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Cattle Performance and Economic Analysis of Diets Containing Wet Distillers Grains and Dry-Rolled or Steam-Flaked Corn

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Summary

A finishing study was conducted to determine the effect of utilizing dry-rolled (DRC) or steam-flaked (SFC) corn in diets containing wet distillers grains without solubles (WDG). An interaction between corn processing method and DG level was observed for average daily gain (ADG) and feed-gain ratio (F:G), but not for dry matter intake (DMI). In diets containing DRC, ADG increased quadratically (P = 0.02) as WDG level increased, but no difference was observed in gain when steers were fed SFC diets with increasing level of WDG. Feed efficiency responded quadratically for diets containing DRC, with an optimum WDG inclusion of 20% of diet DM (P < 0.01) No difference in F:G was observed as WDG increased in SFC-based diets.

Introduction

Previous research has determined an interaction between corn processing method and optimum wet distillers grains plus solubles (WDGS) level (*2007 Nebraska Beef Report*, pp. 33-35). In that study, F:G improved with increasing inclusion of WDGS in dry-rolled corn (DRC) based diets. However, in steam-flaked corn (SFC) based diets, F:G remained constant as WDGS inclusion increased from 0% to 40% diet DM. Optimal inclusion with DRC was observed at 40% of diet DM, but only at 15% to 20% with SFC. However, no research has been conducted to determine if an interaction occurs in diets containing wet distillers grains without solubles (WDG).

Wet distillers grains and distillers solubles are produced as separate components during ethanol production. The two fractions are often added together from the individual components to produce WDGS. However, each ethanol plant, based on plant capacity and ability, has the opportunity to add back all, none or a portion of the solubles. It has been hypothesized that rumen pH and concentrate level may negatively impact the response of WDG when steers are fed SFC. It also has been hypothesized that if steers fed SFC-based diets perform similarly to steers fed DRC-based diets with WDG, then feeding DRC may have an economic advantage. Therefore, there were three objectives in the current study. The primary objective was to determine performance when steers consume diets containing WDG and DRC or SFC. The secondary objective was to determine if additional roughage in diets containing SFC and 40% WDG would improve performance. The final objective was to assess the economic impact of different WDG inclusion levels in DRC- or SFC-based diets.

Procedure

Cattle Performance and Carcass Characteristics

A 145-day finishing trial was conducted utilizing 120 crossbred yearling steers (BW = 784 ± 55 lb) in a randomized complete block design. Steers were fed individually using Calan electronic gates. Five days prior to the initiation of the trial, steers were limit fed to minimize variation in rumen fill (1:1 ratio of alfalfa hay and wet corn gluten feed at 2% BW). Steers were then weighed individually on days -1, 0 and 1 to determine initial BW. Animals were blocked by BW, stratified within blocks and assigned randomly to one of eight treatments in one of four barns. Animal served as the experimental unit, and there were a total of 15 replications per treatment.

Dietary treatments were designed as a 2 x 3 + 2 factorial arrangement (Table 1). Two types of corn processing method (dry-rolled or steam-flaked) were represented in diets containing 0%, 20%, or 40% WDG on a DM basis (0-DRC, 20-DRC, 40-DRC, 0-SFC, 20-SFC and 40-SFC). These diets all contained 7.5% alfalfa hay and 5% dry supplement. Molasses was included in the diets containing 0% WDG to aid in mixing the low moisture diets. Soypass™ (Rothschild, Wis.) also was included in those diets containing 0% WDG at 2% of the diet DM, replacing corn from day 1 to day 50 to meet the metabolizable protein requirement of those calves. Two additional diets were formulated with SFC and 40% WDG and additional roughage to determine the impact on steer performance. Those diets are

Table 1. Diets fed to finishing steers containing dry-rolled or steam-flaked corn with 0%, 20% or 40% wet distillers grains (WDG). All values are expressed as % of diet DM.

Ingredient	0% WDG	20% WDG	40% WDG	40%WDG-MID[1]	40% WDG-HIGH[1]
DRC or SFC [2]	82.5	67.5	47.5	43.8	40.0
WDG	0.0	20.0	40.0	40.0	40.0
Alfalfa	7.5	7.5	7.5	11.3	15.0
Molasses	5.0	0.0	0.0	0.0	0.0
Supplement	5.0	5.0	5.0	5.0	5.0

[1]40% WDG-MID/HIGH = alfalfa hay replaced SFC at 11.3 or 15.0% of diet DM.
[2]DRC = dry-rolled corn; SFC = steam-flaked corn.

Table 2. Effect of corn processing method and wet distillers grains (WDG) level on cattle performance and carcass characteristics.

	DRC			SFC			*P*-value		
Item	0%	20%	40%	0%	20%	40%	CPM x WDG[1]	CPM[2]	WDG[3]
Initial BW, lb	784	782	785	786	784	783	0.99	0.94	0.99
Final BW, lb[4]	1225	1316	1291	1294	1311	1270	0.16	0.49	0.10
DMI, lb/d	21.6	22.5	21.3	22.1	21.5	20.3	0.27	0.28	0.06
ADG, lb[5]	3.05	3.68	3.49	3.50	3.64	3.36	0.09	0.43	0.03
F:G[5,6]	7.14	6.10	6.13	6.33	5.92	6.06	0.02	0.03	<0.01
HCW, lb	772	829	814	815	826	800	0.16	0.49	0.10
12th rib fat, in	0.40	0.49	0.49	0.43	0.47	0.42	0.36	0.88	0.06
Marbling score[7]	513	495	473	493	523	471	0.36	0.41	0.13
LM area, in^2	13.6	14.1	13.5	13.9	14.3	13.9	0.96	0.36	0.38
Calculated yield grade[8]	2.56	2.87	2.97	2.71	2.75	2.65	0.31	0.43	0.41

[1]CPM x WDG = *P*-value for the effect of corn processing method x WDG inclusion level.
[2]CPM = *P*-value for the main effect of corn processing method (DRC or SFC).
[3]WDG = *P*-value for the main effect of wet distillers grain level.
[4]Final BW = HCW / common dressing percent of 63%.
[5]Quadratic response observed within DRC.
[6]F:G = 1/G:F; analyzed as G:F.
[7]450 = Slight 50; 500 = Small 0; etc.
[8]Yield grade = 2.5 + 2.5(12th rib fat, in) – 0.32(LM area, in^2) + 0.2(KPH fat, %) + 0.0038(HCW, lb).

designated 40-MID and 40-HIGH, for 11.3% and 15.0% alfalfa, respectively.

On day 50 of the experiment, calves were implanted with Revalor-S (Intervet, Millsboro, Del.). All steers were slaughtered on day 145 at Greater Omaha (Omaha, Neb.). On the day of slaughter, hot carcass weights (HCW) and liver abscess data were recorded. Following a 48-hour chill, marbling score, 12th rib fat thickness and LM area data were collected. Final BW, ADG and F:G were calculated by dividing HCW by a common dressing percentage of 63%. Yield grade was calculated using the USDA yield grade equation [yield grade = 2.5 + 2.5(12th rib fat thickness, in) - 0.32(LM area, in^2) + 0.2(KPH fat, %) + 0.0038 (HCW, lb)].

Steer performance and carcass data were analyzed using the MIXED procedures of SAS (SAS Institute, Cary, N.C.). The model included corn processing method, WDG inclusion level, and corn processing method by WDG inclusion level interaction. Orthogonal contrasts were used to determine linear and quadratic effects of WDG inclusion levels within corn processing methods when a significant interaction was present ($P < 0.10$). Linear and quadratic responses to increasing roughage level in diets containing 40% WDG and SFC were analyzed separately.

Economic Analysis

Six of the eight diets were utilized to determine the effect of corn and byproduct price on profitability of steers consuming diets containing DRC or SFC with increasing WDG inclusion level. Diets included in the analysis were 0-DRC, 20-DRC, 40-DRC, 0-SFC, 20-SFC and 40-SFC (Table 1). Steers were assumed to have been purchased on day 0 of the experiment and fed for 145 days until slaughter. Two corn prices were utilized ($5.50/bu and $4.00/bu on an as-is basis). Distillers grains, when forward-contracted from the ethanol plant, are hypothesized to be priced 65-80% of the price of corn; therefore, the WDG was priced at either 65% or 80% of the price of corn. Costs of corn processing for DRC and SFC were added to the base corn price and determined by previous research conducted at the University of Nebraska (Macken, C., 2006, The cost of corn processing for finishing cattle, *The Professional Animal Scientist 22*: 23-32). Prices reflect a 20,000-head capacity feedlot utilizing a roller and two flakers processing 48.1 ton/hour and 12 ton/hour for DRC and SFC, respectively. Natural gas and electricity prices reflect the 2007 commercial sector average price $0.272/kL and $0.0624/kwh in Nebraska. Total processing costs were $0.88/ton and $7.41/ton for DRC and SFC, respectively. Hay price was determined using the monthly composited average price of alfalfa hay for 2007 as reported by USDA-AMS. Molasses and supplement prices were determined according to basal ingredients, priced according to Nebraska Beef Cattle Budgets (*www.extension.unl.edu/publications*).

Fed-cattle price was $92.10/cwt, the 2007 Nebraska average choice slaughter steer price as reported by USDA-AMS. Veterinary, medical and processing costs were charged at $15.00 per head for the finishing period. Marketing costs were determined by multiplying the final steer weight by $1.50/cwt. Interest was assumed to accrue on the animal and all costs of production at 8.5% over the 145-day finishing period. A yardage charge was assessed at $0.35/head/day over the feeding period. The 0-DRC diet was used to calculate break-even (BE) by dividing total cost (less initial steer value) by initial steer weight to determine the price paid for a 700-800 lb feeder steer in May 2007. Cost of gain (COG) was determined by dividing total cost by pounds of weight gain over the feeding period. Profitability of each treatment was determined by adding initial steer value and all costs

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incurred over the feeding period and subtracting that total from the final value of each steer.

Results

Corn Processing Method x WDG Level Interaction

Performance results and carcass characteristics are presented in Table 2. An interaction between corn processing method and WDG level occurred for ADG and F:G ($P < 0.10$). Gain and F:G responded quadratically for steers consuming DRC with increasing WDG inclusion ($P = 0.02$). Optimum inclusion of 20% WDG in DRC-based diets was observed. However in SFC-based diets, ADG and F:G were not affected by WDG inclusion level ($P > 0.18$). Steers consuming SFC were more efficient at 0% WDG inclusion versus cattle consuming DRC at 0% WDG inclusion. However, at 20% and 40% WDG inclusion, there was no difference in F:G between steers consuming SFC (5.92 and 6.06 for 20% and 40% WDG, respectively) or DRC (6.10 and 6.13 for 20% and 40% WDG, respectively). Corn processing method had no effect on final BW, DMI, ADG, F:G, HCW, 12th rib fat, marbling score, LM area or calculated yield grade for steers consuming DRC or SFC ($P > 0.35$).

WDG Inclusion Level

Final carcass adjusted BW responded quadratically as WDG inclusion increased from 0% to 40% ($P < 0.05$). Dry matter intake, on the other hand, decreased linearly as WDG inclusion increased ($P = 0.06$). Additionally, an effect of WDG inclusion was observed for HCW and marbling score ($P < 0.10$). Cattle consuming 20% WDG had the highest numerical HCW over the 0% or 40% WDG inclusion. Marbling score tended to decrease linearly as WDG inclusion increased in the diet ($P = 0.07$).

Roughage Level

As roughage level increased from 7.5% to 15.0% in those diets containing 40% WDG and SFC, DMI tended to increase linearly ($P = 0.07$). There was no effect on ADG across treatments as roughage level increased ($P = 0.99$). Therefore, F:G tended to increase linearly as roughage increased from 7.5% to 15% diet DM ($P = 0.09$).

Table 3. Effect of roughage level inclusion on animal performance and carcass characteristics in steers fed steam-flaked corn and 40% wet distillers grains with increasing roughage.

	Roughage Level[1]				*P*-value	
Item	7.5%	11.3%	15.0%	SEM	Linear	Quadratic
Initial BW, lb	783	781	784	13	0.98	0.89
Final BW[2], lb	1270	1239	1270	22	0.98	0.25
DMI, lb/d	20.3	20.5	21.8	0.6	0.07	0.49
ADG, lb	3.35	3.20	3.36	0.13	0.99	0.32
F:G[3]	6.06	6.37	6.49		0.09	0.23
HCW, lb	800	780	800	14	0.98	0.25
Marbling score[4]	471	466	460	17	0.65	0.96
12th rib fat, in	0.42	0.38	0.41	0.03	0.88	0.37
LM area, in^2	13.9	13.6	13.8	0.4	0.87	0.71
Calculated yield grade[5]	2.65	2.56	2.65	0.2	0.98	0.66

[1]Roughage level treatments: 7.5% = 40-SFC; 11.3% = 40-MID; 15% = 40-HIGH.
[2]Final BW = HCW / common dressing percent of 63%.
[3]F:G = 1 / G:F, analyzed as G:F.
[4]450 = Slight 50; 500 = Small 0; etc.
[5]Yield grade = 2.5 + 2.5(12th rib fat, in) – 0.32(LM area, in^2) + 0.2(KPH fat, %) + 0.0038(HCW, lb).

Table 4. Effect of dietary treatment on profitability of steers fed dry-rolled or steam-flaked corn with wet distillers grains (Corn = $5.50/bu and WDG = 80% the value of corn).

Item	0-DRC	20-DRC	40-DRC	0-SFC	20-SFC	40-SFC
Initial steer value[1], $	680.91	680.91	680.91	680.91	680.91	680.91
Feed cost[2], $	335.68	333.98	302.40	352.47	326.36	292.54
Total cost[3], $	447.32	446.95	414.46	465.42	439.13	404.12
Final steer value[4], $	1128.23	1212.04	1189.01	1191.77	1207.43	1169.67
Cost of gain[5], $	101.43	83.70	81.91	91.62	83.33	82.98
Breakeven[5], $	92.10	85.70	84.85	88.59	85.43	85.44
Profit/Loss, $	0.00	84.14	93.65	45.44	87.39	84.64
Profit/Loss[6], $	0.00	95.30	114.73	45.44	98.03	104.71
Profit/Loss[7], $	0.00	88.52	89.74	47.39	88.08	77.10
Profit/Loss[8], $	0.00	96.61	105.07	47.39	95.81	91.70

[1]Initial steer value determined using experiment average initial weight multiplied by $92.61/cwt.
[2]Feed cost = sum of treatment ingredient prices/lb over the feeding price, using DMI to determine intake; Ingredient price = ([DMI x % ingredient inclusion in each treatment] x ingredient price/lb).
[3]Total cost = diet cost + veterinary and medical + marketing + feedlot interest + animal interest + yardage.
[4]Live sale price = $92.10/cwt.
[5]All prices on a cwt basis.
[6]Profit/Loss: Corn = $5.50/bu and WDG = 65% the value of corn.
[7]Profit/Loss: Corn = $4.00/bu and WDG = 80% the value of corn.
[8]Profit/Loss: Corn = $4.00/bu and WDG = 65% the value of corn.

Profitability Analysis

A partial budget to determine the effect of dietary treatment on profitability is presented in Table 4. In this scenario, corn was priced at $5.50/bu and WDG at 80% of the relative value of corn. However, within corn price, only small numerical differences in diet cost, total cost, COG, BE and profit/loss (P/L) were observed among WDG pricing levels. Therefore, corn and WDG pricing scenarios were combined to make generalized conclusions in the following section. It is important to note that as the price of corn increases from $4.00/bu to $5.50/bu, producers will need to pay $9.88/cwt less for 700-800 lb feeder steers to achieve the same breakeven price.

Total cost over the feeding period is primarily dictated by diet cost, which is determined by corn price and inclusion of WDG. The cost of corn processing is not affected by corn price; however, processing does affect total diet cost. Total diet cost was $15.83/steer higher in diets containing SFC than in diets containing DRC with 0% WDG. However, regardless of corn processing method, as the inclusion of WDG increased in the diet, total diet cost decreased $35.67/steer.

Performance results indicate steers consuming 0% WDG in SFC-based diets had an advantage in ADG and F:G versus steers consuming DRC-based diets. Additionally COG, BE and P/L favored SFC-based diets when the diet contained no WDG. COG was $8.85/cwt lower for steers consuming SFC versus DRC. In SFC-based diets a $3.59/cwt advantage in BE was observed compared to DRC-based diets. Reduced COG and BE corresponded to a $46.41/steer increase in profitability in steers consuming SFC versus DRC.

However, due to the response of WDG inclusion, the net reduction in COG and BE were greater in DRC- versus SFC-based diets. When comparing DRC- and SFC-based diets, the net reduction in COG and BE was realized when WDG was included at 20% or 40% diet DM versus traditional diets containing no WDG. COG was reduced $15.49 to $23.69/cwt in DRC-based diets, but $7.49 to 12.76/cwt in SFC-based diets. Similarly, BE was reduced $6.40 to $8.89/cwt in DRC-based diets, whereas in diets containing SFC, BE was reduced by $3.06 to $4.73/cwt.

Since WDG is priced lower relative to corn, reduced diet costs (by including WDG at 20% or 40% diet DM) are primarily responsible for increased profitability. Profitability increased $87.39 to $104.71/steer and $84.17 to $114.73/steer in SFC- and DRC-based diets containing 20% or 40% WDG, respectively. The greatest increase in profitability was observed in DRC-based diets with 40% WDG inclusion, which increased $114.73/steer over DRC-based diets containing 0% WDG.

In summary, optimum WDG inclusion in DRC-based diets was observed at 20% of diet DM, while in SFC-based diets there was no difference at 20% or 40% WDG inclusion. The response to WDG inclusion was greater in DRC- versus SFC- based diets. Also, adding roughage in diets containing SFC and WDG did not appear to positively influence performance. Results of the economic analysis indicated that SFC-based diets with no WDG had lower COG and BE and were more profitable than DRC-based diets with no WDG. However, the advantage of WDG inclusion was realized in DRC-based diets. DRC-based diets containing WDG have a greater net reduction in COG and BE than SFC-based diets containing WDG. Steers fed DRC and WDG were more profitable compared to those fed SFC-based diets containing WDG, as long as WDG was priced at 65% to 80% of the price of corn.

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