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Summary

Two experiments, calves fed November to May (WINTER) and yearlings fed May to September (SUMMER), were conducted to evaluate the effects of feeding a high level of wet distillers grains plus soluble (WDGS) and wheat straw or a corn control diet (CON) on average daily gain (ADG), feed-to-gain (F:G), manure nitrogen (N), and N losses. In both experiments, the CON treatment had greater dry matter intake (DMI), ADG hot carcass weight (HCW), marbling and fat depth. There was greater N intake and N excretion for both the WINTER and SUMMER experiments on the WDGS. However, for the WINTER experiment there was no difference in the amount of N in the manure due to diet or pen cleaning frequency. In the SUMMER experiment, cleaning pens monthly almost doubled dry matter (DM), organic matter (OM), and N removed in manure. There was a tendency for the WDGS treatment to have greater N loss than the control treatment in the WINTER experiment and a significant increase in N losses for the WDGS treatment in the SUMMER experiment, despite the greater amount of manure N removed.

Introduction

One method that reduces N losses from feedlots is the addition of carbon (C) to the pen surface to increase C:N. Research at UNL has used either direct or indirect methods to increase the C:N ratio. Corn milling byproducts are a common indirect method used to increase the C:N ratio on the pen surface through the manure. Corn bran was effective in reducing N losses *(2000 Nebraska Beef Cattle Report*, pp. 54-57), but cattle performance suffered. When steep was added to the corn bran treatment (*2004 Nebraska Beef Cattle Report*, pp. 61-63; *2005 Nebraska Beef Cattle Report*, pp. 54-56), ADG and F:G improved while N losses were reduced. Feeding wet DGS increased the amount of OM and N in the manure (*2008 Nebraska Beef Cattle Report*, pp. 53-56) but not to the same extent as corn bran. Pen cleaning frequency reduces the amount of time manure is exposed to the environment, therefore, reducing amount of N lost through volatilization. Cleaning pens approximately every 28 days has been reported to increase the amount of DM, OM, and N in the manure as well as decrease the N loss compared to cleaning at the end of the feeding period (*2004 Nebraska Beef Cattle Report*, pp. 72-73). Effects of feeding either a high level of wet distillers grains plus solubles with added fiber from wheat straw or a corn-based diet and pen cleaning frequency on cattle performance and nutrient mass balance were evaluated in our study.

Procedure

Cattle Performance

Two experiments were conducted using 128 steers each, calves (686 +/- 22 lb) fed for 173 days from November to May (WINTER) and yearlings (805 +/- 11 lb) fed for 145 days from May to October (SUMMER) to evaluate the effect of feeding high levels of both distillers grains and wheat straw compared to a corn-based diet. Steers were stratified by body weight (BW) and assigned randomly to 16 pens (8 steers/pen). The SUMMER and WINTER dietary treatments consisted of 1) 85% dry-rolled corn, 5% molasses, 5% wheat straw, 5% supplement (CON), or 2) 70% WDGS and 25% wheat straw, 5% supplement (WDGS + straw). For the 21-day adaptation period, alfalfa hay was replaced by dry-rolled corn in the CON treatment. Wheat straw was kept constant through the adaptation period and WDGS replaced alfalfa hay. A supplement contained Rumensin, Tylan, and Thiamine at 30 g/ton DM, 90, and 130 mg/steer daily, respectively, in both experiments.

Steer calves in the WINTER trial were implanted on day 1 with Synovex Choice (Fort Dodge Animal Health) followed by a re-implant on day 85 with Synovex Choice. Yearling steers on the SUMMER trial were implanted with Revalor-S (Intervet Schering-Plough Animal Health) on day 35 of the feeding period. Due to the goal of harvesting steers at similar BW, the WINTER CON treatment was slaughtered on day 173 and the WDGS + straw treatment was slaughtered on day 229. For the SUMMER, the yearling steers were slaughtered on day 144 for the CON and day 159 for the WDGS + straw of the feeding experiment. Steers were harvested at a commercial abattoir (Greater Omaha) and hot carcass weight and liver scores were recorded on day of slaughter. Fat thickness, lean matter area, and USDA called marbling score were collected after a 48-hour chill. Final BW, ADG, and G:F were calculated based on HCW adjusted to a common dressing percentage of 63%. Feed efficiency data were analyzed as G:F and reported as F:G.

Nutrient Mass Balance

Runoff N was determined using 12 open feedlot pens with retention ponds to collect runoff from

Table 1. Growth performance and carcass characteristics for steers fed during the WINTER trial.

Dietary Treatments[1]	CON	WDGS + straw	SEM	*P*-value[2]
WINTER[3]				
Performance				
DMI, lb	22.6	18.5	0.3	<0.01
ADG, lb	3.57	2.36	0.4	<0.01
Feed: Gain	6.33	7.81	.002	<0.01
SUMMER[4]				
Performance				
DMI, lb	23.6	21.1	0.3	<0.01
ADG, lb	3.15	2.62	0.05	<0.01
Feed: Gain	7.47	8.00	0.003	0.04

[1]Dietary treatments: CON = Control corn-based diet, WDGS + straw = 70% WDGS, 25% wheat straw.
[2]*F*-test statistic for dietary treatment.
[3] CON – fed for 173 days, WDGS – fed for 229 days.
[4] CON – fed for 144 days, WDGS – fed for 156 days.

Table 2. Effect of dietary treatment on nitrogen mass balance[1] during WINTER[2] trial.

Dietary treatment[3]	CON	WDGS + straw	SEM	*P*-value[4]
N intake	76.3	123.1	1.1	<0.01
N retention[5]	12.1	11.9	0.3	0.25
N excretion[6]	64.2	111.4	1.1	<0.01
Manure N[7]	23.6	26.2	3.5	0.63
N Run-off	—	—	—	—
N Lost	40.4	85.1	4.2	<0.01
N loss%[8]	62.9	76.4	5.1	0.08
DM removed	4776	5257	672	0.62
OM removed	1114	1418	170	0.23

[1]N mass balance analyzed for equal days across treatments.
[2]Values are expressed as lb/steer over entire feeding period (WINTER – fed for 173 days, SUMMER – fed for 144 days).
[3]Dietary treatments: CON = Control corn-based diet, WDGS + straw= 70% WDGS, 25% wheat straw.
[4]*F*-test statistic for dietary treatment.
[5]Calculated using the NRC net protein and net energy equations.
[6]Calculated as N intake – N retention.
[7]Manure N with correction for soil N.
[8]Calculated as N loss divided by N excretion.

Table 3. Effect of pen cleaning frequency on nitrogen mass balance[1] during WINTER[2] trial.

Pen cleaning frequency[3]	End	Monthly	SEM	*P*-value[4]
N intake	100	99	1.103	0.39
N retention[5]	12.13	11.90	0.27	0.91
N excretion[6]	88.42	87.10	1.13	0.41
Manure N[7]	21.83	28.00	3.5	0.24
N Run-off	—	—	—	—
N Lost	66.37	59.10	4.19	0.21
N loss%[8]	73.5	65.5	5.1	0.29
DM removed	3837	6194	670	0.03
OM removed	1005	1526	170	0.05

[1]N mass balance analyzed for equal days across treatments.
[2]Values are expressed as lb/steer over entire feeding period (WINTER – fed for 173 day, SUMMER – fed for 144 days).
[3]Pen cleaning frequency: end = cleaned at end of feeding period, monthly = cleaned every 28 days.
[4]*F*-test statistic for dietary treatment.
[5]Calculated using the NRC net protein and net energy equations.
[6]Calculated as N intake – N retention.
[7]Manure N with correction for soil N.
[8]Calculated as N lost divided by N excretion.

rainfall. When runoff did occur, it was collected in the retention ponds and they were drained, sampled, and quantified. Pens that were randomly assigned to the 28-day pen cleaning schedule were scraped and the manure was piled on a cement apron and sampled for nutrient analysis while being loaded. Pens that were assigned to the end-of-the-feeding-period cleaning were subjected to this cleaning after the steers were removed for harvest. Manure was then weighed before it was hauled to the University of Nebraska compost yard, where treatments were kept separated. Manure samples were then freeze dried for nutrient analysis and oven dried for DM calculation. Ingredients were sampled weekly, and feed refusals were analyzed to determine nutrient intake using a weighted composite on a pen basis. Individual steer N retention was calculated using the NRC net energy and protein equations (NRC, 1996). Nutrient excretion was determined by subtracting nutrient retention from intake. Total N lost (lb/steer) was calculated by subtracting manure N and runoff N from excreted N. Percentage of N loss was calculated as N lost divided by N excreted.

Animal performance and nutrient balance data were analyzed using the MIXED procedures of SAS as a 2 X 2 factorial design with the factors being dietary treatments and timing of pen cleaning.

Results

Cattle Performance

There was no interaction between dietary treatments or pen cleaning frequency ($P > 0.24$) for either SUMMER or WINTER trials; therefore, only main effects will be discussed. In the WINTER, cattle fed the WDGS + straw had lower DMI (18.5 lb/day versus 22.6 lb/day). Average daily gain was also lower in the WDGS + straw treatment (2.36 versus 3.57 lb), which resulted in a greater F:G ($P < 0.01$) compared to the cattle consuming the CON treatment.

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Cattle fed during the SUMMER trial had similar performance results as the WINTER calf-feds. Intake was lower for the WDGS + straw treatment ($P < 0.01$) as well as ADG ($P < 0.01$), which resulted in a higher F:G (8.00 lb versus 7.47 lb ($P = 0.04$)). This lower performance (Table 1) for the WDGS + straw treatment is most likely due to the high inclusion of wheat straw in the diet, which was added to help increase the amount of OM on the pen surface and prevent sulfur-related polioencephalomalacia (2009 *Nebraska Beef Cattle Report,* pp. 79-80).

Nutrient Balance

There was no interaction between dietary treatments or pen cleaning frequency ($P > 0.10$) for either SUMMER or WINTER trials; therefore, only main effects will be discussed.

Steers fed during the WINTER had greater N intake and N excretion when consuming the WDGS + straw treatment ($P < 0.01$, Table 2). However, manure N was similar for the CON and WDGS + straw treatments. Therefore, because WDGS + straw calves excreted more N with the same amount in manure as the CON calves, the calves consuming the WDGS + straw had greater N losses ($P < 0.01$). There was a tendency ($P = 0.08$) for the WDGS + straw steers to have a greater N loss (76.4% vs. 62.9%) when expressed as a percentage of N excreted. There was not enough precipitation during the WINTER trial to generate runoff. The dry matter and OM removed were similar across dietary treatments ($P > 0.10$). Amount of DM removed was greater for pens cleaned monthly compared to those cleaned at the end of the feeding period ($P = 0.03$) (Table 3).

Steers on trial in the SUMMER consuming the WDGS + straw had greater ($P<0.01$) N intake and N excretion, due to excess CP with the WDGS + straw treatment compared to the CON treatment (24% versus 12%, Table 4). Runoff N was not impacted ($P = 0.28$) by either dietary treatments or pen cleaning frequency; however, there was almost double the amount of manure N, DM, and OM removed for the steers consuming the WDGS + straw compared to the CON ($P < 0.01$). Table 5 reports the pen cleaning frequency results. Monthly pen cleaning also almost doubled ($P < 0.01$) the amount of N, DM, and OM removed in the manure. Despite increases in manure N, N losses were greater ($P < 0.01$) for the WDGS + straw compared to the CON treatment. Cleaning pens monthly decreased ($P < 0.01$) N losses by 8.4 lb or 50.5% compared to cleaning at the end of the feeding period. Runoff N did not constitute much of what was excreted, resulting in 3.5% of N excreted for the CON treatment and 2.2% for the WDGS + straw.

These data indicate feeding 70% WDGS with 25% wheat straw does decrease DMI, ADG, and F:G year around. Feeding WDGS at 70% diet DM increased N intake and N excretion due to the high concentration of CP in the byproduct. Cleaning feedlot pens monthly does increase total amount of manure removed, but there is also a greater amount of OM and N removed.

Table 4. Effect of dietary treatment on nitrogen mass balance[1] during SUMMER[2] trial.

Dietary treatment[3]	CON	WDGS + straw	SEM	*P*-value[4]
N intake	63.8	115.1	1.1	<0.01
N retention[5]	8.8	8.4	0.1	0.02
N excretion[6]	55.0	106.7	1.1	<0.01
Manure N[7]	17.4	31.7	1.7	<0.01
N Runoff	1.9	2.3	0.63	0.64
N Lost	33.5	69.9	2.2	<0.01
N loss%[8]	60.9	65.5	2.5	<0.01
DM removed	7784	12287	947	<0.01
OM removed	1160	2317	98	<0.01

[1]N mass balance analyzed for equal days across treatments.
[2]Values are expressed as lb/steer over entire feeding period (WINTER – fed for 173 days, SUMMER – fed for 144 days).
[3]Dietary treatments: CON = Control corn-based diet, WDGS + straw= 70% WDGS, 25% wheat straw.
[4]*F*-test statistic for dietary treatment.
[5]Calculated using the NRC net protein and net energy equations.
[6]Calculated as N intake – N retention.
[7]Manure N with correction for soil N.
[8]Calculated as N loss divided by N excretion.

Table 5. Effect of pen cleaning frequency on nitrogen mass balance[1] during SUMMER[1].

Pen cleaning frequency[2]	End	Monthly	SEM	*P*-value[3]
N intake	90	89	0.68	0.68
N retention[4]	8.56	8.60	0.79	0.91
N excretion[5]	81.21	80.50	0.13	0.79
Manure N[6]	16.82	32.26	1.70	<0.01
N Run-off	3.51	5.76	1.39	0.28
N Lost	60.92	42.47	2.21	<0.01
N lost%[7]	164.6	114.06	5.53	<0.01
DM removed	6090	13981	941	<0.01
OM removed	1252	2225	98	<0.01

[1]Values are expressed as lb/steer over entire feeding period (WINTER – fed for 173 days, SUMMER – fed for 144 days).
[2]Pen cleaning frequency: end = cleaned at end of feeding period, monthly = cleaned every 28 days.
[3]*F*-test statistic for dietary treatment.
[4]Calculated using the NRC net protein and net energy equations.
[5]Calculated as N intake – N retention.
[6]Manure N with correction for soil N.
[7]Calculated as N lost divided by N excretion.

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