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Summary

The objective of this study was to determine the effectiveness of soybean hulls as an energy source for newly received feeder calves and their effects on ADG, DMI, gain/feed (**G/F**), morbidity rate and mineral status. Steers from a single source were blocked into previously weaned (**PW**; n = 63; BW = 265 ± 2.9 kg) and non-weaned (**NW**; n = 92; BW = 264 ± 2.4 kg) groups, then allotted to one of two dietary treatment groups. Diets consisted of either rolled corn (**CRN**) or soybean hulls (**SBH**), and oat silage and vitamin/mineral supplements. Liver biopsies and blood samples were collected at the initiation of the trial and again after 28 d on feed. Steers fed CRN had lower ($P < 0.10$) ADG through d 28 compared to SBH. Previously weaned steers had a higher ($P < 0.10$) ADG than NW steers through d 28. The SBH diets caused higher ($P < 0.01$) DMI through d 28 and overall. There was a diet × weaning group interaction ($P < 0.10$) for DMI through d 28. Cumulative feed/gain (**F/G**) was lower ($P < 0.05$) for cattle fed CRN diets. Liver Cu concentrations decreased ($P < 0.01$) by 22% in steers fed SBH, but were unchanged in steers fed CRN diets. Previously weaned steers had a greater loss of liver Cu compared to NW steers ($P < 0.01$). Liver Zn concentration was affected by a diet × weaning group interaction ($P < 0.05$). Morbidity rate (6.5%) was not affected by treatments. These results suggest the use of soybean hulls in newly received calf diets has the potential to stimulate DMI, and that Cu and Zn in soybean hulls may have limited availability.

Key words: Soybean hulls, Rolled corn, Feedlot, Steers, Minerals

Introduction

Soybean hulls (**SBH**) are high in NDF and ADF. It is a common practice to use higher fiber feedstuffs with newly received feeder calves. SBH represent a palatable and digestible fiber source. The use of SBH in diets fed to receiving calves has been reported to increase dry matter intake. This could be advantageous to the calves by helping to stimulate intakes of those calves which intakes are expected to be low. The objectives of this study were to determine the effectiveness of SBH as an energy source in newly received feeder calves and SBH effects on production variables and mineral status.

Materials and Methods

Single source, Angus steers received from a ranch in western South Dakota on October 31 were used in this trial. Upon arrival, all calves received long stem hay and free access to water. The following day, all calves were weighed, individually identified, vaccinated with a 7-way clostridial vaccine and with a modified live vaccine containing Infectious Bovine Rhinotracheitis Virus (IBR), Parainfluenza 3 (PI_3), Bovine Respiratory Syncytial Virus (BRSV) and Haemophilus Somnus. Calves were treated with doramectin for internal and external parasites.

Steers (n = 155) were blocked into two groups, steers not weaned (NW) at the ranch (n = 92, BW = 584 ± 5.3 lb) and steers weaned (PW) approximately 30 d prior to shipment and fed at the ranch (n = 63, BW = 584 ± 6.4 lb). The previously weaned steers were from 2 and 3 year old dams. Within these blocks, steers were then allotted to one of two diets.

Diets consisted of oat silage (45%) and either rolled corn (CRN) or soybean hulls (SBH) making up 45% of the diet. The remaining 10% was comprised of a pelleted supplement (Table 1). The diets were formulated to have similar CP levels and provide adequate metabolizable protein. The caloric content of the diets were allowed to be different while keeping the proportion of CRN and SBH equal. Both diets were formulated to meet or exceed NRC (1996) requirements and to contain similar levels of Cu and Zn. Copper (as $CuSO_4$) and zinc (as

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$ZnSO_4$) supplementation were needed in the CRN diet to meet NRC requirements of these minerals. Supplemental Cu and Zn were not required in the SBH diets. Diets were replicated by 9 pens, 4 PW pens and 5 NW pens.

During the initial 28 d on feed, feed samples were analyzed weekly for Cu, Zn, Ca, Fe, Mg, Mn, K, Na, S and P using atomic absorption spectrophotometry and Mo using atomic absorption spectrophotometry with a graphite furnace[1] (Table 3). These samples were also assayed for Se using a fluorometric method. Subsequent weekly feed samples were analyzed for the listed minerals as biweekly composites (Table 4).

Steers were weighed at the time of processing and again after 8 d on feed at which time a Ralgro Magnum implant was administered. Subsequent body weights were recorded after 28, 57 and 74 d on feed. All weights were recorded prior to feeding with no restrictions of feed or water. Liver biopsies and serum samples were obtained 3 d after arrival and after 28 d on feed from 54 steers (3 steers / pen, 27 steers / diet). Liver samples were analyzed for Cu, Zn, Mo, S, Fe, Na, K, Ca, P, Mg and Mn using inductively coupled plasma-atomic emission[2] spectroscopy. Serum samples were assayed for Se concentration using a fluorometric method.

Liver biopsies were performed using a JorVet Soft Tissue Biopsy Needle[3] inserted through a puncture wound at the point where a horizontal line drawn cranial from the middle of the paralumbar fossa crosses the eleventh intercostal space on the right side of the animal. Animals were given a prophylatic dose of long acting penicillin (20 ml, 300,000 IU / ml; sc) following the biopsy procedure. Hepatic tissue was kept at - 20° C until analyzed. Serum samples were obtained via jugular venipuncture using non-heparinized evacuated tubes. Whole blood was centrifuged for 30 minutes the morning following sampling and serum removed and frozen at –20° C until analyzed.

Morbidity was identified using criteria based on general appearance of the animal, willingness to eat, as well as other symptoms associated with illness such as coughing, non-clear discharge from the nasal passage, and lameness. Animals considered morbid were treated as outlined in the South Dakota State University Research Feedlot Health Protocol.

Animal performance and mineral data were analyzed as a factorialized design using the GLM procedure of SAS. Pen was the experimental unit used in the analysis for all performance variables. Animal was the experimental unit used for all physiological mineral variables.

Results and Discussion

The nutrient composition of the diets was based upon laboratory assays (except NE). The CP content was similar between diets, while SBH diets had a greater NDF and ADF content and a lower NEm and NEg content. Diet comparisons were made for first 28 days (Table 3) as well as for the entire feeding period (Table 4) on all mineral constituents. The Cu, Zn, Se, Ca and P levels were lower ($P < 0.01$) in the SBH diets while these diets contained greater ($P < 0.01$) levels of Fe, Mg, Mn and K.

Initial and final body weights did not differ ($P > 0.10$) between diets. Through d 28, steers fed SBH tended to have a greater ($P < 0.10$) ADG than CRN fed steers. This effect on ADG began to diminish through subsequent weighing periods. The increased ADG in steers fed SBH through d 28 may have been caused by fill differences associated with the greater DMI of steers fed SBH.

Steers fed SBH had a higher DMI ($P < 0.01$) than those fed the CRN diets through d 28 and overall (Table 5) (Figure 1). The increase in DMI could be due to cattle having a preference for SBH or may be a function of rumen kinetics. Feed conversion (Table 5) was not affected through d 28, however; overall F/G was greater ($P < 0.05$) in the SBH fed steers compared to CRN fed steers.

Preweaning management was confounded by cow age and sires represented. Accordingly it is not a useful comparison of previous weaning as a management tool. The PW calves were acclimated to total mixed diets that were fortified with trace minerals. since this may affect behavior (especially eating behavior) and

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mineral status at feedlot arrival, these data are presented for consideration of diet influences across management group.

Previously weaned steers had a greater ($P < 0.10$) ADG than NW steers through 28 d on feed. There was no effect of weaning group on ADG for the remainder of the feeding period. The difference in ADG seen in PW steers may also be a result of greater fill caused by higher DMI. The 28 d DMI was also affected ($P < 0.10$) by a diet x weaning group interaction (Figure 2) in which SBH caused a greater increase in DMI over corn in PW vs NW steers. Previously weaned steers also had a greater DMI ($P < 0.01$) through d 28 and overall compared to non-weaned steers (Figure 1).

The hepatic and serum mineral concentrations revealed that there could be an availability issue with some of the nutrients in SBH diets. Hepatic Cu levels (Table 6) were decreased ($P < 0.01$) to a greater extent in steers fed SBH than in steers fed CRN. There was a 22% decrease in liver Cu in SBH fed steers while liver Cu remained unchanged in the CRN fed steers. Lower dietary Cu, lower digestibility of Cu in SBH, or interference caused by elevated Fe levels in SBH may be contributing factors in this response. The decrease in liver Cu concentrations was also greater ($P < 0.01$) in PW steers compared to NW steers (Table 7). This difference was probably a result of PW steers having a greater ($P < 0.01$) initial hepatic Cu concentration than NW steers (Table 7). Hepatic Zn concentration included a diet x weaning group interaction ($P < 0.05$) (Table 7). The decrease in hepatic Zn concentrations for CRN and SBH diets, respectively, was 35% and 30% in PW steers while the decrease in NW steers was 13% and 25% respectively. Previously weaned steers had a greater decrease ($P < 0.01$) in hepatic P and S concentration (Table 7). Even though 17% of the animals had hepatic Cu levels that were lower than 25 ppm, apparent Cu deficiency symptoms were not present in any of the animals. The morbidity rate in this study was 6.5% throughout the entire trial and neither morbidity nor mortality was affected by diet or weaning group.

Tables

Table 1. Diet composition[a]

	Diet	
Ingredient	CRN	SBH
	------------------- % ------------------	
Oat silage	45.0	45.0
Rolled corn	45.0	
Soybean hulls		45.0
Supplement		
Soybean meal	7.901	5.029
Ground corn	0.874	4.597
Limestone	0.892	0.055
TM salt[b]	0.298	0.295
Premix	0.027	0.024
$CuSO_4$	0.002	
$ZnSO_4$	0.006	

[a] DM basis.

[b] Contains not less than 94% NaCl, 37% Na, 0.35% Zn, 0.20% Fe, 0.20% Mn, 0.03% Cu, 0.007% I, 0.005% Co.

[c] Premix provided added dietary levels of: monensin at 20g/ton; 1000 IU Vitamin A/lb; 10 IU Vitamin E/lb.

Table 2. Nutrient composition of diets

	Diet		
Item	CRN	SBH	SEM
Dry matter[a], %	68.8	70.3	0.60
Crude protein[a],%	11.8	12.3	0.20
NDF[a], %	26.2	52.2	3.00
ADF[a], %	14.9	34.3	2.24
Ash[a], %	6.10	7.33	0.06
NE_m[b], Mcal/cwt	81	75	2.2
NE_G[b], Mcal/cwt	51	47	0.45

[a] Values based upon feed assays.

[b] Value calculated based on NRC (1996) values.

Table 3. Mineral content of diets for initial 28 days [a]

	Diet		
Item	CRN	SBH	SEM
Ca, %	0.50	0.37	0.03
P, %	0.30	0.20	0.02
Na, %	0.25	0.25	0.002
K, %	1.32	1.69	0.07
Mg, %	0.15	0.19	0.01
S, %	0.20	0.21	0.001
Cu, ppm	13.2	10.2	0.59
Zn, ppm	41.9	33.2	1.68
Mo, ppm	1.34	1.30	0.03
Se, ppm	0.37	0.38	0.01
Fe, ppm	131	327	37.2
Mn, ppm	29.2	37.5	1.56

[a] All values based upon feeds assays.

Table 4. Mineral composition of diets for entire feeding period[a]

	Diet		
Item	CRN	SBH	SEM
Ca, %	0.48	0.38	0.01
P, %	0.30	0.23	0.01
Na, %	0.25	0.25	0.001
K, %	1.31	1.71	0.05
Mg, %	0.15	0.20	0.01
S, %	0.20	0.20	0.01
Cu, ppm	13.0	10.6	0.29
Zn, ppm	43.2	35.1	1.04
Mo, ppm	1.41	1.22	0.07
Se, ppm	0.39	0.38	0.003
Fe, ppm	129	335	23.8
Mn, ppm	30.3	42.8	1.66

[a]All values based upon feeds assays.

Table 5. Backgrounding phase performance by diet treatments

Item	Diet		SEM	P< [a]
	CRN	SBH		
Initial BW, lb	584	582	3.84	NS[b]
Final BW, lb	809	814	5.03	NS
d 1 to 28				
ADG, lb	2.73	2.98	0.22	0.10
DMI, lb	12.8	13.6	0.15	0.01
F/G	5.16	5.07	0.12	NS
d 29 to 57				
ADG, lb	3.15	3.31	0.11	NS
DMI, lb	19.2	21.1	0.26	0.01
F/G	6.10	6.42	0.21	NS
d 58 to 74				
ADG, lb	2.62	2.27	0.18	NS
DMI, lb	21.6	24.1	0.22	0.01
F/G	8.43	11.6	1.11	0.10
Cumulative				
ADG, lb	2.87	2.95	0.15	NS
DMI, lb	16.7	18.3	0.20	0.01
F/G	5.82	6.19	0.11	0.05

[a] Probability.
[b] P > 0.10.

Table 6. Backgrounding phase performance by weaning management groups

Item	Weaning Group		P < [a]
	NW	PW	
Initial BW, lb	582 ± 5.27	584 ± 6.37	NS[b]
Final BW, lb	807 ± 6.57	818 ± 7.92	NS
d 1 to 28			
ADG, lb	2.73 ± 0.20	3.00 ± 0.22	0.10
DMI, lb	12.2 ± 0.15	14.2 ± 0.18	0.01*
F/G	4.47 ± 0.12	4.73 ± 0.13	NS
d 29 to 57			
ADG, lb	3.22 ± 0.11	3.29 ± 0.13	NS
DMI, lb	19.7 ± 0.24	20.7 ± 0.29	0.05
F/G	6.16 ± 0.20	6.36 ± 0.22	NS
d 58 to 74			
ADG, lb	2.47 ± 0.18	2.43 ± 0.20	NS
DMI, lb	22.9 ± 0.22	22.7 ± 0.24	NS
F/G	9.67 ± 1.04	10.4 ± 1.17	NS
Cumulative			
ADG, lb	2.84 ± 0.15	2.98 ± 0.15	NS
DMI, lb	16.8 ± 0.18	11.1 ± 0.20	0.01
F/G	5.92 ± 0.11	6.07 ± 0.12	NS

[a] Probability.
[b] P > 0.10.
* Diet x Weaning group interaction P < 0.10.

Table 7. Initial and change in hepatic and serum mineral concentrations by diet

Item	Diet CRN	SBH	SEM
	- - - - - - - - Initial, ppm - - - - - - - -		
Cu	90	86	8.7
Mo	3.22	3.32	0.09
Zn	189	176	75
Ca	258	251	47
P	11,448	11,569	91.0
Mg	667	667	6.0
S	7,761	7,768	64.6
Fe	341	307	13.5
Na	3,715	3,671	91.9
K	9,426	9,437	103
Mn	6.56[d]	7.00[e]	0.12
Se[a]	0.099	0.095	0.002
	- - - - - - - - Change, ppm - - - - - - - -		
Cu	2.07[b]	-18.8[c]	3.07
Mo	- 0.19	- 0.08	0.08
Zn	- 45.1	-47.3	8.03
Ca	- 22.0	- 13.0	5.55
P	- 1,079	-1,051	117
Mg	- 28.7	- 28.6	7.55
S	-378	-209	71.6
Fe	- 41.9	- 11.6	15.7
Na	21.1	274	120
K	- 700	- 993	174
Mn	0.55[b]	1.43[c]	0.17
Se[a]	- 0.012	- 0.009	0.002

[a] Serum concentration of the element.

[b, c] Within a row, means differ ($P < 0.01$).

Table 8. Initial and change in hepatic and serum mineral concentrations by weaning management group

Item	Weaning Group: NW	Weaning Group: PW
	- - - - Initial , ppm - - - -	
Cu	55.32 ± 8.16[b]	120.5 ± 9.12[c]
Mo	3.37 ± 0.08	3.17 ± 0.09
Zn	176.9 ± 7.05	188.1 ± 7.88
Ca	234.3 ± 4.42[b]	274.8 ± 4.94[c]
P	11,397 ± 85.8	11,620 ± 95.9
Mg	632.0 ± 5.64	701.7 ± 6.31[c]
S	7,569 ± 60.9[b]	7,959 ± 68.1[c]
Fe	307.4 ± 12.7	340.0 ± 14.2
Na	3,618 ± 86.6	3,769 ± 96.9
K	9,065 ± 97.0[d]	9,798 ± 108[e]
Mn	6.98 ± 0.11[d]	6.58 ± 0.12[e]
Se[a]	0.092 ± 0.002[b]	0.103 ± 0.002[c]
	- - - - Change, ppm - - - -	
Cu	- 0.40 ± 2.90[b]	- 16.3 ± 3.24[c]
Mo	- 0.12 ± 0.07	- 0.16 ± 0.08
Zn*	- 33.3 ± 7.58[b]	- 59.1 ± 8.47[c]
Ca	- 8.20 ± 5.23	- 26.8 ± 5.85
P[d]	- 788.0 ± 111[b]	- 1343 ± 5.85
Mg	1.00 ± 7.12[b]	- 58.3 ± 7.96[c]
S[d]	24.7 ± 67.5[b]	- 612 ± 75.5[c]
Fe	- 24.9 ± 14.8	- 28.6 ± 16.5
Na	119.7 ± 113	175.4 ± 126
K	- 340.3 ± 164[b]	- 1353 ± 183[c]
Mn	0.90 ± 0.16	1.08 ± 0.17
Se[a]	- 0.003 ± 0.002[b]	- 0.017 ± 0.002[c]

[a] Serum concentration of the element.
[b, c] Within a row, means differ ($P < 0.01$).
[d, e] Within a row, means differ $P < 0.05$).
[*] Diet x Weaning group interaction ($P < 0.01$).

Figures

Figure 1. DMI for each treatment group for entire feeding period

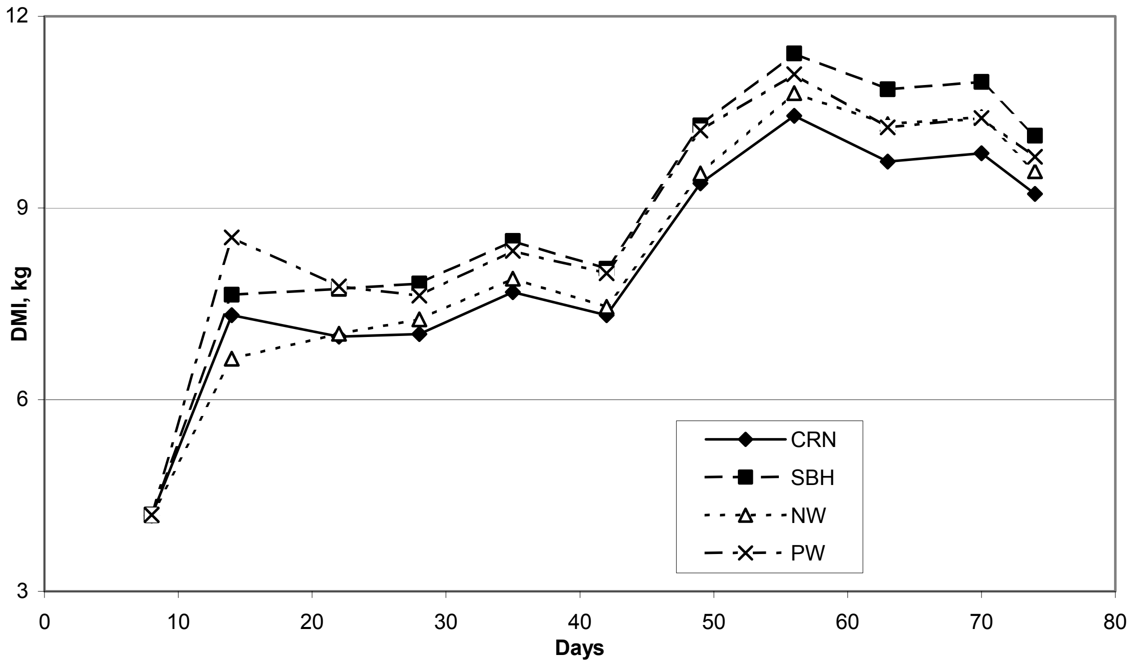

Figure 2. DMI interaction effects