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Effects of Roughage Source and Level with the Inclusion of Wet Distillers Grains on Finishing Cattle Performance and Economics

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Summary

A finishing trial was conducted to evaluate roughage source and level compared to no roughage inclusion in finishing diets containing 30% (DM basis) wet distillers grains plus solubles (WDGS). Roughage sources included alfalfa hay, corn silage, or corn stalks fed at either a low (4% alfalfa hay) or high (8% alfalfa hay) level and sources were included on an equal NDF basis. In general, higher roughage levels increased DMI, ADG, and profit. However, steers fed 3% corn stalks performed similarly to steers fed high levels of roughage. When roughage was eliminated from the diet, DMI, ADG, and profit were decreased compared with diets containing corn stalks or high levels of alfalfa or corn silage. Results indicate at high roughage levels, sources can be exchanged on an equal NDF basis in finishing diets containing 30% WDGS (DM basis).

Introduction

Roughages such as alfalfa hay or corn silage have traditionally been used to control acidosis in finishing diets. More recently, corn milling by-products have been shown to help manage acidosis and it may be beneficial to change traditional roughage sources and levels in finishing diets when by-products are included. Research at Nebraska has shown when 35% wet corn gluten feed (WCGF; DM basis) was included in finishing diets, it was beneficial to reduce alfalfa hay from traditional levels (Farran et al., 2003 *Nebraska Beef Report*, pp. 61-63). The cost of roughages can vary, and at times, can be quite expensive sources of energy and nutrients. Reducing the inclusion level will lower roughage costs in a finishing diet. Another option may be to replace more expensive roughages with a lower cost roughage such as corn stalks.

The objectives of this study were to: 1) determine if roughage sources can be exchanged on an equal NDF basis in diets containing 30% WDGS (DM basis), and 2) determine the effects of roughage inclusion levels compared with no roughage inclusion in finishing diets containing 30% WDGS (DM basis).

Procedure

Three hundred eighty-five crossbred steer calves (BW = 763 ±63 lb) were used in a randomized complete block design. Upon arrival, steers were vaccinated and weaned on smooth bromegrass for approximately four weeks. Steers were then implanted with Synovex-C *(Fort Dodge Animal Health,* Fort Dodge, Iowa*)* and allowed to graze corn stalks for 45 days. While on stalks, steers were supplemented with 6 lb/head/day of a blend of WCGF and alfalfa (DM basis). Steers were brought back to the feedlot five days before initiation of the trial and limit-fed a diet consisting of 50% wet corn gluten feed and 50% alfalfa hay (DM basis) at 2% of body weight. On day 0 and day 1, steers were individually weighed in order to get an accurate initial weight and all steers were implanted with Revalor-S® (*Intervet, Millsboro, Deleware*). The weights from day 0 were used to assign steers to treatment. Steers were blocked by weight into three blocks, stratified by weight within block and assigned randomly to pen (11 steers/pen). There were two light, two medium, and one heavy weight blocks. Pens were assigned randomly to one of seven finishing diets within block (five pens/diet). During the trial, there were seven steers treated for polioencephalomalacia (PEM, polio, "brainer") and two of these steers were removed. Two other steers were removed due to death and 14 other steers were treated for other health reasons.

The seven dietary treatments (Table 1) consisted of a control (CON) with no roughage inclusion and two levels of roughage inclusion for alfalfa hay (LALF and HALF), corn silage (LCSIL and HCSIL), and corn stalks (LCSTK and HCSTK). Inclusion of alfalfa hay at 4 and 8% was used for the low and high inclusion level, respectively. Diets containing corn silage or corn stalks were then balanced to provide equal percentages of NDF from the roughage. This resulted in feeding approximately 6 or 12% corn silage or 3 or 6% corn stalks. All diets contained a mixture of dry-rolled and high-moisture corn fed at a 1:1 ratio and 30% WDGS (DM Basis). Diets were initially formulated to contain 3% dry supplement but on day 42, it was increased to 5%, replacing the corn mixture. The increase in dry supplement was done because of concerns that the supplement was not getting mixed sufficiently into the diets. All diets were formulated to contain a minimum of 0.65 % calcium, 0.60% potassium, and supply 360 mg/steer Rumensin® (*Elanco Animal Health, Greenfield, Ind.*), 90mg/steer Tylan® (*Elanco Anima Health*), and 130mg/steer thiamine daily. Feed ingredients were sampled weekly and dry matter was conducted by drying samples in a 60°C forced air oven for 48-hours. After the trial, all diet samples were

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composited by month and analyzed for CP and NDF.

The dry-rolled corn, high-moisture corn, and corn silage were grown at the Agriculture Research and Development Center near Mead, Neb. The corn silage was nonirrigated and yielded 16.7 ton/acre at 35% DM. The alfalfa hay was purchased at one time from one supplier, as were the baled corn stalks, in an attempt to reduce variation of roughage sources during the feeding period. The corn silage was coarsely chopped at harvest and ensiled in a plastic silo bag. Both the alfalfa hay and corn stalks were ground through a tub grinder using a 5-inch screen. Roughage particle size was determined using dry sieving and alfalfa, corn silage, and corn stalks had an average geometric mean diameter of 1,498, 2,927, and 4,323 μm, respectively. As mentioned, alfalfa hay and corn stalks were both ground through a tub grinder with the same screen from a practical standpoint, however, they did not grind to the same particle size. Wet distillers grains plus solubles were obtained from a commercial ethanol plant (*Abengoa Bioenergy,* York, Neb.) and delivered on an as needed basis (approximately 1 load /week).

Cattle were adapted to grain by feeding a roughage mixture composed of alfalfa hay, corn silage, and corn stalks on an equal NDF basis which replaced the corn mixture in the final diets. There were five steps formulated to supply NDF equal to 45% , 35%, 25%, 15%, and 8% alfalfa hay (DM basis). The five steps were fed for 3, 4, 6, 6, and 5 days, respectively, where the corn replaced the roughage mixture. Steers fed diets containing higher roughage levels, 6-12%, were fed their respective forage at step 5 (NDF supply equal to 8% alfalfa hay). Steers fed diets containing low levels or no roughage were fed their respective diet on day 25. Steers were fed once daily and allowed ad libitum access to feed and water. All cattle were supplemented with Optaflexx™ (*Elanco Animal Health*) the last 28 days of the feeding period at a rate of 200 mg/ steer daily. Cattle were fed for 139 days (January 25, 2006 to June 12, 2006) and harvested at a commercial packing plant (*Greater Omaha Pack,* Omaha, Neb.) Hot carcass weight and liver score were collected the day of harvest and 12th rib fat, LM area, and USDA called marbling score were collected following a 24-hour chill. Yield grade was calculated using the following equation (YG = (2.50 + (0.0038*HCW, lb) + (0.2*2.0% KPH) + (2.5*12th rib fat, in) - (0.32*LM area, in^2)) published in the Meat Industry Handbook, 2001. Final BW, ADG, and feed:gain were calculated using hot carcass weight divided by an average dressing percentage of 63%.

Economic analysis was performed for all diets and seven-year average pricing (1998-2004) was used. Initial steer price was calculated as average initial BW of a pen multiplied by the USDA Nebraska auction markets 1998 to 2004 average January calf price ($84.67/cwt) for a 600 to 700 lb calf. Final selling price was calculated as average live final BW of a pen multiplied by the USDA Nebraska markets 1998 to 2004 average June fed steer price ($71.74/cwt). Seven year average prices during the months of January to June were used for corn ($4.49/cwt) and alfalfa hay ($69.67/ton DM, baled). The price used for corn stalks was $55.87/ton DM, baled. Adjustments used for corn processing were from previous research at Nebraska (Cooper et al., *2001 Nebraska Beef Report,* pp. 51-54) and a cost of $8.00/ton DM was used for grinding alfalfa hay and corn stalks. The price for corn silage was calculated according to Guyer and Duey (NebGuide G99) using the average corn price. The price for WDGS was priced at 95% the price of corn. Cattle were charged a cost of $0.26/steer daily for the last 28 days of the finishing period for the cost of Optaflexx™. Feed ingredient costs (DM basis) were ground alfalfa hay ($81.76/ton), corn silage ($72.48/ton), corn stalks ($67.23), dry-rolled corn ($91.40/ton), high-moisture corn ($92.14/ton), WDGS ($85.20/cwt), and dry supplement ($100/ton). Ration prices of the finishing diet for each treatment are listed in Table 1.

Total finishing cost includes health cost, feed cost, yardage, death loss, and interest charges. Steers were charged $16.66 for health and processing costs. Feed costs were calculated by multiplying the cost of each diet by the average DMI for that diet. Yardage was charged at a rate of $0.33/steer daily. A 1.5% death loss was used for all treatments. Interest was charged using prime interest rate plus 1% (7.6%) for all costs. Simple interest was charged on initial steer cost and health over the entire ownership. Interest was charged on feed and yardage costs for half the finishing period. Total cost of production includes total finishing costs and initial steer cost.

Table 1. Composition of finishing diets and formulated nutrient analysis[a].

Treatments[b]:	CON	LALF	LCSIL	LCSTK	HALF	HCSIL	HCSTK
DRC	32.50	30.50	29.44	30.98	28.50	26.37	29.46
HMC	32.50	30.50	29.44	30.98	28.50	26.37	29.46
WDGS	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Alfalfa Hay	—	4.00	—	—	8.00	—	—
Corn Silage	—	—	6.13	—	—	12.26	—
Corn Stalks	—	—	—	3.04	—	—	6.08
Dry Supplement[c]	5.0	5.0	5.0	5.0	5.0	5.0	5.0
CP, %	16.4	16.7	16.3	16.3	17.0	16.3	16.1
Roughage NDF, %[d]	0.00	2.44	2.65	2.30	4.89	5.31	4.60
Ration Cost, $/ton	90.21	89.81	89.03	89.46	89.41	87.84	88.72

[a]Values presented on a DM basis.
[b]CON = Control, LALF = low alfalfa hay, LCSIL = low corn silage, LCSTK = low corn stalks, HALF = high alfalfa hay, HCSIL = high corn silage, and HCSTK = high corn stalks.
[c]All diets were formulated to contain a minimum of 0.65 % calcium, 0.60% potassium, 360 mg/steer daily Rumensin®, 90mg/steer daily Tylan®, and 130mg/steer daily thiamine. 200mg/steer daily Optaflexx™ was fed for the least 28 days.
[d]Roughage NDF: NDF supplied from roughage source included in the diet.

Table 2. Effects of roughage source and level compared to no roughage inclusion on performance, carcass characteristics, and economics of steers fed finishing diets containing 30% WDGS .

Treatments[a]:	CON	LALF	LCSIL	LCSTK	HALF	HCSIL	HCSTK	SEM	P-value
Roughage Inclusion[b]:	0.00	4.00	6.13	3.04	8.00	12.26	6.08		
Performance									
Final BW, lb[c]	1365^{w}	1396^{wxy}	1392^{wx}	1432^{z}	1425^{yz}	1422^{xyz}	1430^{z}	11	<0.01
DMI, lb/day	22.3^{w}	24.4^{x}	24.3^{x}	25.0^{xy}	25.7^{y}	25.3^{y}	25.6^{y}	0.3	<0.01
ADG, lb	4.33^{w}	4.54^{wx}	4.52^{w}	4.79^{y}	4.76^{xy}	4.75^{xy}	4.80^{y}	0.08	<0.01
Feed:gain[d]	5.14	5.37	5.36	5.20	5.41	5.33	5.32	0.04	0.09
Carcass Characteristics									
HCW, lb	860^{w}	879^{wxy}	877^{wx}	902^{z}	898^{yz}	896^{xyz}	901^{z}	7	<0.01
12th rib fat, in	0.57^{w}	0.65^{y}	0.58^{wx}	0.66^{y}	0.64^{y}	0.63^{xy}	0.66^{y}	0.02	<0.01
LM area, in^{2}	13.7	13.6	14.1	13.9	13.7	13.9	13.7	0.2	0.81
Marbling score[e]	489	497	494	489	503	501	510	11	0.37
Choice or above, %	39.8	47.4	46.0	45.6	59.4	44.0	52.2	5.9	0.80
Yield grade[f]	3.20^{wx}	3.52^{y}	3.16^{w}	3.54^{y}	3.52^{y}	3.44^{xy}	3.56^{y}	0.09	0.01
Liver Abscesses[g]	3	3	3	6	0	2	4		
Economics									
Cost of gain, $[h]	40.58	40.83	40.60	38.93	40.03	39.00	39.42	0.56	0.10
Breakeven, $[i]	65.16^{w}	64.70^{wx}	64.43^{wx}	63.31^{y}	63.83^{xy}	63.43^{y}	63.42^{y}	0.41	0.02
P/L, $[j]	91.73^{w}	100.74^{wx}	100.85^{wx}	122.63^{y}	114.57^{xy}	118.98^{xy}	121.31^{y}	6.73	0.02

[a]CON = Control, LALF = low alfalfa hay, LCSIL = low corn silage, LCSTK = low corn stalks, HALF = high alfalfa hay, HCSIL = high corn silage, and HCSTK = high corn stalks.
[b]Inclusion level of each roughage source in the finishing diet (DM basis).
[c]Final BW calculated as hot carcass weight divided by a common dressing percentage of 63%.
[d]Analyzed as gain:feed, reciprocal of feed conversion.
[e]Marbling score: 400 = Slight 0, 450 = Slight 50, 500 = Small 0, etc.
[f]Yield grade: 2.50 + (0.0038*HCW, lb) + (0.2*2.0% KPH) + (2.5*12th rib fat, in) - (0.32*LM area, in^{2}).
[g]Liver Abscesses: Number of A- liver abscesses observed, only A- liver scores were observed in this study.
[h]Cost of gain: (feed cost + health cost + yardage + interest + death loss) / (Final BW - Initial BW).
[i]Breakeven: (Initial steer cost ($84.67/cwt) + feed cost + health cost + yardage + interest + death loss) / Final BW.
[j]Profit or loss: Final steer value ($71.74/cwt) - (Initial steer cost ($84.67/cwt) + feed cost + health cost + yardage + interest + death loss) .
^{w,x,y,z}Means in a row with unlike superscripts differ *(P*<0.05).

Cost of gain was calculated by dividing total finishing cost by the average gain for each pen. Slaughter breakeven was calculated by dividing the total cost of production by the carcass-adjusted final BW. Profit or loss (P/L) was calculated by subtracting the total cost of production from the final steer value.

Data were analyzed using the Mixed procedure of SAS (*Version 9.1,* SAS Inc., Cary, N.C.) as a randomized complete block design, with pen serving as the experimental unit. All treatments were analyzed using the Least Significance Difference method to separate least square means.

Results

Across treatments, final BW, DMI, and ADG were different *(P*<0.01; Table 2). Steers fed CON without any roughage inclusion had lower *(P*<0.01) DMI compared with steers fed roughages. There were no differences (*P*>0.05) in DMI observed between steers fed low roughage levels or between steers fed corn stalks or high levels alfalfa hay or corn silage. Steers fed CON had lower (*P*<0.05) final BW and ADG compared with steers fed corn stalks or high levels of alfalfa hay or corn silage. Final BW and ADG of steers fed CON and low levels of alfalfa or corn silage were not different (*P*> 0.05). For steers fed corn stalks, final BW and ADG were higher (*P*<0.05) compared with steers fed CON or low levels of alfalfa or corn silage but similar (*P*> 0.05) to steers fed high levels of alfalfa or corn silage. Additionally, no differences (*P*> 0.05) were observed between final BW of steers fed corn silage and LALF or between final BW and ADG of steers fed alfalfa hay and HCSIL. Feed:gain tended to be different (*P*=0.09) across treatments where feed conversion was lowest for steers fed CON and LCSTK and highest for steers fed HALF.

The only observed carcass characteristics differences were for fat thickness (*P*<0.01) and yield grade (*P*=0.01). Fat thickness of cattle fed CON was lower (*P*<0.05) compared with steers fed alfalfa, corn stalks, or HCSIL and was similar (*P*> 0.05) to cattle fed LCSIL. Yield grade of steers fed CON was lower (*P*<0.05) compared with steers fed alfalfa or corn stalks and was similar (*P*>0.05) to steers fed corn silage. There were no differences (*P*>0.05) in fat thickness between steers fed corn silage. Additionally, there were no differences observed for fat thickness or yield grade between steers fed alfalfa hay, corn stalks or HCSIL. There was a trend for cost of gain to be different (*P*=0.10) across treatments where cost of gain was lowest for steers fed corn stalks or HCSIL and highest for steers fed CON, LALF, or LCSIL. Breakeven and P/L was different (*P*=0.02) among treatments. There were no differences in breakeven or P/L (*P*>0.05) observed between steers fed CON or low levels of alfalfa hay or corn silage. For steers fed CON, breakeven was increased (*P*<0.05) and profit was decreased (*P*<0.05) compared with steers fed corn stalks or high levels of alfalfa hay

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or corn silage. Breakeven for steers fed low levels of alfalfa hay or corn silage were similar ($P > 0.05$) to cattle fed HALF and increased ($P < 0.05$) compared with steers fed HCSIL. Profit was similar ($P > 0.05$) between steers fed alfalfa hay and corn silage. There were no differences ($P > 0.05$) in breakeven and P/L between steers fed corn stalks and high levels of alfalfa or corn silage. However, for steers fed corn stalks, breakeven was decreased ($P < 0.05$) and profit was increased ($P < 0.05$) compared to steers fed CON or low levels of alfalfa or corn silage.

In general, higher roughage levels resulted in increased DMI, ADG, and live profit. The increase in DMI may be due to an energy dilution effect from increased roughage levels where cattle are attempting to eat to a constant energy level. It cannot be concluded that roughage sources can be exchanged on an equal NDF basis at all levels, because DMI, ADG, and profit of steers fed low levels of corn stalks was similar to steers fed high levels of roughage. However, at high roughage levels (6-12%), results from this study indicate roughage sources can be successfully exchanged on an equal NDF basis in finishing diets containing 30% WDGS (DM basis) without any effects on steer performance or economics. Furthermore, results indicate that in finishing diets containing 30% WDGS (DM basis) and low levels of roughage, it is beneficial to use corn stalks compared to alfalfa hay or corn silage. When roughage was eliminated from the diet, DMI, ADG, and profit was decreased compared to diets containing corn stalks or high levels of alfalfa hay or corn silage. Due to the differences in particle size of alfalfa hay and corn stalks, even though, from a practical standpoint, they were ground through a tub grinder using the same screen, it may be necessary to account for NDF digestibility or the physical effectiveness of NDF from roughage sources. The physical effectiveness of NDF is described as the percent of NDF from particles remaining on a 1.18 mm screen after dry sieving.

In conclusion, results from this study indicate it is not beneficial to completely eliminate roughage sources from a finishing diet containing 30% WDGS (DM basis). Overall, with the increase in supply and use of WDGS in the feedlot industry, along with the large supply and reasonable price of corn stalks in Nebraska, it appears that the use of corn stalks as a roughage source in diets containing WDGS is a viable option.

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