Effects of phase feeding of protein on performance, blood urea nitrogen concentration, manure nitrogen:phosphorus ratio, and carcass characteristics of feedlot cattle

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ABSTRACT: Two experiments with a randomized complete block design were conducted to determine the effects of phase feeding of CP on performance, blood urea nitrogen (BUN), manure N:P ratio, and carcass characteristics of steers fed in a feedlot. In Exp. 1, 45 crossbred steers (initial BW = 423 ± 3.3 kg) were individually fed a diet formulated to contain 13.0% CP (DM basis) for 62 d. On d 63, the dietary CP was maintained at 13.0% or formulated to contain 11.5 or 10.0% CP until slaughter. Actual CP values were 12.8, 11.8, and 9.9%, respectively. Reducing the CP concentration of the diet did not affect ADG of steers from d 62 to 109 ($P = 0.54$) or over the 109-d feeding period (1.45, 1.50, and 1.49 kg/d for 13.0, 11.5, and 10.0% CP, respectively; $P = 0.85$). No differences ($P > 0.12$) among treatments were detected for BUN concentrations on d 0, 62, or 109. Gain:feed, DMI, and carcass characteristics did not differ among treatments ($P > 0.10$). In Exp. 2, 2 trials were conducted using 184 (initial BW = 406 ± 2.6 kg) and 162 (initial BW = 342 ± 1.9 kg) crossbred steers. Data from the 2 trials were pooled for statistical analysis, and trial effect was added to the statistical model. Steers were fed a diet formulated to contain 13.0% CP until reaching approximately 477 kg. When the average BW of the pen was 477 kg, diets were maintained at 13.0% CP or reduced to contain 11.5 or 10.0% CP. Actual CP values were 12.4, 11.5, and 9.3% CP for treatments 13.0, 11.5, and 10.0% CP, respectively. Reducing the CP content of the diet did not affect ADG after the diet changed ($P = 0.16$) or throughout the finishing period ($P = 0.14$). Immediately before slaughter, steers fed the 13.0% CP diet had greater ($P < 0.001$) BUN concentrations than steers fed the 11.5 and 10.0% CP diets. Carcasses from cattle fed the 11.5% CP diet had greater ($P = 0.02$) fat thickness than the 13.0 and 10.0% CP treatments, whereas carcasses from cattle fed 13.0% CP had greater ($P = 0.004$) marbling scores than steers fed the 11.5 or 10.0% CP diets. Other carcass characteristics, DMI, and G:F did not differ ($P > 0.10$) among treatments. The N:P ratio was increased with the 10.0% CP diet ($P = 0.02$) compared with the 11.5 or 13.5% CP treatments; however, manure composition did not differ ($P > 0.10$) among treatments. These results indicate that reduced CP concentration during the finishing period does not affect feedlot performance but can improve the N and P relationship in the manure.

Key words: environment, feedlot, nitrogen, phase feeding, phosphorus

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INTRODUCTION

Concentrated animal feeding operations are facing increased concerns because of environmental issues. Cattle feedlots continue to increase in size, which concentrates manure and the nutrients contained therein (Klopfenstein and Erickson, 2002). Consequently, feed nutrients such as N, P, and trace minerals are being concentrated in a relatively small geographic area (Cole and Greene, 1998).

Environmental issues are related to nutrient management, runoff of nutrients, odor, and aerial emissions of NH_3, CH_4, and dust (Van Horn et al., 1996). In addition, N and P can cause significant water pollution when discharged into surface water through runoff or depos-

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ited in water from aerial emissions (Klopfenstein et al., 2002). The volatilized N in the form of NH_3 from animal manure returns to the land or water via rainfall, dry deposition, or direct adsorption (Klopfenstein et al., 2002).

Decreasing dietary N inputs into concentrated animal feeding operations could potentially decrease environmental concerns related to air and water quality (Cole et al., 2003). The N requirements for feedlot cattle change during the finishing period, being greater during the initial part when rates of protein deposition are high and diminishing during the later stages of finishing. Consequently, N is underfed early and overfed late in the feeding period (Klopfenstein et al., 2002). Reducing dietary excesses, where they exist, could reduce nutrients in feedlot manure. Feeding nutrients at concentrations that closely match animal requirements can prevent excess N output (Galyean, 2001; Klopfenstein et al., 2002). Plant supplemental protein sources usually contain high P (greater than 0.80%). Reducing dietary CP to match requirements also reduces dietary P.

Modifying feedlot diets by decreasing CP while maintaining animal performance may be the most practical method to reduce N output (Todd et al., 2006). The objective of these studies was to investigate the effects of decreasing CP concentration as time on feed increases (phase feeding) on performance, blood urea nitrogen (**BUN**), carcass characteristics, and concentrations of N and P in manure of feedlot cattle.

MATERIALS AND METHODS

Two experiments were conducted at the Texas Agricultural Experiment Station/USDA-ARS Conservation and Production Laboratory feedlot near Bushland, TX, from November 2002 to June 2004. Care, handling, and management of steers were approved by the Cooperative Research, Education, and Extension Triangle Animal Care and Use Committee (Texas Agricultural Experiment Station, USDA-ARS, and West Texas A&M University).

Experiment 1

In Exp. 1, 54 crossbred steers previously grazing native grass pastures were blocked into 3 weight groups and randomly assigned to 6 pens (2 pens/block). Steers were trained to consume their daily feed from individual Calan electronic gate feeders (American Calan, Northwood, NH) for a 2-wk period while being fed a high-roughage diet. Those steers that did not adapt to consume from the feeders or were sick were removed from the study, resulting in 45 steers (average initial BW = 423 ± 3.3 kg) being used in the experiment. After training, steers were weighed, implanted with Synovex-S (20 mg of estradiol benzoate and 200 mg of progesterone; Fort Dodge Animal Health, Overland Park, KS) and assigned to 1 of 3 dietary treatments (Table 1). Steers were not reimplanted.

During the first 62 d, steers were fed a high concentrate finishing diet formulated to contain 13.0% CP (Table 1). Supplemental CP was provided from equal amounts of N provided by urea and cottonseed meal. All diets contained monensin and tylosin (Rumensin and Tylan, respectively, Elanco Animal Health, Greenfield, IN). On d 63, which was estimated to be approximately half of the feeding period, dietary CP was maintained at 13.0% or reduced to 11.5% by removing equal proportions of N from urea and cottonseed meal, whereas all supplemental N was removed to produce the 10.0% CP diet. Actual CP values were 12.8, 11.8 and 9.9%, respectively. There were 14, 15, and 16 steers receiving the 13.0, 11.5, and 10.0% CP diets, respectively.

Steers were individually fed ad libitum once daily at 0800. Feed refusals were collected and weighed at 7-d intervals. Weight gain and G:F were measured for the first 62 d, for the 47-d period thereafter, and for the total 109-d feeding period. At the time of diet change, average steer BW was 536 ± 4.4 kg. Steers were slaughtered on d 109 (BW = 585 ± 5.4 kg) at a commercial packing plant. Carcass characteristics were determined by the West Texas A&M University Cattlemen's Carcass Data Service.

Experiment 2

Two trials were conducted using pen-fed steers in the summer (trial 1) and winter (trial 2) of 2003. In trial 1, 184 steers (initial BW = 406 ± 2.6 kg) were purchased from 2 sources (previously grazing native grass pastures) and were transported to the experimental feedlot at Bushland, TX. Steers were blocked by initial weight and starting date. Steers were placed on feed on June 6, 2003 (6 pens, 2 blocks; n = 54) or on June 17, 2003 (15 pens, 5 blocks; n = 130). Similarly, steers were blocked by start date and then weighed and housed in similar pens by block. Within a block, pens were randomly assigned to 1 of 3 experimental diet treatments (7 pens/treatment).

In trial 2, 162 steers (initial BW = 342 ± 1.9 kg) were selected from a group of steers that had previously grazed a sorghum × sudan hybrid forage during the summer and a short-grass prairie range at the James Bush Research Farm, Texas Agricultural Experiment Station, in Bushland, TX, and were then transported 5 km to the experimental feedlot at Bushland. Steers were blocked by weight and randomly assigned to 3 experimental diets in 18 pens and placed on feed on December 11, 2003.

Steers from trials 1 and 2 were initially fed a common 50% concentrate diet for 2 wk and a common 70% concentrate diet for 1 wk before they were fed the 90% concentrate experimental finishing diet. Steers were then weighed, implanted with Synovex-S, and assigned to 1 of 3 dietary CP treatments (Table 1). Steers were

Table 1. Composition and analyzed nutrient content of diets containing 13, 11.5, and 10% CP and fed to finishing steers (Exp. 1 and Exp. 2)[1,2]

	Dietary treatment					
	13.0% CP		11.5% CP		10.0% CP	
Item	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2
Ingredient						
Corn grain, steam flaked, %	72.56	74.07	75.10	76.25	77.20	79.50
Alfalfa hay, mid bloom, %	10.00	—	10.00	—	10.00	—
Sorghum-sudan, silage, %	—	7.50	—	7.50	—	7.50
Molasses, cane, %	4.00	4.00	4.00	4.00	4.00	4.00
Fat, %	3.00	3.00	3.00	3.00	3.00	3.00
Limestone, %	0.80	1.00	0.80	1.00	0.80	1.00
Mineral and vitamin premix,[3] %	5.00	5.00	5.00	5.00	5.00	5.00
Urea, %	0.55	0.75	0.34	0.46	—	—
Cottonseeed meal, %	4.09	4.68	1.76	2.79		—
Analyzed composition						
CP, %	12.75	12.36	11.80	[illegible].48	9.85	9.30
NDF, %	13.70	13.80	[illegible]	13.91	12.70	14.26
NE_m, Mcal/kg	1.91	1.99	1.93	1.99	1.92	2.03
NE_g, Mcal/kg	1.27	[illegible]	1.28	1.34	1.28	1.37
Ca, %	0.74	0.70	1.12	0.96	0.73	0.65
P, %	[illegible]	0.31	0.33	0.34	0.30	0.28

[1]Diets were based on [illegible] requirements.
[2]DM [illegible]
[3]Comp[illegible] of 5.44% Ca, 0.20% P, 4.43% NaCl, 0.51% Mg, 3.94% K, 0.29% S, 1.83% Na, 827 ppm Mn, 1286 ppm Zn, 633 ppm Fe, 135 ppm Cu, 0.17 ppm Se, 2.68 ppm Co, 13.64 ppm I, 18,651 IU of vitamin A/kg, and 110 IU of vitamin E/kg. All diets contained monensin (30 mg/kg) and tylosin (11 mg/kg).

not reimplanted. All steers were fed a finishing diet formulated to contain 13.0% CP once daily at 0730 until they reached approximately 477 kg of BW, which was an estimate of the halfway point of the feeding period. Supplemental CP was provided from equal amounts of N provided by urea and cottonseed meal. As each pen reached an average BW of 477 kg, dietary CP was maintained at 13.0% or reduced to 11.5 or 10.0%. The actual CP values were 12.4, 11.5, and 9.3% CP for the 13.0, 11.5, and 10.0% treatments, respectively. Steer ADG and G:F were determined for the period before the steers reached 477 kg, for the period thereafter, and for the total feeding period. The daily feed intake was also measured. Steers were slaughtered as described in Exp. 1.

Sampling

In both experiments, blood samples were collected via jugular venipuncture before feeding on d 0, on the day of the diet change, and immediately before slaughter to determine BUN. Blood samples were collected using 13-mL Vacutainer tubes containing gel and clot activator (Becton Dickinson, Franklin Lakes, NJ) and centrifuged for 30 min at 5,000 × *g*. An aliquot of approximately 3 mL of serum was obtained, transferred to a 5-mL transport tube, and stored at 4°C until analyzed for BUN.

Blood urea nitrogen concentrations from Exp. 1 and trial 1 in Exp. 2 were determined using a commercial kit (Urea Nitrogen Procedure No. 640, Sigma Diagnostics, St. Louis, MO) that was slightly modified by using a standard calibration curve containing 0, 7.5, 15, and 30 mg of urea N/100 mL. Samples were read on a Hewlett Packard 8453 UV-Visible Spectrophotometer (Agilent Technologies, Palo Alto, CA). Samples from trial 2 of Exp. 2 were analyzed using a commercial kit (L type Wako UN, Wako Chemicals, Richmond, VA) in a microplate reader at 340 nm (96-well plate).

Samples of the diet ingredients (flaked corn, cottonseed meal, alfalfa hay, sorghum silage, molasses, tallow, and premix) and total mixed ration were collected weekly and composited over the entire feeding period. Samples of the total mixed ration were dried weekly (60°C for 3 d) for DM analysis. Feed samples were analyzed by a commercial laboratory (Dairy One Forage Lab, Ithaca, NY) for the following items: DM, CP (Kjeldahl; AOAC, 1990); ADF and NDF (Ankom 200 Fiber Analyzer, Ankom Co., Fairport, NY); and Ca, P, Mg, K, Na, Fe, Zn, Cu, Mn, and Mo (Iris ICP atomic emission spectrophotometer, Thermo Jarrell Ash Corp., Franklin, MA).

After the end of each trial in Exp. 2, manure from each pen surface was sampled for laboratory analysis. A small sample (approximately 500 g) was dried for 24 h in a forced-air oven (60°C), weighed, ground, frozen, and sent to a commercial laboratory (Dairy One Forage Lab) for N, P, and K analysis (Iris ICP atomic emission spectrophotometer; Thermo Jarrell Ash Corp.).

Statistical Analyses

Data were analyzed using PROC MIXED (SAS Inst. Inc., Cary, NC). The analyses of treatment effects were performed with the REML method for convergence. The variance component type was used for the variance and (co)variance matrix. For each treatment, the least square means were computed, and pairwise comparisons were conducted if the F-test was significant at P < 0.05. For Exp. 1, data were analyzed by ANOVA as a randomized complete block design, with each animal as the experimental unit. Blocks were considered random effects. For Exp. 2, data were pooled for trials 1 and 2. Pens were considered the experimental unit. Trials and blocks within trials were considered random effects. Main effects of trial, block, treatments, and their interactions were tested for significance. No trial × treatment interaction (minimum P value = 0.40) was detected in Exp. 2. For all analyses, P values less than 0.05 were considered significant, whereas P values less than 0.10 were discussed as trends.

RESULTS

Experiment 1

Performance. Reducing the CP concentration of the diet did not affect (P = 0.54) ADG from d 63 to 109 (Table 2). Additionally, the ADG was similar (P = 0.89) over the 109-d feeding period regardless of dietary CP treatment. The DMI after the reduction of CP content (P = 0.38) and the overall DMI (P = 0.81) were not different among treatments. The G:F value did not differ (P > 0.10) regardless of the dietary CP concentration (Table 2).

Blood Urea Nitrogen. No differences among treatments were detected for BUN concentrations in Exp. 1 on d 0 (P = 0.65), 62 (P = 0.49), or 109 (P = 0.12; Table 2). On d 109 there was a numeric separation with a tendency (P = 0.12) for greater BUN concentration for treatments containing greater concentration of CP, as expected. The BUN concentration in this experiment varied between 7 to 9 (d 0), 11 to 13 (d 62), and 10 to 14 (d 109) mg/dL.

Carcass Data. In Exp. 1, there were no differences in fat thickness (P = 0.30), LM area (P = 0.19), KPH (P = 0.27), HCW (P = 0.17), or marbling score (P = 0.66). However, there was a tendency (P = 0.10) for yield grade to decline as dietary CP decreased.

Experiment 2

Performance. Similar to Exp. 1, reducing the CP content of the diet to 11.5 or 10.0% CP did not affect (P = 0.16) ADG (Table 3). Regardless of dietary CP content, ADG was similar (P = 0.14) throughout the finishing period. Treatments 13.0 and 11.5% CP had similar DMI during either period 2 or overall. However, steers fed the 10.0% CP diet had lower DMI than those fed either 13.0 or 11.5% CP during period 2 (P < 0.01) and overall (P = 0.01). The G:F value did not differ (P > 0.75) regardless of dietary CP concentration (Table 3).

Blood Urea Nitrogen. Differences in BUN resulting from different dietary CP levels were observed at the end of Exp. 2 (Table 3). No differences in BUN were observed among treatments initially (P = 0.62) or at the time of the diet change (P = 0.21). However, BUN concentrations at the end of the experiment were greater (P < 0.01) for steers fed 13% CP compared with steers fed either 11.5 or 10.0% CP.

Carcass Data. In Exp. 2, fat thickness was greater (P = 0.02) for animals fed the 11.5% CP diet when compared with either 13.0 or 10.0% CP treatments. Marbling scores were greater (P < 0.01) for carcasses from steers fed the 13.0% CP treatment when compared with the 10.0 and 11.5% CP treatments. Other carcass characteristics were not affected (P > 0.10) by dietary CP levels (Table 3).

Manure Composition. No differences (P > 0.17) were observed in manure nutrient concentrations collected from pens housing steers fed the 3 different dietary CP levels (Table 4); however, the N:P ratio was increased with the 10.0% CP diet (P = 0.02) compared with the 11.5 or the 13.5% CP treatments. No difference (P = 0.98) in manure N:P was observed between the 11.5 and 13.5% CP treatments.

DISCUSSION

Performance

Similar studies also found no effect of phase feeding or precision feeding of protein on performance of finishing calves (Erickson and Klopfenstein, 2001; McBride et al., 2003) when dietary CP concentrations were lowered. Erickson et al. (1998) reported similar ADG and feed efficiency for yearlings and calves fed in a phase feeding system in several trials. The trials consisted of control diets compared with experimental diets with CP concentration varying from 13.4 to 13.6% CP and reduced to a range of 10.8 to 12.7% CP. Other trials conducted by the same investigators with calves and yearlings (Erickson and Klopfenstein, 2001) showed similar results. The standard diet was 92.5% concentrate (dry-rolled corn) formulated to contain 13.5% CP. Phase fed diets were formulated to match degraded intake protein, undegraded intake protein, and MP requirements throughout the feeding period. In yearlings, phase feeding resulted in greater DMI and improved G:F when compared with the 13.5% CP standard diet. In finishing calves, phase feeding improved G:F by approximately 4% compared with the conventional diet. No differences were observed for ADG.

McBride et al. (2003) fed 3 concentrations of dietary CP (11.5, 13.0, and 14.5% DM) and 3 ratios of urea and cottonseed meal (100:0, 50:50, and 0:100 of supplemental N). Results suggested that diets formulated to contain 11.5 or 13.0% CP may improve ADG of feedlot steers from d 0 to 38 compared with 14.5% CP diets. However, there was no effect of dietary CP level on steer performance after d 38. These data from McBride et al. (2003) suggested that the 11.5% CP level, regardless of CP source, was adequate to meet the N requirement of the steers in that study.

Table 2. Effects of phase feeding of CP on ADG, DMI, G:F, blood urea nitrogen (BUN), and carcass characteristics of feedlot steers (Exp. 1)

	Dietary treatment				
Item	13.0% CP	11.5% CP	10.0% CP	SEM	*P*-value
ADG, kg					
d 0 to 62	2.30	2.45	2.19	0.20	0.41
d 63 to 109	0.99	1.06	1.12	0.11	0.54
Overall	1.45	1.50	1.49	0.09	0.89
DMI, kg					
d 0 to 62	10.42	10.36	10.48	0.55	0.97
d 63 to 109	8.03	8.72	8.65	0.53	0.38
Overall	9.59	9.82	9.82	0.40	0.81
G:F					
d 0 to 62	0.23	0.24	0.21	0.02	0.42
d 63 to 109	0.12	0.12	0.13	0.01	0.50
Overall	0.15	0.15	0.15	0.01	0.98
BUN, mg/dL					
d 0	8.74	8.09	7.43	0.95	0.65
d 62	11.69	11.18	12.62	0.84	0.49
d 109	13.85[a]	12.08[ab]	10.04[b]	1.22	0.12
Carcass characteristic					
Fat thickness, cm	1.58	1.42	1.25	0.06	0.30
LM area, cm^2	84.10	85.34	89.99	2.52	0.19
KPH, %	2.08	1.85	1.96	0.10	0.27
HCW, kg	372.05	359.96	383.05	10.26	0.17
Marbling score[1]	456.63	491.94	483.33	28.94	0.66
Yield grade	3.56[a]	3.07[ab]	2.80[b]	0.24	0.10

[a,b]Within a row, means without a common superscript letter differ ($P < 0.05$).
[1]Marbling score: 300 = slight; 400 = small; 500 = modest.

Table 3. Effects of phase feeding of CP on ADG, DMI, G:F, blood urea nitrogen (BUN), and carcass characteristics of feedlot steers (Exp. 2)

	Dietary treatment				
Item	13.0% CP	11.5% CP	10.0% CP	SEM	*P*-value
ADG, kg					
Period 1	1.85	1.89	1.86	0.10	0.89
Period 2	1.54	1.58	1.47	0.06	0.16
Overall	1.67	1.73	1.64	0.05	0.14
DMI, kg					
Period 1	9.77	9.74	9.72	0.11	0.93
Period 2	10.14[a]	9.98[a]	9.43[b]	0.18	<0.01
Overall	9.99[a]	9.88[a]	9.56[b]	0.14	0.01
G:F					
Period 1	0.19	0.19	0.19	0.01	0.90
Period 2	0.15	0.16	0.16	0.01	0.92
Overall	0.17	0.16	0.17	0.01	0.75
BUN, mg/dL					
Entry	7.12	6.87	6.70	0.34	0.62
Time of the diet change	7.30	6.70	7.89	0.51	0.21
Slaughter	8.36[a]	6.51[b]	6.14[b]	0.50	<0.01
Carcass characteristic					
Fat thickness, cm	1.20[c]	1.30[a]	1.23[b]	0.03	0.02
LM area, cm^2	86.94	87.15	86.13	0.64	0.50
KPH, %	1.94	1.94	1.97	0.02	0.51
HCW, kg	362.10	363.48	365.13	1.68	0.43
Live weight, kg	575.39	578.55	581.50	2.57	0.23
Dressing percent, %	63.06	62.96	62.92	0.31	0.94
Marbling score[1]	442.73[a]	414.01[c]	438.85[b]	6.64	<0.01
Yield grade	2.79	2.91	2.89	0.05	0.21

[a–c]Within a row, means without a common superscript letter differ ($P < 0.05$).
[1]Marbling score: 300 = slight; 400 = small; 500 = modest.

Table 4. Effects of phase feeding of CP on concentrations of N, ammonia, P (DM basis), and N:P ratio from surface manure (Exp. 2)

	Dietary treatment				
Item	13.0% CP	11.5% CP	10.0% CP	SEM	*P*-value
N, %	2.89	2.63	2.69	0.19	0.38
Ammonia-N, %	0.26	0.24	0.24	0.03	0.76
Organic N, %	2.63	2.40	2.46	0.17	0.39
P, %	0.78	0.71	0.68	0.05	0.23
K, %	2.08	1.85	1.88	0.18	0.17
N:P	3.70[b]	3.72[b]	3.96[a]	0.09	0.02

[a,b]Within a row, means without a common superscript letter differ ($P < 0.05$).

In contrast, other precision feeding studies have observed an effect of level of dietary CP on performance. Duff et al. (2002) observed that DMI and ADG increased quadratically with increased CP concentration from 11.5 to 14.5% CP. No differences were noted for G:F with increasing CP levels, and no differences were observed in ADG, DMI, or G:F among supplemental CP sources (Duff et al., 2002). Peterson et al. (1973) observed increased ADG when CP concentration was increased (9.0, 11.0, 13.0, and 15.0%). A linear response in ADG was observed with increasing energy level. Gleghorn et al. (2003) observed a quadratic effect of CP level on ADG and carcass-adjusted ADG. Their results indicated that increasing CP levels from 11.5 to 13.0% increased ADG but that 14.5% CP seemed to be detrimental to ADG.

In the present experiments, dietary CP concentration was decreased once during the feeding period, and in contrast to the design of previously discussed phase feeding experiments, the different CP levels were not fed throughout the feeding period. Erickson and Klopfenstein (2001) fed 3 finishing diets to yearlings for 28, 28, and 54 d. They also fed 8 finishing diets to calves that were switched every 14 d, with the eighth diet being fed for 73 d. In the present experiments, diets were changed approximately halfway through finishing. In Exp. 1, basing the CP change on days on feed was easier to manage. In Exp. 2, cattle were weighed frequently to make sure diets would be changed at 477 kg.

Blood Urea Nitrogen

Johnson and Preston (1995) conducted a study to ascertain an optimal level of dietary CP for maximum performance while limiting N waste, based on BUN concentrations. Forty-eight crossbred steers were fed diets containing 10, 12, 14, and 16% CP, and determinations of BUN were made every 28 d. As the CP level of the diet increased, a linear increase in BUN was observed. Each 2-percentage unit increase in the CP concentration resulted in a 1 to 3 mg/dL increase in BUN, with the difference between CP concentrations growing larger as days on feed increased. Based on their data, Johnson and Preston (1995) suggested that excessive N intake and N wastage would be indicated by levels of BUN greater than 5 to 8 mg/dL. According to Johnson and Preston (1995) the high BUN on d 62 and 109 in Exp. 1 would suggest wastage of N.

In Exp. 2, data suggest that the 13.0% CP diet exceeded the N requirement of steers, as expected (Table 3). Lower concentrations of BUN in animals fed lower concentrations of CP suggest less wastage of N.

Carcass Data

Changes in carcass characteristics have not been observed in previous work when lower levels of CP were fed (Shain et al., 1998; Cole et al., 2003; Gleghorn et al., 2003). Gleghorn et al. (2003) observed that HCW, LM area, and dressing percent tended ($P < 0.06$) to increase linearly with increasing dietary urea level. Differences in back fat and yield grade were not evident among treatments. Cole et al. (2003) observed that steers fed 14% CP tended ($P < 0.10$) to have lower dressing percent, smaller LM area, and greater quality grade than steers fed an oscillating CP regimen, and also tended ($P = 0.08$) to have a lower percentage of carcasses that graded low Choice or greater than other treatments. Reasons for these differences, however, were not clear.

Manure Composition

The utilization of feedlot manure for crops can be a challenge because N volatilizes from the pen surface whereas P remains (Erickson and Milton, 2003). A lower N:P ratio leads to P build-up on cropland. In Exp. 2 the N:P ratio increased when lower CP diets were fed. These data suggest that decreasing the CP level in the diet likely resulted in a proportional reduction in N being metabolized and excreted via urine. That means that more N was excreted in the feces relative to P, causing an increase in the N:P ratio and suggesting that less N was volatilized. These data suggest that the N and P relationship in the manure was improved by reducing the dietary CP level (Table 4). That could potentially reduce the need for supplemental N when this manure is applied on the basis of P needs. Dietary P is not normally supplemented to feedlot cattle. Protein supplements generally supply the greatest amount of P to the diet. Reducing dietary CP by removal of byproduct protein sources will likely reduce P excretion.

IMPLICATIONS

Reducing dietary crude protein to conserve nitrogen during the final stages of the finishing phase of feedlot cattle could decrease nitrogen excretion into the environment without reducing animal performance.

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