

**PROTEIN SUPPLEMENTATION OF BRANGUS STOCKER CALVES
GRAZING WINTER TALLGRASS PRAIRIE**

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ABSTRACT: In years when growing conditions are not favorable for establishment of fall wheat pasture in the Southern Great Plains, producers need cost-effective grazing alternatives for home grown calves until spring wheat pasture is available. The objective of this research was to evaluate the potential of wintering Brangus calves on perennial tallgrass prairie and offering limited amounts of a cottonseed meal (CSM) or fish meal (FSM) based supplement. Two weeks after weaning in October 2000, calves were sorted by sex and placed on one of four pastures (Big Bluestem, Little Bluestem, Dropseed, Cheat; avg 49.5% ADF and 5.5% CP). Calves were supplemented by pasture with CSM (20 steers and 25 heifers) or FSM (20 steers and 25 heifers) for 90 d. Measures included calf weights, hip height, serum metabolites and ADF digestibility using acid detergent insoluble ash as an internal marker. Supplements had 42% CP and similar *in situ* digestibilities. Calves lost weight during the first 40 d on pasture (-0.21 kg d^{-1}); therefore, daily supplement amounts were increased from 908 to 1362 g hd^{-1} . No differences in gain were detected between steer groups over the last 50 d ($0.44 \pm 0.038 \text{ kg d}^{-1}$), but heifers fed FSM gained more ($P < 0.001$) than those fed CSM ($0.42 \text{ vs } 0.26 \pm 0.034 \text{ kg d}^{-1}$). Calves fed FSM vs CSM had a greater increase ($P < 0.05$) in hip height ($3.3 \text{ vs } 2.8 \pm 0.23 \text{ cm}$). Steers had lower ($P < 0.001$) serum urea nitrogen levels than heifers ($15 \text{ vs } 21 \pm 0.9 \text{ mg dl}^{-1}$). Serum glucose levels tended to be lower for steers fed CSM than FSM ($62 \text{ vs } 73 \pm 2.2 \text{ mg dl}^{-1}$), but similar between heifer groups ($82 \pm 2.0 \text{ mg dl}^{-1}$). By d 90, a higher ADF digestibility was found for heifers fed FSM as compared to heifers fed CSM and steers fed CSM or FSM ($66 \text{ vs } 56, 55, 51 \pm 2.5\%$). Although supplying FSM improved heifer utilization of winter tallgrass prairie, no differences were detected for subsequent 60 d gains ($1.2 \pm 0.06 \text{ kg d}^{-1}$) or pregnancy rates (66%) when heifers were placed on spring wheat pasture. Results suggest Brangus calves can be wintered on lower quality pasture with minimal inputs when annual cool season forages are not available.

Key words: Forages, Protein Supplementation, Digestibility

Introduction

In the Southern Great Plains, producers often utilize annual winter wheat as both a pasture resource and grain crop. During most years, this system provides a readily available forage base which can support high rates of inexpensive gain in stocker calves prior to feedlot placement or in replacement heifers. However, fall weather conditions are not always favorable to allow for early seeding and (or) sufficient growth of wheat pasture to support late fall or early winter grazing. Producers who commit early to retaining or receiving calves in the fall must have cost-effective alternatives to purchasing feed. Therefore, this research was conducted to evaluate the potential of wintering fall-weaned Brangus calves on perennial tall grass prairie pastures and offering limited amounts of high protein supplements.

Materials and Methods

Ninety, spring-born Brangus calves were raised at the USDA-ARS Grazinglands Research Laboratory in El Reno, OK. Calves were weaned October 5, 2000 (avg age = 208 d). At weaning, calves were weighed, wormed, branded, and vaccinated. Only steers were implanted (Synovex-S; Fort Dodge Animal Health, Overland Park, KS), because heifers were destined for spring breeding. Immediately after weaning, calves were given free access to prairie hay (5.1% CP, 85% NDF) and offered a commercial protein supplement (38% CP) in a drylot.

Due to dry conditions, wheat pasture was not available for fall and winter grazing. On October 11, calves were sorted by sex and randomly allotted to receive either a cottonseed meal-based (CSM) supplement (25 heifers and 20 steers) or fish meal-based (FSM) supplement (25 heifers and 20 steers). Supplement formulations are presented in Table 1. Calves were randomly placed on four tall grass prairie pastures. Calves had free access to water and trace mineralized salt mix during the entire trial.

Pasture composition was estimated by recording and ranking forage species within ten, 0.25 m² frames across each pasture (Gillen and Smith, 1986). Forage within frames was clipped and dried in a 55°C forced air oven. This was done prior to placing calves on pasture (October 10, 2000), after calves were adapted to supplemental

treatments (November 15, 2000), and late in the experiment (January 23, 2001). Diet quality samples were collected via the ruminal evacuation technique on October 11 and by esophageally-cannulated steers (January 19). Mastigate samples were oven-dried (55°C), ground (2 mm), and analyzed for OM, CP (AOAC, 1996), and NDF and ADF (Goering and Van Soest, 1970) using an ANKOM²⁰⁰ fiber analyzer (Fairport, NY). Acid detergent insoluble ash (ADIA) (Appeddu and Bodine, 2002) was determined for use in digestibility estimates.

Two ruminally cannulated steers were used to evaluate *in situ* digestibilities of supplements. Ground supplements (2 mm) were weighed (4.5 g) into bags (10 x 20 cm; ANKOM, Fairport, NY) and sealed with an electric tie. On January 11, 2001, cannulated steers were placed on tall grass prairie pasture along with intact steers fed either CSM or FSM supplement. On January 26, bags with both supplements were placed in laundry sacks in the rumen over 108, 48, 24, 6 and 0 h. Following incubation, all bags were removed simultaneously, rinsed in tepid water, and oven-dried (55°C). Dry bags and contents were weighed to estimate amounts remaining. Supplement samples were analyzed for OM content and percentage CP prior to and after incubation. *In situ* ADF digestibility of mastigate samples were estimated similarly in two, unsupplemented, cannulated steers for 48 h of ruminal incubation.

Calves were group-fed the same commercial protein supplement (908 g hd⁻¹ d⁻¹) offered at weaning from October 11 to October 22. Starting October 23, calves received increasing amounts of CSM or FSM in place of the commercial supplement. Initial heifer measures were taken on October 31 and initial steer measures, on November 3, when calves were fully consuming experimental supplements. Calf weights and hip heights were recorded. Fecal grab samples were taken, oven-dried (55°C), and ground (2 mm) for evaluation of ADF digestibility using ADIA as an internal marker (Appeddu and Bodine, 2002). Blood samples were taken via jugular venipuncture, harvested for serum, and frozen until later analysis. In heifers, estimates of backfat were taken between the 12th and 13th rib via ultrasonography. Empty weights were taken after taking calves off feed and water for 12 h.

Heifer weights, serum samples, and fecal samples were taken on November 28, 2000, and January 9, 2001. Similar measures for steers were taken November 30 and January 11. All calves were weighed on December 12. At this time, supplement rates were increased for all calves from 908 to 1362 g hd⁻¹ d⁻¹. Furthermore, heifers had to be moved to adjacent pastures as a result of pasture size being half that of the steers. Final steer measures were taken on January 31, and final measures for heifers were taken February 1; final measures were the same as initial measures. Final shrunk weights for steers and heifers were recorded on February 1 and 2, respectively.

Serum samples were analyzed for urea nitrogen and glucose using prepared kits (Sigma-Aldrich Corp., St. Louis, MO) adapted for analysis using a 96-well plate and a microplate reader (Appeddu et al., 2003). The average R square for urea nitrogen was 0.999, and intraplate and interplate coefficients of variation were 4.5 and 6.2%, respectively. The average R square for serum glucose was 0.999, and intraplate and interplate coefficients of variation were 6.6 and 5.5%, respectively.

Following final measures, heifers were introduced to wheat pasture. Steers were placed in the feedlot due to limited wheat pasture. Heifers were weighed again on April 1, 2001, after grazing wheat pasture for 60 d. At this time, heifers were synchronized for one heat attempt at artificial insemination, after which heifers were exposed to bulls. Heifer pregnancy rates were estimated via rectal palpation in September 2001.

Data were analyzed using a repeated measures model with the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Due to ample amounts of forage available in pastures, calf was considered as the experimental unit. The model included the effects of treatment (calf sex x supplement), sampling date, and their interaction. When treatment x date was significant, data were sorted and analyzed by time. Orthogonal contrasts were used to evaluate treatment effects of calf sex, supplement, and their interaction. When a sex x supplement interaction was detected, differences were further evaluated using a means separation test (DIFF).

Results and Discussion

Average species composition of pastures is presented in Table 2. Higher quality forages were available, as shown by the presence of cool season forages (cheat, sedge, forbs). Although considered “invaders” on tall grass prairie, these forages were kept short by grazing through the course of the experiment.

A decline in CP and increase in NDF was observed in masticate samples during the experiment (Table 3). This suggests utilization of higher quality forages by calves first. These differences may also have been influenced by method of masticate collection. Other masticate chemical components were similar between sampling dates. According to recommendations of a 9.5% CP diet for 250 kg large frame calves (NRC, 1984), pasture alone would not support calf gain at a rate of 0.454 g d⁻¹ by the end of the experiment. However, actual diet quality was probably higher, as supported by observations of calves including cool season forages in the diet.

Supplements had similar protein contents (51.9% CP, OM basis; 81% OM). Similar *in situ* protein degradabilities were detected between supplements at 6, 24, 48, and 108 h (25, 18, 16, and 8 ± 1.4% CP remaining, respectively). Fish meal is reported to have a lower ruminal protein degradability than cottonseed meal (67 vs 43% UIP; NRC, 1996). However, replacing 20% of plant protein with an

animal protein did not appear to change supplement degradability at times measured.

Initial shrunk weights were similar, but steers were heavier ($P = 0.05$) than heifers on the final weigh date (Table 4). Calves lost weight (average -0.20 kg d^{-1}) until supplement feeding was increased from 908 to $1362 \text{ g hd}^{-1} \text{ d}^{-1}$. An interaction was detected ($P = 0.007$) for calf gain across the last period of supplementation. During this time, heifers fed CSM gained the least amount of weight ($0.26 \text{ vs } 0.44 \pm 0.038 \text{ kg d}^{-1}$; $P = 0.002$). A similar interaction was detected ($P = 0.05$) for shrunk ADG.

Steers were taller than heifers when initial ($47.3 \text{ vs } 45.9 \pm 0.44 \text{ cm}$; $P = 0.001$) and final ($50.3 \text{ vs } 49.3 \pm 0.38 \text{ cm}$; $P = 0.01$) measures were taken. Calves consuming FSM had a greater overall increase in hip height than those fed CSM ($3.3 \text{ vs } 2.8 \pm 0.23 \text{ cm}$; $P < 0.05$). On both initial and final days, heifers had $0.2 \pm 0.02 \text{ mm}$ of backfat. No differences were found for change in backfat for heifers fed CSM or FSM ($-0.01 \text{ vs } -0.05 \pm 0.017 \text{ mm}$; $P = 0.15$).

A treatment by day interaction ($P < 0.001$) was detected for serum urea nitrogen and serum glucose levels. Steers fed CSM vs FSM had increased levels of serum urea nitrogen ($18 \text{ vs } 14 \pm 1.1 \text{ mg dl}^{-1}$) and glucose ($80 \text{ vs } 63 \pm 3.1 \text{ mg dl}^{-1}$) on the fourth weigh day. As a result, serum glucose levels to be higher in steers fed CSM than FSM ($73 \text{ vs } 62 \pm 2.2 \text{ mg dl}^{-1}$). Glucose levels were similar between heifers fed CSM and FSM ($82 \pm 2.0 \text{ mg dl}^{-1}$). On average, steers had lower serum urea nitrogen levels than heifers ($15 \text{ vs } 21 \pm 0.9 \text{ mg dl}^{-1}$; $P < 0.001$).

Pastures consisted of clay loam and sandy loam soil types (USDA, 1976). Fecal OM content (range 71.6 to 81.4%) suggested a low level of inorganic matter intake (Appeddu and Bodine, 2002). Therefore, it was concluded ADIA would be an acceptable digestibility marker for this experiment (Appeddu and Bodine, 2002). A treatment by day interaction was found for ADF digestibility ($P = 0.02$). Heifers had greater ($P < 0.001$) ADF digestibilities than steers on the fourth weigh day (Fig. 1). This increase was likely due to increases in forage selection after placing heifers on new pastures on December 12 (fecal samples not taken). An interaction was detected on the final weigh date ($P < 0.01$), when heifers fed FSM had the greatest ($P < 0.01$) estimate of ADF digestibility.

No carryover effects of treatments were found after heifers were placed on spring wheat pasture on February 2, 2001. Heifers gained $1.2 \pm 0.06 \text{ kg d}^{-1}$ over 60 d. Fall pregnancy rates were the same between treatment groups (66%).

The loss in weight during the first part of the experiment suggests 383 g of supplemental CP was not enough to support a positive weight gain in Brangus calves grazing winter tall grass prairie pasture. In contrast, supplying 574 g CP supported an average 0.40 g d^{-1} of gain. Recommendations from the NRC (1984) suggest large-frame steer calves need 552 g CP d^{-1} to support this rate of growth. Because it is assumed the pasture would supply

protein in addition to supplemental protein, calves most likely used supplemental protein as energy precursors to support growth along with that supplied from forage fermentation (Table 3). It may also be suggested that increasing protein supplementation of dormant pastures increased forage intake (Kunkle et al., 1999), although this variable was not measured. If the relationship between protein intake and weight change was assumed to be linear, 453 g of supplemental protein would be needed for maintenance of calf weight to be achieved.

Differences in serum metabolites between steers and heifers also suggest supplementation needs vary by sex of calf. It may be expected that nutrients in steers would be directed toward skeletal and lean growth, especially after being implanted, whereas heifer development would include both growth and synthesis of reproductive hormones.

Supplying FSM supported greater increases in calf height, heifer forage digestibility, and heifer gain. Lower fluctuations in serum and weight values for calves fed FSM may also indicate a more stable metabolic status over time as compared to calves fed CSM. Improved gains and reproductive traits have been found when supplementing with FSM (Hussein and Jordan, 1991). However, steer gains were not higher and no carryover effects on reproduction were found for heifers. Therefore, supplying FSM in place of CSM did not improve economic traits over supplementing with a traditional CSM-based supplement in this experiment. Overall, wintering Brangus heifers at a low rate of gain did not decrease subsequent performance.

Implications

These results suggest Brangus calves can be wintered on tall grass pasture with minimal inputs when annual cool season forages are not available. Between 383 and 574 g of supplemental protein per day would have to be provided to ensure maintenance of calf weight. Source of protein (fishmeal versus cottonseed meal) did not change winter weight gain or spring breeding rates in Brangus calves grazing tall grass prairie pasture during the winter.

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Table 1. Composition (% as-fed) of a cottonseed meal (CSM) or fish meal (FSM) based supplement.

Ingredient	CSM	FSM
Cottonseed meal	70.2	50.0
Fish meal	--	20.0
Wheat middlings	13.5	19.0
Molasses	8.0	8.0
Dicalcium Phosphate	2.5	0.5
Limestone	2.5	1.0
Urea	1.5	--
Vegetable Oil	1.0	1.0
Calcium Sulfate	0.8	0.5

Table 2. Species composition of tall grass prairie pastures.

Species	10/10/00	11/15/00	1/23/01
Big bluestem	45.1	55.0	31.9
Dropseed	31.0	17.9	14.3
Old World bluestem	5.7	2.9	19.5
Scribner's panicum	2.3	0.2	0.5
Little bluestem	1.0	10.8	19.3
Cheat	1.5	7.8	7.2
Forbs	4.4	2.5	3.2
Sedge	5.4	2.0	3.5
Other ^a	3.6	0.9	0.6

^a Other = Forage species recorded in minor amounts in one pasture (Rush, Blue grama, Switchgrass, Meadow foxtail, Three-awn, Vine mesquite).

Table 3. Nutrient composition of masticate samples.

Nutrient	11/1/01 ^a	1/19/01 ^b
OM	82.0	83.7
CP ^c	10.0	5.3
NDF ^c	76.7	83.0
ADF ^c	49.5	48.9
ADIA ^c	5.0	4.6
Digestibility ^{c,d}	54.8	54.6

^a Collected via ruminal evacuation.

^b Collected via esophageally cannulated steers.

^c OM basis.

^d Determined from 48 h *in situ* (ruminal) incubation.

Fig. 1. ADF digestibility in steers (S) or heifers (H) fed either a cottonseed meal (CSM) or fish meal (FSM) based supplement.

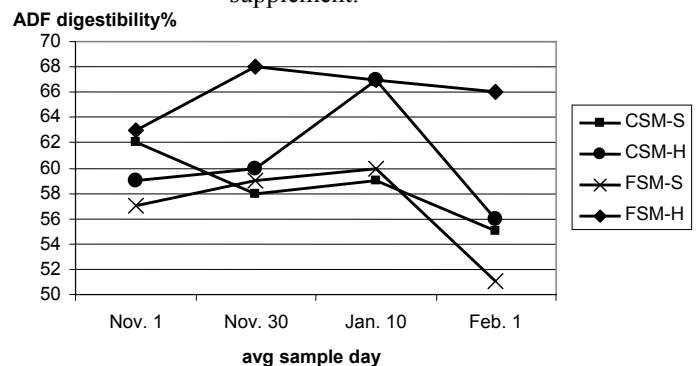


Table 4. Growth measures for Brangus steers or heifers fed a cottonseed meal (CSM) or fish meal (FSM) based supplement.

Variable	CSM steer	CSM heifer	FSM steer	FSM heifer	SEM ^a	Sex ^b	Supplement ^b	Sex by Supplement ^b
Initial empty weight, kg	236	227	236	227	7.2	0.17	0.95	0.96
Final empty weight, kg	252	233	249	238	7.9	0.05	0.85	0.56
Empty ADG, kg d ⁻¹	0.17	0.06	0.14	0.13	0.026	0.01	0.43	0.05
ADG (11/1-12/12), kg d ⁻¹	-0.23	-0.11	-0.27	-0.22	0.031	0.002	0.01	0.19
ADG (12/12- 2/1), kg d ⁻¹	0.46	0.26	0.43	0.42	0.038	0.004	0.08	0.007

^a SEM = Standard error of the mean.

^b Orthogonal contrasts and probability levels.