diet composition, intake, total tract digestion, in situ disappearance rate, and ruminal pH in nursing calves grazing native range.

Materials and Methods

Animals, Experimental Design, and Diets. Research was conducted at North Dakota State University's Dickinson Research Extension Center and used eight ruminally cannulated Angus x Hereford nursing steer calves (145 ± 44 kg initial BW). Animals used in this research were handled and cared for according to approved Institutional Animal Care and Use guidelines. Calves were allotted randomly to one of two treatment groups: 1) control (non-supplemented) and 2) field pea-based supplemental creep (19.1% CP, DM basis) fed at 0.45% BW (DM) daily

(Table 1). Previous research conducted at Dickinson Research and Extension Center showed this ratio of field peas to wheat middlings optimized calf performance (Landblom et al., 2002).

All calves grazed native pasture with their dams from July 1 to November 5. Salt and mineral (composition was: (%) 11 Ca, 12 P, 2.3 Mg, 2.0 K, 1.0 S; (mg/kg) 27 Co, 70 I, 35 Se; (g/kg) 2.7 Cu, 4.7 Mn, 4.8 Zn; (kIU/kg) 500 Vitamin A, 75 Vitamin D_3, 5 Vitamin E; (mg/kg) was available on a continuous basis. Measures of calf responses to treatment were taken July, August, September, and October and included BW, fecal output, milk consumption, diet composition, digestion, ruminal pH, and ruminal ammonia.

Laboratory Analysis. A masticate sample was collected by ruminal evacuation techniques and composited two weeks prior to each collection period for in situ fermentation. Samples were taken to the lab, freeze-dried, and ground through a Wiley mill (2-mm screen). Five gram samples were sealed in Dacron bags and incubated in the rumen during collection periods. Feces were collected using fecal bags with harnesses for 5 d at the beginning of each collection period. A 10% sub-sample was taken twice daily, composited, and frozen. Samples were allowed to thaw, mixed and sub-sampled, dried in a 55° C oven for 48 h, and then ground through a Wiley mill (1-mm screen). Masticate samples were collected by ruminal evacuation techniques on d 8 of each collection period and frozen. Samples were freeze-dried and ground through a Wiley mill (1-mm screen).

Fecal, masticate, and creep feed samples were analyzed for DM, OM, ADF, and CP (AOAC, 1990). Neutral detergent fiber was analyzed using an Ankom 200 Fiber Analyzer (Ankom Co., Fariport, NY). In vitro OM digestibility (Tilley and Terry, 1963) was determined using composited innoculate from two ruminally cannulated steers fed a grass hay diet. Acid detergent insoluble nitrogen (ADIN) was analyzed using the Kjeldahl method of nitrogen determination on the ADF residue. Ruminal pH was taken immediately following ruminal fluid collection (200 mL) using a combination electrode. Samples were then acidified with 7.2 N H_2SO_4 at 1 mL/100 mL ruminal fluid and frozen for later analysis. Ruminal fluid samples were centrifuged at 20,000 x g for 20 minutes and analyzed for ammonia (Sigma Technical Bulletin #640; Sigma Diagnostics, St. Louis, MO).

Statistical Analysis. Dietary composition, forage and OM intake, total tract digestibility, and in situ data were analyzed as a spilt-plot (Gill and Hafs, 1971). Effects for sampling period, treatment, sampling period x treatment, and animal within treatment were included in the model. Treatment effects were tested using animal within treatment as the error term. Period and subsequent interactions were tested with residual error. A split-split-plot analysis (Gill and Hafs, 1971) was used to evaluate ruminal fermentation data (pH and ammonia). The statistical model included effects for treatment, sampling time, sampling period, and animal within treatment, as well as interactions. As before, animal within treatment was used as the error term to test treatment. The GLM procedures of SAS (SAS Inst., Cary, NC) were used for all statistical computations.

Results and Discussion

Supplementation did not alter grazed forage NDF, but ADF tended to decrease (P = 0.09) and CP tended to increase (P = 0.07; Table 2). Grazed forage ADIN and IVOMD were not altered by supplementation (P = 0.54 and 0.76, respectively). There were no seasonal effects for grazed forage NDF or ADF ($P \geq 0.10$; Table 2). Crude protein and ADIN decreased linearly with advancing season ($P \leq 0.03$). In vitro organic matter digestibility decreased (P < 0.01) from July (58.5%) to October (41.3%). Calf weight was similar (P = 0.51) between treatments at the beginning of the trial (145 ± 44 kg); however, in October supplemented calves were heavier (P = 0.05; 225 vs 257 kg for control and supplemented, respectively).

Forage intake (% BW) was not different (P = 0.89) between treatments, but increased linearly with advancing season (P = 0.03; Table 3). Milk intake was similar (P = 0.55) between control and supplemented calves, but decreased linearly (P = 0.001) over time when expressed as a percentage of calf BW. By design, supplement intake (kg/d) increased linearly (P = 0.002) over time, because calves were fed supplement at a constant percent BW. Supplemented calves had greater total intake (forage + milk + creep; P = 0.05) compared with control calves.

Organic matter and CP digestibilities of grazed forage were higher (P = 0.004; Table 4) for supplemented calves compared with controls. There was no treatment effect on total tract digestibility of NDF and ADF of the forage, which were similar findings as Krysl et al. (1989). With advancing season, NDF, ADF, and OM digestibilities decreased linearly (P < 0.01; Table 4). No treatment effects were observed for in situ DM disappearance rate of forage or creep (P > 0.37, Table 5). Creep DM disappearance rate decreased linearly (P = 0.02) and forage DM disappearance rate decreased quadratically (P = 0.03) with advancing season.

Forage intake did not differ between the two treatment groups, which is similar to the findings of Loy et al. (2002), but contradictory to the findings of Lardy et al. (2001) and Faulkner et al. (1994). Forage types in the above mentioned trials were predominately cool season, with Loy et al. (2002) having the largest portion of warm-season species at 40% of the total forage available. In the studies of Lardy et al. (2001) and Loy et al. (2002) milk intake was not influenced by supplemental creep feed, and, as % BW, decreased over time. This study had similar findings, which was not unexpected since cows were past peak lactation. Total intake was greater for supplemented calves compared to control calves, which also agrees with data from Lardy et al. (2001) who reported nursing calves receiving supplement had greater total intakes than control calves. These data indicate supplementation increases total intake but has no effect on forage or milk consumption of nursing calves.

Treatment x sampling time x sampling period interactions were detected for ruminal pH (P < 0.01). Supplementation reduced (P < 0.01) ruminal pH at several time points: in July ruminal pH was reduced at 2, 4, 6, 8 and

10 h post-feeding; during August and October, ruminal pH was reduced at 6 h post-feeding; and in September, ruminal pH was reduced at 4, 8 and 10 h post-feeding (Table 6). Ruminal ammonia levels were higher ($P < 0.01$) in supplemented compared with control calves; ruminal ammonia levels for control were 2.7 m*M* and compared with 6.0 m*M* ± 0.34 for supplemented calves. Seasonal effects of ruminal ammonia indicate a cubic effect with ammonia levels of 4.00, 5.80, 4.33, and 3.17 ± 0.33 m*M* for July, August, September, and October, respectively. Ruminal pH decreased, while ruminal ammonia levels increased with supplement. This is similar to the findings of Krysl et al. (1989). Krysl et al. (1987) reported that ruminal pH differed between non-supplemented control and cottonseed meal supplemented Rambouillet ewes, while ruminal ammonia levels were not different. In a different study (Krysl et al., 1988) using steers, they reported similar results with ruminal pH, but reported a feed type effect on ruminal ammonia levels. Ruminal ammonia levels increased with soybean meal compared to steam-flaked sorghum grain, and non-supplemented controls. Tarr et al. (1994) conducted a study using a 12% CP creep with calves having ad libitum access to a 27% CP tall fescue. They reported ammonia levels higher in the control calves than the creep fed calves, which was likely due to the lower proportion of protein in the diet with additional starch based creep. They also reported decreased ruminal pH with increased levels of creep feed.

Implications

Forage quality consumed by nursing beef calves declines with advancing season in western North Dakota. A field pea-based creep feed may be used to increase nutrient intake and improve nutrient status in nursing calves.

References

AOAC. 1990. Official Methods of Analysis (15th Ed.). Association of Official Analytical Chemists, Arlington, VA.

Anderson, V. L. 1998. Field peas in creep feed for beef calves (Progress Report). Carrington Research Extension Center Annual Beef Report. Available: http://www.ag.ndsu.nodak.edu/carringt/98beef/fpcreep.htm. Accessed May 30, 2002.

Faulkner, D. B., D. F. Hummel, D. D. Buskirk, L. L. Berger, D. F. Parrett, and G. F. Cmarik. 1994. Performance and nutrient metabolism by nursing calves supplemented with limited or unlimited corn or soyhulls. J. Anim. Sci. 72:470-477.

Gill, D. L., and H. D. Hafs. 1971. Analysis of repeated measurements of animals. J. Anim. Sci. 33:331-336.

Hart, S. P. 1987. Associative effects of sorghum silage and sorghum grain diets. J. Anim. Sci. 64:1779-1789.

Krysl, L. J., M. E. Branine, A. U. Cheema, M. A. Funk, and M. L. Galyean. 1989. Influence of soybean meal and sorghum grain supplementation on intake, digesta kinetics, ruminal fermentation, site and extent of digestion and microbial protein synthesis in beef steers grazing blue grama rangeland. J. Anim. Sci. 67:3040-3051.

Krysl, L. J., M. E. Branine, M. L. Galyean, R. E. Estell, and W. C. Hoefler. 1987. Influence of cottonseed meal supplementation on voluntary intake, ruminal and cecal fermentation, digesta kinetics and serum insulin and growth hormone in mature ewes fed prairie hay. J. Anim. Sci. 64:1178-1188.

Landblom, D. G., W. W. Poland, G. P. Lardy. 2002. Application of salt-limited pea/wheat midd creep diets in southwestern North Dakota. Dickinson Research Extension Center Annual Beef Report. Available: http://www.ag.ndsu.nodak.edu/dickinso/research/2001/beef01b.htm. Accessed June 14, 2002.

Lardy, G. P., D. C. Adams, T. J. Klopfenstein, R. T. Clark, and J. Emerson. 2001. Escape protein and weaning effects on calves grazing meadow regrowth. J. Range Manage. 54:233-238.

Loy, T. W., G. P. Lardy, M. L. Bauer, W. D. Slanger, and J. S. Caton. 2002. Effects of supplementation on intake and growth of nursing calves grazing native range in southeastern North Dakota. J. Anim. Sci. 80:2717-2725.

Robertson, J. B., and p. J. Van Soest. 1981. The detergent system of analysis and its application to human foods. In: W. P. T. James and Theander (Eds.) The Analysis of Dietary Fiber. Pp. 123-158. Marcell Dekker, New York.

Sigma Technical Bulletin #640. The colorimetric determination of urea nitrogen. Sigma Diagnostics, St. Louis, MO 63178.

Tarr, S. R., D. B. Faulkner, D. D. Buskirk, F. A. Ireland, D. F. Parrett, and L. L . Berger. 1994. The value of creep feeding during the last 84, 56, or 28 days prior to weaning on growth performance of nursing calves grazing endophyte-infected tall fescue. J. Anim. Sci. 72:1084-1094.

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

Uden, P. 1984. Digestibility and digesta retention in diary cows receiving hay ro silage at varying concentrate levels. Anim. Feed Sci. Technol. 11:279

Table 1. Creep feed supplement composition (DM basis)

Ingredient	%
Field peas	62.10
Wheat middlings	31.05
Molasses	5.00

Limestone	1.80
Trace mineral & vitamin premix	0.05
----------Laboratory Analysis----------	
CP	19.1
NDF	17.6
ADF	6.8
IVOMD	88.1

Table 2. Effects of field pea-based creep and advancing season on grazed forage diet quality (OM basis)

	Treatment				**Season**					**Contrast[b]**		
Item	**CON**	**SUP**	**SEM[a]**	***P***	**July**	**Aug**	**Sept**	**Oct**	**SEM[a]**	**L**	**Q**	**C**
OM, % DM basis	84.8	86.2	1.38	0.49	88.4	81.4	87.5	84.6	1.96	0.84	0.32	0.02
	---%, OM basis---											
NDF	67.9	66.4	1.0	0.32	68.6	66.6	68.6	64.9	1.4	0.24	0.55	0.10
ADF	40.8	39.2	0.6	0.09	40.0	40.2	41.1	38.7	0.9	0.56	0.17	0.27
CP	8.6	9.8	0.4	0.07	9.7	10.3	8.1	8.6	0.6	0.03	0.92	0.08
ADIN	0.23	0.25	0.02	0.54	0.25	0.29	0.21	0.21	0.02	0.02	0.30	0.08
IVOMD	52.7	53.4	1.5	0.76	58.5	57.1	55.3	41.3	1.3	<0.001	<0.001	0.003

[a]SEM=standard error of the mean; n=2 for treatment; n=4 for season
[b]L=linear contrast; Q=quadratic contrast; C=cubic contrast

Table 3. Effect of field pea-based creep and advancing season on intake by nursing calves (DM basis) grazing native range

	Treatment				Season					Contrast[b]		
	CON	**SUP**	**SEM[a]**	***P***	**July**	**Aug**	**Sept**	**Oct**	**SEM[a]**	**L**	**Q**	**C**
Intake, kg												
Milk	1.01	1.04	0.15	0.90	1.18	1.03	0.96	0.94	0.14	0.23	0.62	0.83
Forage	2.32	2.72	0.31	0.40	1.67	1.90	3.12	3.38	0.22	<0.001	0.93	0.30
Total	3.33	4.66	0.47	0.09	3.19	3.32	4.56	4.89	0.26	<0.001	0.71	0.36
Intake, g/kg BW												
Milk	5.75	5.39	0.41	0.55	8.05	5.77	4.59	3.86	0.75	<0.001	0.31	0.45
Forage	12.80	13.05	1.27	0.89	11.79	10.78	14.98	14.15	1.17	0.03	0.94	0.12
Total	18.55	22.88	1.25	0.05	22.10	18.77	21.79	20.23	1.39	0.88	0.54	0.09

[a]SEM=standard error of the mean; n=2 for treatment; n=4 for season
[b]L=linear contrast; Q=quadratic contrast; C=cubic contrast

Table 4. Effect of field pea-based creep and advancing season on total tract digestibilities (%, OM basis) by nursing calves grazing native range

	Treatment				Season					Contrast[b]		
Item	**CON**	**SUP**	**SEM[a]**	***P***	**July**	**Aug**	**Sept**	**Oct**	**SEM[a]**	**L**	**Q**	**C**
NDF	46.0	45.6	1.82	0.88	53.0	53.1	41.0	36.0	2.85	< 0.001	0.31	0.37
ADF	44.3	41.7	1.92	0.35	49.0	51.7	38.6	32.7	3.01	< 0.001	0.10	0.25
OM	45.4	57.7	2.07	0.004	58.2	56.4	46.0	45.5	2.96	< 0.001	0.80	0.34
CP	25.1	48.3	4.40	0.004	36.2	44.2	27.2	39.2	4.98	0.42	0.65	0.03

[a]SEM=standard error of the mean; n=2 for treatment; n=4 for season
[b]L=linear contrast; Q=quadratic contrast; C=cubic contrast

Table 5. Effect of field pea-based creep and advancing season on in situ DM disappearance (%/h) of creep feed and forage in nursing calves grazing native range

	Treatment				Season					Contrast[b]		
Digestion Rate; %/h	**CON**	**SUP**	**SEM[a]**	***P***	**July**	**Aug**	**Sept**	**Oct**	**SEM[a]**	**L**	**Q**	**C**
Creep	8.4	6.4	1.5	0.38	9.7	7.9	8.5	3.6	1.5	0.02	0.27	0.09
Forage	2.0	1.7	0.4	0.55	---	2.1	2.4	1.1	0.24	0.02	0.03	---

[a]SEM=standard error of the mean; n=2 for treatment; n=4 for season
[b]L=linear contrast; Q=quadratic contrast; C=cubic contrast

Table 6. Effect of field pea-based creep and advancing season on ruminal pH of nursing calves grazing native range

	Time, h[a]						
Item	-2	0	2	4	6	8	10
July							
CON	6.87	6.87	6.95	6.95	6.99	7.09	6.92
SUP	6.78	6.83	6.36	6.30	6.40	6.71	6.32
SEM[b]	0.10	0.04	0.10	0.05	0.07	0.08	0.07
P	0.54	0.52	0.01	< 0.001	< 0.001	0.02	0.001
August							
CON	6.91	6.80	6.87	6.69	6.72	6.69	6.67
SUP	6.95	6.62	6.67	6.49	6.14	6.46	6.50
SEM[b]	0.07	0.08	0.11	0.09	0.11	0.11	0.10
P	0.71	0.18	0.22	0.16	< 0.001	0.18	0.28
September							
CON	6.94	6.86	6.74	7.26	6.70	6.72	7.24
SUP	7.07	6.70	6.62	6.85	6.37	6.29	6.80
SEM[b]	0.22	0.09	0.15	0.14	0.13	0.15	0.10
P	0.67	0.28	0.59	0.09	0.12	0.09	0.02
October							
CON	6.79	6.65	6.73	6.65	6.48	6.41	6.18
SUP	6.71	6.65	6.48	6.45	6.18	6.27	6.38
SEM[b]	0.11	0.15	0.13	0.08	0.09	0.19	0.18
P	0.65	0.98	0.23	0.15	0.07	0.63	0.47

[a]Interactions present ($P < 0.01$) for treatment*time; treatment*period; treatment*time*period
[b]SEM=standard error of the mean