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Summary

Two experiments were conducted to evaluate the effects of decreasing digestibility of a finishing diet by replacing dry rolled corn (DRC) with corn bran, or a combination of corn bran and steep, on cattle performance and nitrogen mass balance in open feedlots. Replacement of DRC with bran had no impact on performance when steep was included in the finishing diets at 15% DM. Feeding bran and steep, in combination, was an effective means of reducing N losses in winter, as well as maintaining cattle performance throughout the year.

Introduction

Less than 15% of dietary nitrogen (N) is retained by feedlot cattle (*1996 Nebraska Beef Cattle Report*, pp 74-77). The other 85% is excreted and can be lost by volatilization. By increasing the amount of carbon in the manure, it is possible to trap more N in manure and thus volatilize less N.

One way to increase the amount of organic matter (OM) in the manure is to increase the amount of hind gut fermentation by lowering diet digestibility (*1996 Nebraska Beef Report*, pp 74-77). Corn bran is a highly digestible fiber source that is effective in increasing the amount of OM and trapping more N in manure. N losses were reduced by 20.4% in winter, when bran was included at 30% diet DM; however, feed efficiency was reduced by 10.6% (*2002 Nebraska Beef Report*, pp 54-57).

Corn steep is a by-product of the wet corn milling industry and has been shown to have a higher energy value than dry rolled corn (DRC). It is a combination of both distillers solubles and steep liquor. The optimal inclusion level of steep in finishing diets was determined to be 15% of diet DM, when bran was also included in the diet at 15% or 30% (*1998 Nebraska Beef Report*, pp 69-71). Feed efficiency was improved 9.3% when steers were fed a combination of bran and steep. Steep and bran are normally combined in the production of wet corn gluten feed, which is becoming a common feed in feedlot diets. The objectives of this study were to evaluate the effect on cattle performance and N mass balance of replacing DRC with corn bran and corn steep in finishing diets.

Procedure

Cattle Performance

In the first experiment (WINTER), 128 steer calves (693 + 29 lb) were fed 167 days, from November 2002 to April 2003, and in the second experiment (SUMMER), 256 yearling steers (806 + 31 lb) were fed for 126 days, from May to September 2003. Steers were stratified by weight and assigned randomly to one of four dietary treatments.

The control (CON) diet was formulated to provide a typical dry rolled corn-based diet (Table 1). Corn bran then replaced DRC at 30% diet DM (30/0), similar to previous studies (*2002 Nebraska Beef Report*, pp 54-57, *2003 Nebraska Beef Report*, pp 54-58). Bran and steep replaced DRC and molasses at 30% and 15% (DM basis), respectively

Table 1. Composition of dietary treatments for WINTER and SUMMER trials (% DM basis).

Ingredient	CON	30/0	30/15	45/15
Dry rolled-corn	75	45	35	20
Corn Silage	15	15	15	15
Corn Bran	—	30	30	45
Steep	—	—	15	15
Molasses	5	5	—	—
Dry Supplement				
Limestone	1.56	1.65	1.66	1.66
Urea	1.50	0.99	0.10	—
Blood Meal	0.15	0.75	—	—
Feather Meal	0.15	0.75	—	—
Fine Ground Corn	1.08	0.27	2.70	2.80
Salt	0.30	0.30	0.30	0.30
Tallow	0.15	0.15	0.15	0.15
Beef Trace Mineral	0.05	0.05	0.05	0.05
Potassium Chloride	0.02	0.05	0.05	0.05
Rumensin Premix	0.018	0.018	0.018	0.018
Tylan Premix	0.013	0.013	0.013	0.013
Vitamin Premix	0.01	0.01	0.01	0.01
Nutrient Composition (%)				
CP[a]	13.7	13.4	14.0	14.2
DIP[b]	8.9	9.8	9.5	10.4
Calcium[c]	0.70	0.70	0.70	0.70
Phosphorus[c]	0.32	0.26	0.47	0.44

[a]Calculated based on average CP analysis of feedstuffs for WINTER and SUMMER trial.
[b]DIP = degradable intake protein.
[c]Calculated based on tabular values.

Table 2. Effects of dietary treatment on steer performance during WINTER trial.

	Treatment[a]					
Item	CON	30/0	30/15	45/15	SEM[b]	F-Test[c]
DMI, lb/day	23.2	24.3	25.1	23.7	0.43	0.06
ADG, lb	3.70	3.80	3.90	3.70	0.08	0.22
Feed:Gain[d]	6.27	6.39	6.42	6.44	0.14	0.56
Hot Carcass Weight, lb	826	835	848	824	9.18	0.27
12th rib fat, in	0.59	0.53	0.55	0.56	0.03	0.67
Marbling score[e]	539	512	535	551	16.93	0.46

[a]Treatments: CON = dry rolled corn-based diet with no byproduct inclusion; 30/0 = dry rolled corn replaced with 30% bran and 0% steep; 30/15 = dry rolled corn and molasses replaced with 30% bran and 15% steep; 45/15 = dry rolled corn and molasses replaced with 45% bran and 15% steep.
[b]Standard error of the mean.
[c]Data were analyzed using a protected F-test where numbers represent P-value for variation due to treatment.
[d]Analyzed as Gain:feed.
[e]Marbling score: 400 = slight^0; 450 = slight^{50}; 500 = small^0; 550 = small^{50}; etc.

Table 3. Effects of dietary treatment on steer performance during SUMMER trial.

	Treatment[a]					
Item	CON	30/0	30/15	45/15	SEM[b]	F-Test[c]
DMI, lb/day	24.0[e]	25.6[f]	26.0[f]	25.4[f]	0.24	<0.01
ADG, lb	3.50	3.46	3.76	3.63	0.08	0.07
Feed:Gain	6.89[e]	7.43[f]	6.92[e]	7.02[e]	0.14	0.05
Hot Carcass Weight, lb	788	784	806	799	7.21	0.15
12th Rib Fat,in	0.48	0.52	0.50	0.49	0.03	0.74
Marbling Score[e]	500	501	515	484	8.51	0.11

[a]CON = dry rolled corn based diet with no byproduct inclusion; 30/0 = dry rolled corn replaced with 30% bran and 0% steep; 30/15 = dry rolled corn and molasses replaced with 30% bran and 15% steep; 45/15 = dry rolled corn and molasses replaced with 45% bran and 15% steep.
[b]Standard error of the means.
[c]Data were analyzed using a protected F-test where numbers represent P-value for variation due to treatment.
[d]Marbling score: 400 = slight^0; 450 = slight^{50}; 500 = small^0; 550 = small^{50}; etc.
[ef]Means within row with different superscripts differ.

(30/15), to evaluate the effect of steep. The final treatment included 45% bran and 15% steep (45/15) on a DM basis, to try and further increase the amount of OM in the manure. Cattle were adapted to diets over a 21-day step up period. During the first 67 days of the WINTER trial, cattle were fed diets containing 6% supplement. Diets were balanced for metabolizable protein. WINTER calves were implanted with Synovex S® and re-implanted with Revalor S®, and SUMMER yearlings were implanted with Revalor-S®.

Following harvest, data were recorded on hot carcass weight, 12th rib fat, marbling and yield grade. Final weights were calculated based on a 63% common dressing percentage. DM intake, ADG, and feed/gain were calculated.

Nutrient Balance

The WINTER experiment was conducted using 16 open feedlot pens with a stocking density of 344 ft^2 per steer and 8 steers per pen. When rainfall occurred, runoff was collected in retention ponds below the pens. Precipitation amount was measured using a rain gauge, and the effluent was drained and quantified using an air bubble flow meter (ISCO, Lincoln, Nebraska). Samples of the effluent were collected and analyzed for DM, OM, and total N content.

The SUMMER experiment was conducted using 24 open feedlot pens. Sixteen of the pens were the same pens used in the WINTER experiment. The other 8 pens had 16 steers per pen, with a stocking density of 328 ft^2 per steer. Runoff collection was similar to the WINTER trial.

For both trials, feed refusals were collected and sampled. Pens were cleaned approximately every 28 days during the WINTER and every 42 days during the SUMMER. Manure was piled on the cement apron, sampled, weighed and then piled in windrows in the compost yard.

Feed sources were sampled monthly and analyzed for ash, CP, and DM content. N intake was calculated based on analyzed dietary N sources, multiplied by DMI and corrected for feed refusals. Retained steer N was calculated using the energy and protein equation found in the NRC (1996). N excretion was determined by subtracting N retention from N intake. The DM digestibility of the CON diet was 79% and the by-product diets were reported as 73.7%, 72.8%, and 72.6% DM digestibility for the 30/0, 30/15, and 45/15 diets respectively in the *2005 Nebraska Beef Cattle Report*, pp 39-41.

Total N loss was calculated on a lb/steer basis. Excreted N minus runoff N and manure N equals total N lost. The percentage of N lost was calculated as N lost divided by N excreted. All data were analyzed using the PROC MIXED procedures in SAS.

Results

Feedlot Performance

Cattle were finished to similar endpoints, with no differences in hot carcass weight or 12th rib fat (Table 2). In WINTER, cattle fed CON diets tended to eat less than cattle on byproduct diets (23.2 lb/day vs. 24.3 lb/day, $P = 0.06$), however, no differences in final weight or feed conversions were detected ($P > 0.05$; Table 2). These data tend to contradict previous research where cattle on 30/0 diets had lower feed conversions.

Cattle fed during the SUMMER (Table 3) were also finished to

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similar endpoints, with no differences detected in final weight or 12th rib fat. Cattle on the CON diet had lower DMI then those on the by-product diets (24.0 lb/day vs. 25.7 lb/day, P<0.01). Cattle fed the 30/0 diet had lower ($P < 0.05$) feed conversions than other treatments (Table 3); however, when corn steep was added to the diet, feed conversions were similar to the CON. These data support the theory that steep helps cattle maintain performance when bran is included in the diet, possibly because of the additional energy provided by steep.

Nutrient Balance

Manure N content was higher from cattle on the 30/0, 30/15, and 45/15 diets ($P < 0.05$) than manure N from the CON fed cattle (Table 4). The 45/15 treatments had the lowest ($P < 0.05$) percentage of N lost and had the highest amount of OM removed from the pen floor. This is similar to what has been observed in previous research (*1996 Nebraska Beef Cattle Report*, pp 74-77). The 45/15 treatments reduced N losses by 43.9%, when compared to the CON diet ($P < 0.05$).

During the SUMMER trial (Table 5), no differences were detected in the percentage of N lost among treatments (averaging 60.1%). Manure N content and the amount of OM removed from the pen were higher for the by-product diets than the CON diet ($P < 0.05$).

Temperature and moisture both affect the amount of N volatilized. During the WINTER trial, the temperature averaged 33.9ºF, with only 3.74 inches of rainfall; however, the SUMMER trial averaged 69.4ºF, with 12.20 inches of rainfall. The higher N losses during the SUMMER can be attributed to these higher temperatures and possibly to the higher rainfall. As with other studies (*2003 Nebraska Beef Report*, pp 54-58, *2002 Nebraska Beef Report*, pp 54-57), reducing N losses through feeding corn bran and increasing OM on the pen floor surface was only effective in the WINTER.

Feeding bran and steep, in combination, was an effective means of reducing N losses in winter, as well as maintaining cattle performance throughout the year.

Table 4. Effects of dietary treatment on nitrogen mass balance during WINTER expressed in lb/steer.

	Treatment[a]					
Item	CON	30/0	30/15	45/15	SEM[b]	F-Test[b]
N intake	91.2[g]	89.5[g]	97.6[h]	93.5[gh]	1.5	0.02
N retention[c]	12.5	12.8	13.2	12.4	0.2	0.24
N excretion[d]	78.8[g]	76.6[h]	84.4[i]	81.2[gi]	1.3	0.01
Manure N	28.6[g]	37.8[h]	40.7[h]	52.0[i]	3.5	<0.01
Run-off	0.20	0.05	0.12	0.01	0.06	0.20
N lost[e]	50.0[g]	38.8[hi]	43.7[gh]	29.2[i]	5.1	0.01
N loss, %[f]	63.7[g]	50.7[h]	51.8[h]	35.8[i]	9.0	0.01
DM removed	2379[g]	2523[g]	2732[g]	3859[h]	302	0.02
OM removed	605[g]	928[h]	935[h]	1269[i]	70	<0.01

[a]CON = dry rolled corn-based diet with no by-product inclusion; 30/0 = dry rolled corn replaced with 30% bran and 0% steep; 30/15 = dry rolled corn and molasses replaced with 30% bran and 15% steep; 45/15 = dry rolled corn and molasses replaced with 45% bran and 15% steep.
[b]Data were analyzed using a protected F-test where numbers represent P-value for variation due to treatment.
[c] Calculated using the NRC net protein and net energy equations.
[d]Calculated as N intake - N retention.
[e]N lost = N excretion - Manure N - Runoff N.
[f]Calculated as N lost divided by N excretion.
[ghi]Means within row with different superscripts differ.

Table 5. Effects of dietary treatment on nitrogen mass balance during SUMMER, expressed as lb/steer.

	Treatment[a]					
Item	CON	30/0	30/15	45/15	SEM	F-Test[b]
N intake	75.2[g]	83.3[h]	81.3[hi]	80.1[i]	0.7	<0.01
N retention[c]	11.2[g]	10.9[g]	12.0[h]	11.5[gh]	0.2	0.05
N excretion[d]	64.1[g]	72.4[h]	69.3[i]	68.6[i]	0.7	<0.01
Manure N	22.3[g]	29.8[h]	28.7[h]	29.2[h]	1.5	0.01
Run-off	2.29	1.65	3.25	1.47	0.5	0.09
N lost[e]	40.7	41.8	39.0	38.6	2.2	0.69
N loss, %[f]	63.5	57.8	56.2	56.4	6.6	0.13
DM removed	1844	2346	2221	2489	200	0.16
OM removed	395[g]	593[h]	575[h]	615[h]	29	<0.01

[a]CON = dry rolled corn-based diet with no by-product inclusion; 30/0 = dry rolled corn replaced with 30% bran and 0% steep; 30/15 = dry rolled corn and molasses replaced with 30% bran and 15% steep; 45/15 = dry rolled corn and molasses replaced with 45% bran and 15% steep.
[b]Data were analyzed using a protected F-test where numbers represent P-value for variation due to treatment.
[c]Calculated using the NRC net protein and net energy equations.
[d]Calculated as N intake - N retention.
[e]N lost = N excretion - Manure N - Runoff N.
[f]Calculated as N lost divided by N excretion.
[ghi]Means within row with different superscripts differ.

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