Chemical Treatment of Low-quality Forages to Replace Corn in Cattle Finishing Diets

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Summary

A finishing experiment evaluated substitution of corn with crop residues in diets containing wet distillers grains. Corn stover, corn cobs, and wheat straw were alkaline treated at 50% moisture or fed without chemical treatment at 20% inclusion. Chemical treatment improved performance compared to untreated. Compared to control (10% roughage), treated diets had similar performance and carcass merit. Economic analysis revealed $6.46, $21.42, and $36.30 average profit per head advantage for diets containing treated residues relative to control when corn was priced at $3.00, $4.50, and $6.00 per bushel. Feeding chemically treated crop residues and wet distillers grains is a cost-effective strategy for replacing corn in feedlot diets without compromising performance or carcass quality.

Introduction

A pilot study (*2011 Nebraska Beef Cattle Report,* pp. 35-36) determined that chemical treatment of poor quality forages with 5% calcium oxide improved digestibility, with additional small increases using 3% CaO + 2% NaOH, and chemical treatment at 50% DM resulting in greater digestibility than at 35% DM. Given the complementary nature of distillers grains with forage on fiber digestibility, substituting corn for treated residue in finishing diets with wet distillers grains may result in acceptable performance while reducing diet costs. Therefore, the objective of this study was to evaluate replacing corn with treated residues in combination with wet distillers grains on cattle performance and carcass merit, along with economic implications.

Procedure

The experiment used 336 short-yearling steers (42 pens, 8 steers/pen) (BW= 784 ±25.4 lb). The experiment had three weight blocks, seven diets (six replications per treatment) and was designed as a randomized complete block design. Main factors included three crop residues (corn cobs, wheat straw, corn stover) treated or untreated; all of which replaced corn and were fed at 20% diet DM (Table 1). The control diet contained a higher amount of corn (46 vs. 36%) and less roughage (10%, equal parts untreated cobs, wheat straw, and corn stover). Chemical treatment consisted of water, CaO (Standard Quicklime), and ground residue (3-inch screen for corn stover and wheat straw, ¾-inch screen for corn cobs) weighed and mixed into Roto-Mix feed trucks. The mixture was calculated to be 50% DM with calcium oxide added at 5% of the total DM. Feed trucks dispensed treated residue into a silage bag, and the treatment process was completed 30 days prior to start of experiment. Untreated residues were ground and stored under roof (no added moisture or chemical). Orts were assessed weekly and were negligible (0.8% of total DM offered). Calcium oxide replaced limestone in treated diets. Data were analyzed using the MIXED procedure of SAS (SAS Inst., Inc., Cary, N.C.). The factorial was analyzed separately from control. To compare treated and untreated diets to the control, least squared means were separated by the pDIFF option with a protected F-test.

Partial budget analysis included costs for yardage ($0.45/steer/day), WDGS (70% value of corn), bagging costs ($8/ton), labor costs for bagging ($5 cobs, $10 corn stover, $15 straw; cost per ton DM), corn price ($3.00, $4.50, $6.00/per bu), roughage price ($50/ton; delivered price for cobs, wheat straw, and corn stover), calcium

Table 1. Dietary treatments.

		Corn Cobs		Wheat Straw		Corn Stover	
Ingredient, % of DM	Control	Treated	Untreated	Treated	Untreated	Treated	Untreated
DRC	46.0	36.0	36.0	36.0	36.0	36.0	36.0
Cobs–treated[1]	—	20.0	—	—	—	—	—
Straw–treated[1]	—	—	—	20.0	—	—	—
Stover–treated[1]	—	—	—	—	—	20.0	21.0
Cobs–not treated	3.3	—	20.0	—	—	—	—
Straw–not treated	3.3	—	—	—	20.0	—	—
Stover–not treated	3.3	—	—	—	—	—	—
WDGS	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Supplement[2]	4.0	4.0	4.0	4.0	4.0	4.0	4.0

[1]Treated with 5% CaO and water added to 50% DM.
[2]Formulated to provide 360 mg/hd/day Rumensin® and 90 mg/head/day Tylan®.

Table 2. Performance and carcass characteristics.

Item	Control	Corn Cobs		Wheat Straw		Corn stover		SE	All Diets F-test	Factorial *P*-value		
		Treated	Untreated	Treated	Untreated	Treated	Untreated			F[1]	T[2]	FxT[3]
Initial BW	785	784	782	790	782	791	780	25.4	0.34	0.86	0.19	0.73
Final BW[5]	1313^{bc}	1304^{bc}	1305^{bc}	1350^{a}	1278^{cd}	1325^{ab}	1267^{d}	24.2	<0.01	0.27	<0.01	<0.01
Final BW[6]	1376^{ab}	1388^{a}	1414^{a}	1414^{a}	1292^{b}	1402^{a}	1373^{ab}	37.3	<0.01	0.31	0.11	0.07
ADG, lb[8]	3.78^{abc}	3.73^{bcd}	3.74^{bc}	4.01^{a}	3.55^{cd}	3.83^{ab}	3.49^{d}	0.08	<0.01	0.30	<0.01	0.01
DMI, lb	25.81	25.36	25.66	25.83	25.29	26.11	25.06	0.32	0.30	0.97	0.11	0.12
F:G[7]	6.83^{ab}	6.80^{ab}	6.86^{ab}	6.44^{a}	7.12^{b}	6.82^{a}	7.18^{b}		0.06	0.31	0.01	0.16
Profit-$3.00*	0.00	2.06	6.91	17.37	-10.28	-0.05	-13.32					
Profit-$4.50*	0.00	14.78	18.30	35.80	-2.08	13.68	-6.70					
Profit-$6.00*	0.00	27.42	29.61	54.16	6.04	27.33	-0.16					
HCW	834^{bc}	828^{bc}	829^{bc}	857^{a}	811^{cd}	841^{ab}	805^{d}	15.3	<0.01	0.28	<0.01	<0.01
12th rib fat	0.53^{a}	0.47^{bc}	0.48^{bc}	0.50^{ab}	0.44^{c}	0.53^{a}	0.44^{c}	0.018	<0.01	0.79	<0.01	0.03
LM area	12.96	13.03	13.41	13.49	13.20	13.13	12.72	0.221	0.11	0.10	0.50	0.10
Marbling[4]	517	507	516	508	484	501	494	9.4	0.12	0.12	0.25	0.14
Calc. YG	3.46	3.23	3.20	3.29	3.12	3.45	3.21	0.101	0.16	0.39	0.08	0.59

[1]Fixed effect of forage fraction.
[2]Fixed effect of chemical treatment.
[3]Forage fraction x chemical treatment interaction.
[4]500 = Small, 600 = Modest.
[5]Calculated as HCW/common dress (63%).
[6]Pen weight before slaughter.
[7]Analyzed as G:F, reciprocal of F:G.
[8]Caculated from carcass-adjusted final BW.
*Average profit per head relative to control when corn is $3.00, $4.50, or $6.00 per bushel.
[abcd]Within a row, values lacking common superscripts, differ ($P < 0.05$).

oxide ($230/ton), and limestone ($100/ton). Due to differences in final BW, treatments were adjusted to a common endpoint (based on weight) by adding days on feed and assuming average DMI and ADG observed during the feeding period for each treatment. Control was calculated to break even at varying corn prices. Price per ton of untreated forage at the bunk was $64 per ton of DM and costs of chemical treatment increased costs to $75, $80, and $85 per ton DM for cobs, corn stover, and wheat straw, respectively. No cost was charged for water in this analysis.

Results

An interaction between chemical treatment and residue ($P < 0.01$) was noted for carcass adjusted final BW, ADG, G:F, and HCW (Table 2). Greater final BW was observed for treated stover (4.6%) and straw (5.6%) compared with untreated stover and straw; however, treated and untreated cobs were similar. Average daily gain was 9.7% greater for treated straw and 12.5% greater for treated stover, compared to untreated. Treated straw and stover diets had G:F improvements of 10.7% and 5.0% relative to diets containing untreated forms. Treated and untreated cobs had similar G:F and ADG. Marbling scores were similar among diets. Treated residues had $6.46 greater profit than control, when corn was priced at $3.00/bu. This difference increased to $21.42 and $36.30 and as corn price increased to $4.50 and $6.00 per bushel. Treated wheat straw had highest profit across diets and corn prices.

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