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Summary

The use of different supplemental protein sources with soybean hulls in receiving cattle diets were evaluated using 200 Angus steer calves. Diets contained either corn and soybean meal (C-SBM), or soybean hulls with soybean meal (H-SBM), dried corn gluten feed (H-DCGF) or dried distillers grains plus solubles (H-DDGS). The replacement of corn (C-SBM) with soybean hulls (H-SBM) stimulated intake within the first 14 d of the receiving period and throughout the entire growing period (52 d). Supplementing soybean hulls with corn origin protein (COP) versus soybean meal did not result in any performance differences throughout the feeding period. Within the COP sources, H-DDGS improved daily gain during the initial 28 d, while H-DCGF stimulated intake during the final 24 d on feed. This would indicate that H-DCGF may potentially have a positive impact on steer performance when fed beyond 52 d in the growing period. No differences in health status were detected; morbidity and mortality rates averaged 11.1% and 0.5%, respectively. Blood metabolite status indicated that changes in the site of protein degradability influence urea nitrogen levels, whereas H-DCGF seemed to supply greater substrate for glucose production compared to H-DDGS. The results indicate that the replacement of corn with soybean hulls is feasible from a performance stand point. Soybean hulls can be supplemented with soybean meal, dried corn gluten feed or dried distillers grains plus solubles without compromising gain performance.

Introduction

The overall costs of roughages in feedlot diets can be quite expensive, but the financial return associated with reduced morbidity and improved gain performance during the receiving period can outweigh the ingredient costs. Receiving cattle diets often contain 40% or more roughage, with valuable roughage sources considered those that are palatable and digestible by newly arrived calves. Soybean hulls are considered an excellent roughage source due to its highly digestible fiber content and palatability. Incorporation of soybean hulls seems to stimulate intake in receiving cattle, a positive attribute to a fiber source. The highly digestible fiber in combination with the increased intake has resulted in gain performances similar to rolled corn in receiving cattle diets.

The current expansion of the fuel ethanol industry in South Dakota has resulted in abundant supplies of corn co-products available to the beef industry. Many of these products are considered a valuable source of escape protein when fed in combination with corn-based diets. This study was designed to evaluate the use of corn-origin proteins in combination with soybean hulls on receiving cattle gain performance, health and blood metabolite status.

Materials and methods

Oat silage-based diets (Table 1) contained either rolled corn and soybean meal (**C-SBM**), soybean hulls and soybean meal (**H-SBM**), soybean hulls and dried corn gluten feed (Cargill Animal Feeds, Wahpeton, ND; **H-DCGF**), or soybean hulls and dried distillers grains plus solubles (**H-DDGS**). Diets were formulated to contain 11.75% CP and similar levels of Cu and Zn (2000 NRC). Grass hay (10% DM basis) replaced a portion of the oat silage on d 14 in all diets.

A single source of 200 Angus steer calves (BW = 590 ± 4 lb.) were shipped from a ranch in western South Dakota on October 28 and 30, 2003 to the SDSU research feedlot in Brookings. All steers received long-stem grass hay and access to water upon arrival. Once calves had time to rest, they were weighed, individually

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identified and vaccinated with a 7-way clostridial vaccine and a modified live vaccine containing Infectious Bovine Rhinotracheitis Virus (IBR), Parainfluenza 3 (PI_3), Bovine Respiratory Syncytial Virus (BRSV) and *Haemophilus somnus*. All calves received a Ralgro Magnum implant (70mg Zernol; Schering-Plough) and were treated for internal and external parasites (Dectomax; Pfizer Animal Health) on d14.

Steers were blocked by weaning management into 3 groups, steers weaned 30 d prior to shipment from the home ranch (390 mi., n = 77, BW = 565 ± 5 lb.), steers weaned the day of shipment from the home ranch (390 mi., n = 79, BW = 626 ± 6 lb.), and steers weaned the day of shipment from an alternate ranch site (590 mi., n = 44, BW = 570 ± 4 lb.). Steers weaned 30 d prior to shipment were from 2 and 3 yr old dams, whereas steers weaned the day of shipment were from dams ≥4 yr old. Weights were stratified over pens within weaning group, with treatment randomly assigned to pen.

Diets were fed once per day at 1300 h, while feed refusals were quantified and sampled when feed went out of condition. Feed samples were collected and analyzed on a weekly basis for DM, CP, NDF, ADF and ash. Body weights were obtained during processing and subsequently on d 14, 28 and 52. Final BW were shrunk 4% to account for fill. Daily feed deliveries, along with feed analyses were used to determine DM disappearance and gain efficiency during interim periods.

Blood samples from the second lightest, second heaviest and middle-weight steers from each pen were collected prior to feeding on d 1, 3, 7, 14, 28 and 52. Blood samples were collected via jugular venipuncture and analyzed for plasma glucose (Sigma Diagnostics, St. Louis, MO), plasma urea nitrogen (PUN), and serum non-esterified fatty acids (NEFA; Wako Industries, Richmond, VA). Blood samples were collected to determine blood metabolite status of steers primarily during the receiving period.

Steer health was monitored on a daily basis. Morbid steers were identified based on general appearance, desire to consume feed as well as phenotypical symptoms associated with illness or lameness. Morbid steers were treated according to the South Dakota State University Research Feedlot Health protocol.

Steer performance was analyzed as a randomized complete block design using the GLM procedures of SAS. Weaning management was the blocking term and pen was the experimental unit. Blood metabolites were analyzed as repeated measures over time using GLM procedures of SAS. Weaning management was considered a random effect and treatment was tested using the steer within treatment error term. Steer was used as the experimental unit for blood metabolites. Contrasts were used to compare main effects of C-SBM vs H-SBM, H-SBM vs mean H-DCGF / H-DDGS **(COP)**, and H-DCGF vs H-DDGS.

Results and discussion

No differences were detected for morbidity or mortality during the feeding period (P > 0.10). Overall, morbidity rates were 11.1% and mortality rates were 0.50% across all treatments.

The inclusion of soybean hulls seemed to stimulate intake early during the receiving period compared to rolled corn, which continued throughout the remaining feeding period (Table 2). This response supports previous studies that showed similar intake effects. No differences were detected (P > 0.10) for ADG or gain efficiency during the initial 28 d or cumulatively. On d 3, H-SBM steers had lower plasma glucose concentrations (P < 0.05; figure 1) and tended to have lower serum NEFA concentrations (P < 0.10) compared to C-SBM steers. Plasma glucose and serum NEFA concentrations were similar between the two treatments at all other collections during the feeding period (P > 0.10). Concentrations of PUN (Figure 1) tended to be lower during d 7 for H-SBM (P < 0.10), but were not different (P > 0.10) at any other collection period compared to C-SBM. The reduced blood metabolite status of H-SBM compared to C-SBM steers early in the receiving period may indicate that the fermentation of corn in C-SBM results in greater amounts of propionate which was metabolized into glucose once absorbed. The increased intake in H-SBM early resulted in greater intake of calories, thus offsetting the glucose differences by d 7. All blood values are considered within normal physiological ranges.

When comparing the inclusion of soybean meal versus COP with soybean hulls, gain performance did not differ (P > 0.10) at any point

in the trial (table 2). There was no difference (P > 0.10) in plasma glucose (Figure 2) or NEFA concentrations at any collection period during the study. Plasma urea nitrogen (Figure 2) was similar between treatments during the first 14 d on feed, but H-SBM resulted in greater PUN concentration during d 28 and 52. The increase in PUN may reflect the combination of greater ruminal protein availability and higher levels of intake, which would result in a greater amount of rumen ammonia production. The similar gain performance in conjunction with different PUN status indicates that steers consuming COP with soybean hulls provides similar metabolizable protein even though site of degradation is likely different. This would indicate that COP is of adequate quality to ensure gain performance in receiving steers similar to soybean meal when soybean hulls make up approximately 50% of the diet.

The H-DDGS diet resulted in greater ADG (P < 0.05) during the initial 28 d, but those differences disappeared during the latter portion of the study resulting in no cumulative gain performance differences (P > 0.10). Gain efficiency tended to be greater for H-DDGS steers (P < 0.10) during d 15 to 28, which most likely resulted in the improved gain performance (P < 0.05) during the same period. Gain efficiency was similar (P > 0.10) between COP sources during all other periods and cumulatively. There were no differences in feed intake (P > 0.10) during the first 28 d, but during the last portion of the study H-DCGF stimulated greater intake. There were no differences in cumulative DM disappearance (P > 0.10), probably influenced by the first 28 d. Plasma glucose concentrations (Figure 3) were greater (P < 0.05) in H-DCGF steers at d 7, 28 and 52. The greater glucose concentrations during d 28 and 52 reflect the increased intake by those steers during the same period. Figure 3 shows that PUN concentrations are not different (P > 0.10) at any sampling time during the feeding period. The PUN concentrations would indicate that H-DCGF cattle are not degrading protein for glucose production, and that the absorbed dietary protein is probably being utilized for growth. The PUN status would also suggest that degradation rate and site were similar between protein sources. Concentration of NEFA were different on d 3 (P < 0.01), but not at any other sampling period (P > 0.10). The reason for the NEFA difference on d 3 is inconclusive at this time. Differences in corn co-product production systems seem to have minimal impact on dietary protein quality when fed with soybean hulls to newly arrived feedlot steers. Further research is warranted to determine nitrogen dynamics of soybean hulls supplemented with corn co-products.

Implications

The use of corn co-products from the dry milling ethanol industry can sustain growth rates comparable to soybean meal when fed with soybean hulls as the principle carbohydrate source. Within corn co-products, dried corn gluten feed seemed to stimulate intake later in the growing period, which may influence glucose concentrations, resulting in a more positive energy balance in those calves.

Tables

Table 1. Diet and nutrient composition[a] of receiving diets.

	Diet[b]			
Item	C-SBM	H-SBM	H-DCGF	H-DDGS
Oat silage	30.00	30.00	30.00	30.00
Grass hay	10.00	10.00	10.00	10.00
Rolled corn	48.92			
Soybean hulls		56.34	45.12	52.63
Supplement[c]				
Soybean meal	9.42	3.35		
Dried corn gluten feed			13.86	
Dried distillers grains + solubles				6.65
Trace mineralized salt	0.30	0.30	0.30	0.30
Limestone	1.35			
$ZnSO_4$[d]	0.0115	0.0083	0.0074	0.0075
$CuSO_4$[e]	0.0023			
DM, %[f]	57.36	58.87	58.79	58.92
CP, %[f]	13.55	12.93	13.12	12.87
NDF, %[f]	21.33	58.82	57.02	58.17
ADF, %[f]	13.63	41.93	37.87	40.47
Ash, %[f]	6.78	7.39	8.48	7.73

[a]Dry matter basis
[b]d1 to 13: Oat silage = 40.00%, grass hay = 0.00% DM basis.
[c]Supplement ingredients were processed into a pellet.
[d]Zinc was balanced for a minimum dietary level of 65 ppm.
[e]Copper was balanced for a minimum dietary level of 15 ppm.
[f]Based on laboratory analyses.

Table 2. Interim and cumulative feedlot performance

	Diet					Contrast[a,b]		
Item	C-SBM	H-SBM	H-DCGF	H-DDGS	SEM	1 vs 2	2 vs 3,4	3 vs 4
Initial BW, lb.	588	586	588	586	6.83	NS	NS	NS
Final BW[c], lb.	768	767	765	771	8.26	NS	NS	NS
d 1 to 14								
ADG, lb.	4.24	4.68	4.37	4.65	0.21	NS	NS	NS
DMI[d], lb/d.	11.30	11.83	12.10	12.05	0.17	0.0628	NS	NS
F/G, lb./lb.	2.67	2.59	2.81	2.64	0.25	NS	NS	NS
d 15 to 28								
ADG, lb.	3.34	3.34	3.07	3.60	0.15	NS	NS	0.0151
DMI, lb/d.	16.17	17.29	17.23	17.76	0.19	0.0038	NS	0.0938
F/G, lb./lb.	4.92	5.24	5.65	4.89	0.24	NS	NS	0.0685
d 29 to 52								
ADG, lb.	4.25	4.08	4.24	4.00	0.12	NS	NS	NS
DMI, lb/d.	20.14	21.17	21.64	20.21	0.31	0.0537	NS	0.0142
F/G, lb./lb.	4.79	5.33	5.16	5.11	0.26	NS	NS	NS
Cumulative 28-d performance								
ADG, lb.	3.76	3.96	3.72	4.11	0.12	NS	NS	0.0275
DMI, lb/d.	13.84	14.69	14.76	15.05	0.17	0.0118	NS	NS
F/G, lb./lb.	3.66	3.70	3.97	3.65	0.17	NS	NS	NS
Cumulative 52-d performance[c]								
ADG, lb.	3.38	3.42	3.35	3.48	0.07	NS	NS	NS
DMI, lb/d.	16.70	17.64	17.87	17.41	0.20	0.0139	NS	NS
F/G, lb./lb.	4.95	5.18	5.34	5.00	0.15	NS	NS	NS

[a]Contrast ID: 1 = C-SBM, 2 = H-SBM, 3 = H-DCGF, 4 = H-DDGS. LS means are presented.
[b]Orthogonal contrasts. NS = *P > 0.10.*
[c]Final BW were shrunk 4%.
[d]DMI = Dry matter disappearance.

Figures

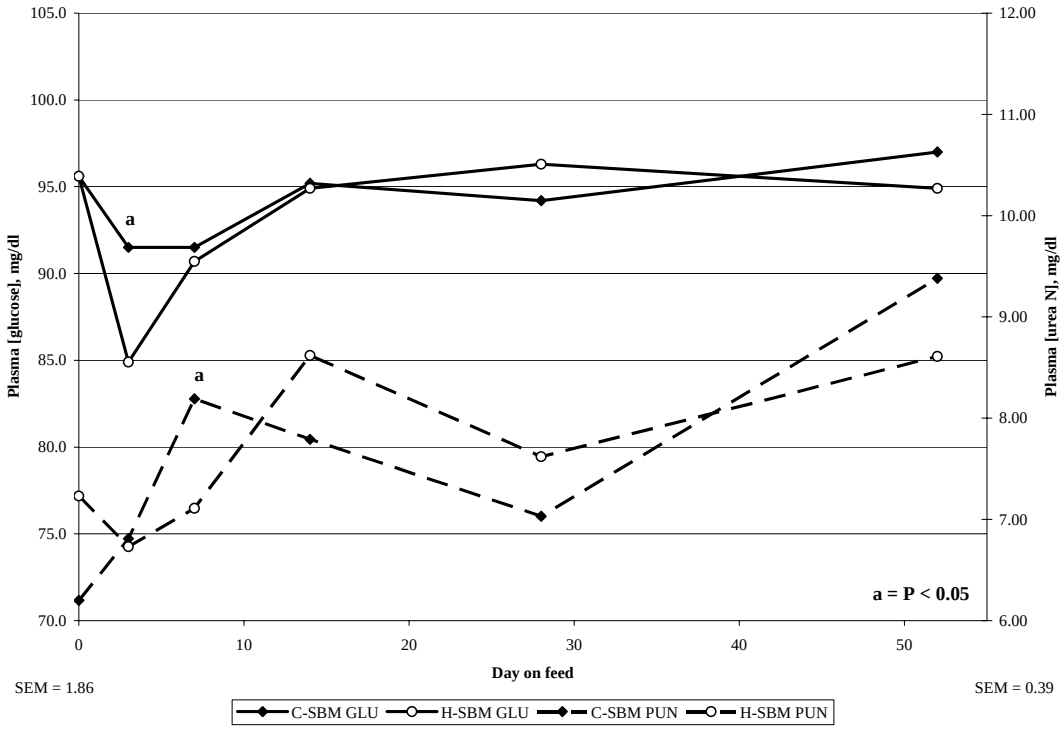

Figure 1. Comparison of plasma levels of glucose and urea nitrogen between C-SBM and H-SBM treatments.

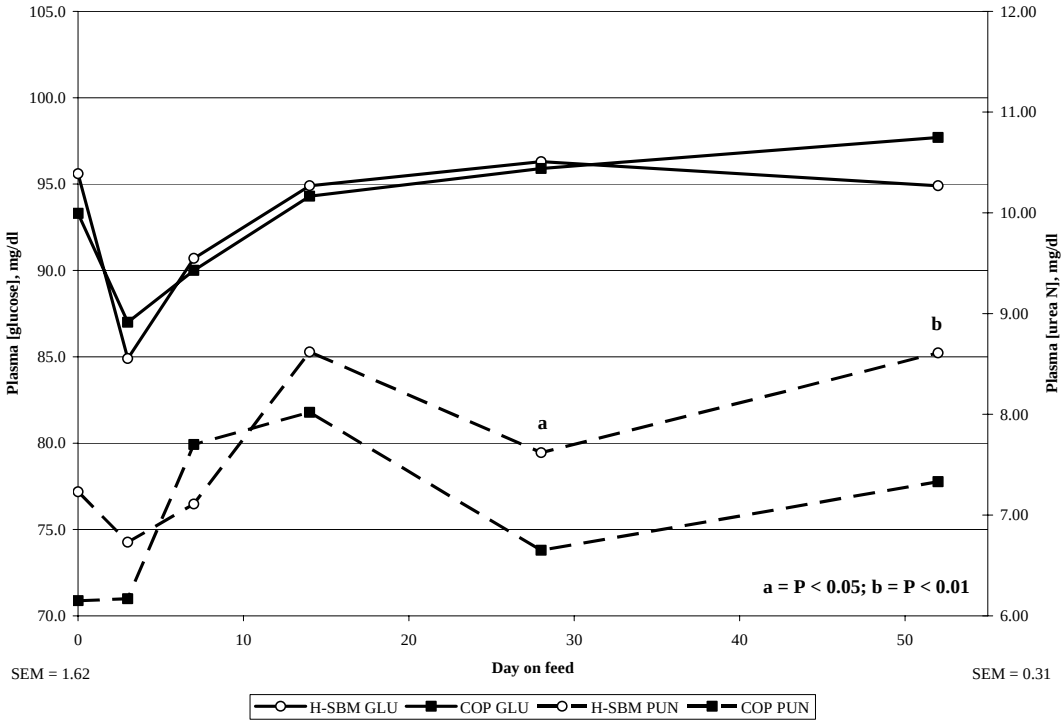

Figure 2. Comparison of plasma levels of glucose and urea nitrogen between H-SBM and H-treatments.

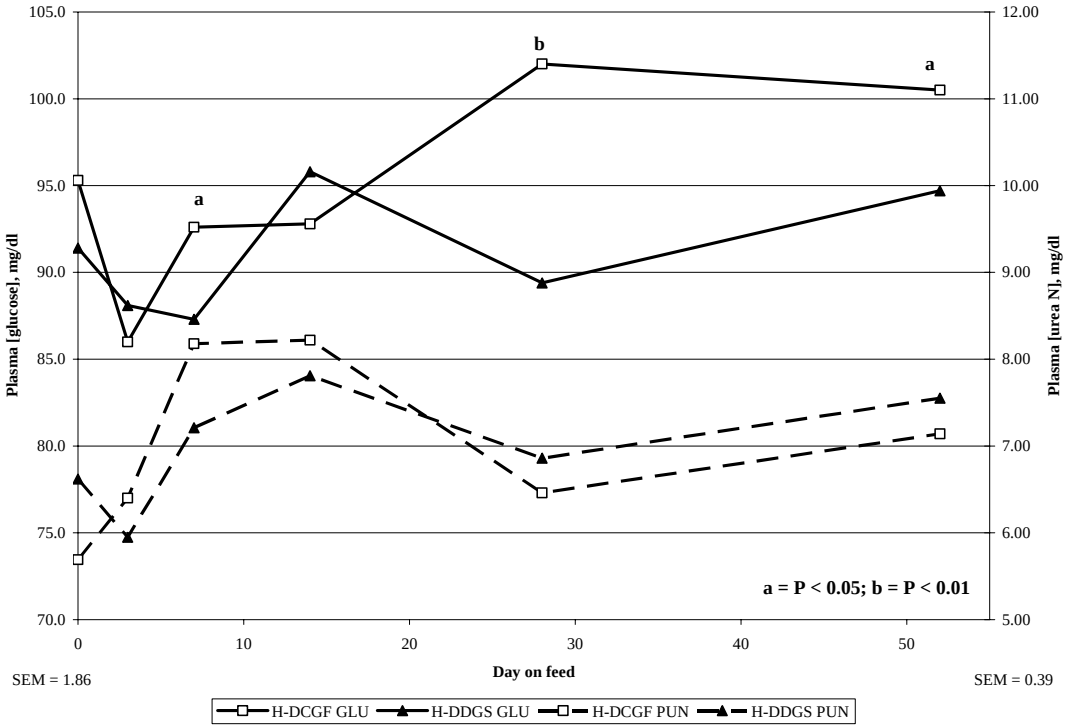

Figure 3. Comparison of plasma levels of glucose and urea nitrogen between H-DCGF and H-DDGS treatments.