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2013 Beef Cattle Report (Whole Report)

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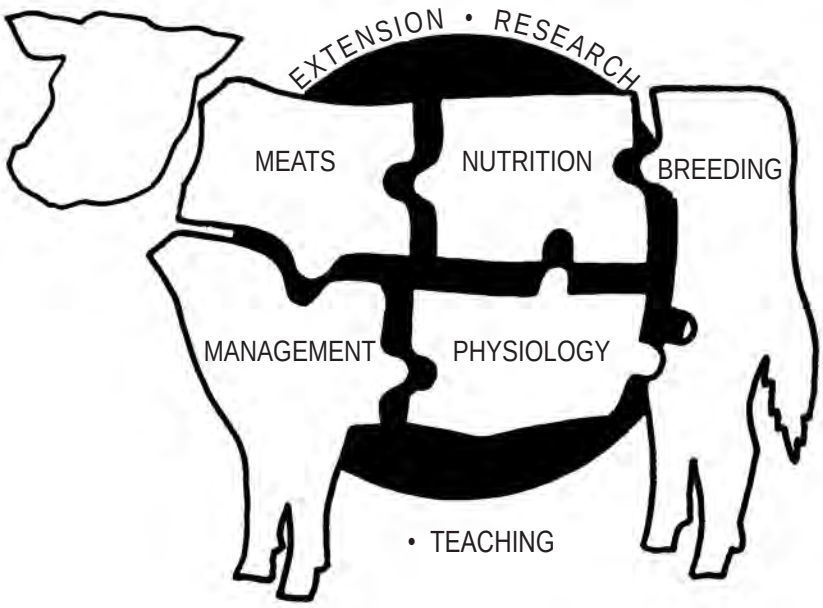

Agricultural Research Division
University of Nebraska Extension
Institute of Agriculture and Natural Resources
University of Nebraska–Lincoln

2013 Beef Cattle Report

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Effect of Beef Heifer Development System on ADG, Reproduction, and Feed Efficiency During First Pregnancy

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Stetson P. Weber
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Summary

This study evaluated the effect of post-weaning development system on heifer ADG, reproductive performance, and subsequent feed efficiency as a pregnant heifer. Heifers were developed on dormant pasture and grazed corn residue or dormant pasture and placed in a drylot. The following winter, a subset of pregnant heifers were placed in a Calan Broadbent individual feeding system during late gestation. Drylot-developed heifers had greater BW from pre-breeding through pregnancy diagnosis and greater overall ADG during development. However, there was no difference in reproductive performance. Pre-calving BW, ADG, and G:F tended to be greater for drylot heifers. Heifers developed on corn residue had reduced BW through early pregnancy; however, reproductive performance was similar to drylot-developed heifers.

Introduction

Previous literature suggests developing heifers to approximately 65% mature BW to maximize pregnancy rates (*Journal of Animal Science*, 1992, 70:4018-4035). Heifers developed to reduced proportions of mature BW are lighter through pregnancy diagnosis compared to heifers developed to greater proportions of mature BW (*Journal of Animal Science*, 2004, 82:3094-3099; *Journal of Animal Science*, 2008, 86:451-459; *Journal of Animal Science*, 2011, 89:1595-1602) and Roberts et al. (*Proceedings, Western Section American Society Animal Science*, 2009, 60:85-88) reported reduced BW through 5-years of age in heifers restricted feed 140 days post weaning compared to their nonrestricted contemporaries. This reduction in BW suggests reduced maintenance requirements and thus decreased production costs. Furthermore, reduced input production systems report similar reproductive performance when compared to contemporaries fed to a higher plane of nutrition or to a greater proportion of mature BW (*Journal of Animal Science*, 2001, 79:819-826; *Journal of Animal Science*, 2004, 82:3094-3099; *Journal of Animal Science*, 2008, 86:451-459; *Proceedings, Western Section American Society Animal Science*, 2009, 60:85-88; *Journal of Animal Science*, 2011, 89:1595-1602). The objective of this study was to determine the effect of post-weaning development system on heifer ADG, reproductive performance, and subsequent feed efficiency as a pregnant heifer.

Procedure

The University of Nebraska–Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in this experiment.

Developing Heifer Management

Weaned crossbred Angus heifers (n= 299) were received at the West Central Research and Extension Center (WCREC), North Platte, Neb. After a 14-day acclimation period, heifers were blocked by BW and randomly assigned to either graze corn residue (CR) or developed in the drylot (DL). Corn-residue heifers grazed dormant pasture 33 days prior to grazing CR 74 days. Subsequently, CR heifers were placed on dormant pastures 66 days prior to being placed in the DL for approximately 40 days for synchronization of estrus and AI. Drylot heifers grazed dormant forage pastures 98 days then were placed in the DL for 112 days. Drylot diet was formulated for heifers to reach 65% mature BW at the beginning of the breeding season. During winter grazing (dormant pasture and corn residue) all heifers were offered 1 lb/day (28% CP) distillers-based supplement. Forty days prior to AI, CR and DL heifers were managed together and fed a common diet. Prior to the breeding season blood samples were collected 10 days apart via coccygeal venipuncture to determine plasma progesterone concentration. Heifers with plasma progesterone concentrations >1.0 ng/mL were considered pubertal.

Estrus was synchronized utilizing the melengestrol acetate-prostaglandin (MGA-PGF) synchronization protocol with heifers fed 0.5 mg/head MGA for 14 days and administered a single injection of PGF 19 days after the end of MGA feeding. Estrus detection was performed for 5 days following PGF administration. Each year heifers were randomly AI to one of four bulls approximately 12 hours after standing estrus. Approximately 10 days following the last day of AI heifers were exposed to bulls (1 bull to 50 heifers) for 60 days. Artificial insemination and overall pregnancy rates were determined 45 days after AI and 45 days after bull removal, respectively, via transrectal ultrasonography.

Primiparous Heifer Management

All heifers remained in a common group through the summer grazing native pasture. After final pregnancy diagnosis, a subset of heifers (year 1 = 38; year 2 = 40; year 3 = 36) confirmed AI pregnant were placed in a Calan Broadbent individual feeding system during late gestation. Heifers were allowed approximately 25 days to adapt to the individual feeding system followed by an 84-day feeding trial. Heifers were offered ad libitum grass hay and either no supplement, 2 lb/

(Continued on next page)

day distillers-based supplement, or 2 lb/day dried corn gluten-based supplement. Supplements were formulated to be isocaloric and isonitrogenous but differed in rumen undegradable protein. Feed offered was recorded daily and refusals were removed and weighed weekly. Residual feed intake (RFI) was calculated as the actual DMI minus the predicted DMI, with DMI calculated based on NE values of the feed to account for different energy levels of the supplement compared to the control diet.

After calving, heifers remained at WCREC through breeding. Artificial insemination utilized a fixed-timed AI protocol and pairs were transported 27 miles to a commercial ranch in the Nebraska Sandhills for summer grazing. A single bull was placed with heifers approximately 10 days after AI for 60 days. Pairs were returned to WCREC prior to weaning for final pregnancy diagnosis.

Statistical Analysis

Data were analyzed using the MIXED and GLIMMIX procedures of SAS. Year was the experimental unit for heifer development data with development system as the fixed effect. A subset of animals from each development system were placed in 1 of 4 pens where individual feeding occurred. This development by pen classification was included as a random variable and considered the experimental unit for individual feeding data with developmental treatment and barn diet as fixed effects and year considered a random effect. Heifer development × second winter treatment interaction was not significant and was removed from the model. For the individual feeding period, heifer development × barn treatment interaction was not significant, thus all data are presented as the effect of heifer development system. A P-value ≤ 0.05 was considered significant.

Table 1. Effect of winter heifer development system on BW, ADG, and reproductive performance.

Item	CR[1]	DL[2]	SEM	P-value
n	150	149		
Initial BW, lb	486	485	6	0.93
Prebreeding BW, lb	692	770	19	0.01
AI pregnancy check BW, lb	767	816	25	0.02
Pregnancy check BW, lb	888	931	20	0.05
ADG, lb/day				
Overall[3]	0.94	1.30	0.06	0.01
Dec-Feb[4]	0.10	0.14	0.27	0.64
Feb-April[5]	1.22	2.40	0.17	0.04
April-May[6]	1.78	1.28	0.28	0.25
June-July[7]	1.15	0.86	0.12	0.24
July-Sept[8]	1.70	1.65	0.66	0.61
Cycling[9], %	42	52	15	0.46
AI pregnant, %	69	63	7	0.33
Pregnant, %	93	91	2	0.41
Mature BW, %	57	63	2	0.01

[1]CR = heifers grazed dormant pastures 33 days, corn residue 74 days, and were placed on dormant pastures 66 days prior to entering the drylot 40 days before AI.
[2]DL = heifers grazed dormant pastures 98 days prior to entering the drylot 112 days before AI.
[3]ADG from initiation to prebreeding.
[4]ADG while grazing dormant pasture and corn residue (CR) or dormant pasture (DL).
[5]ADG while grazing dormant pasture (CR) or while in drylot (DL).
[6]ADG while in the drylot.
[7]ADG from the beginning of the breeding season to AI pregnancy detection.
[8]ADG from AI pregnancy to final pregnancy detection.
[9]Considered cycling if blood serum progesterone concentrations were >1 ng/mL.

Results

Heifer Development BW Gain and Reproduction

Data for heifer development BW gain are reported in Table 1. Body weight was similar for CR and DL heifers at the beginning of the experiment. However, prior to breeding, DL heifers were 78 lb (± 19 lb) heavier (P = 0.01) than CR-developed heifers. Body weight remained greater for DL heifers at AI pregnancy diagnosis (P = 0.02) and final pregnancy diagnosis (P = 0.05) compared to CR heifers.

Overall ADG was greater (P = 0.01) for DL heifers compared to CR heifers. Drylot-developed heifers also had greater (P = 0.04) ADG from February to April compared to CR heifers. This coincides with the time DL heifers were removed from dormant pasture and placed in the DL, and the CR heifers were moved from CR to dormant pasture. However, ADG was similar between CR and DL heifers while both groups were in the DL prior to breeding, and remained similar through AI pregnancy diagnosis.

Although ADG was greater through development for DL compared to CR heifers, there was no difference in the proportion of heifers attaining puberty prior to the breeding season (Table 1). Martin et al., (*Journal of Animal Science*, 2008, 86:451-459) also reported no significant difference in attainment of puberty for heifers fed to 51 vs. 57% mature BW. However, Funston and Larson (*Journal of Animal Science*, 2011, 89:1595-1602) reported decreased puberty in heifers developed on winter range and CR- compared to DL-developed heifers (56 vs. 65% mature BW, respectively). There were no differences in AI pregnancy (69 vs. 63 ± 7%) or final

Table 2. Effect of winter heifer development system on late gestation ADG, feed efficiency and reproductive performance through the subsequent breeding season.

Item	CR[1]	DL[2]	SEM	*P*-value
n	58	56		
Initial BW, lb	989	992	19	0.76
Pre-calving BW, lb	1116	1138	20	0.08
DMI, lb/day	22.35	22.36	0.22	0.96
NE DMI, lb/day[3]	11.57	11.59	0.51	0.92
ADG, lb/day	1.54	1.76	0.09	0.09
RFI, NE[4]	0.458	-0.064	0.244	0.33
G:F	0.068	0.078	0.013	0.07
Gestation length, day	276	276	0.66	0.77
Birth date, Julian	60	61	1.42	0.37
Calf birth BW, lb	72	74	1.58	0.39
Calving ease	1.38	1.48	0.11	0.53
Prebreeding BW, lb	972	974	14	0.89
Pregnancy check BW, lb	1063	1046	56	0.64
Pregnant, %	83	81	17	0.83

[1]CR = heifers grazed dormant pastures 33 days, corn residue 74 days, and were placed on dormant pastures 66 days prior to entering the drylot 40 days before AI.
[2]DL = heifers grazed dormant pastures 98 days prior to entering the drylot 112 days before AI.
[3]DMI based on feed net energy values (NRC, 2000).
[4]Residual feed intake (RFI) = actual intake − predicted intake.

pregnancy rates (93 vs. 91 ± 2%; Table 1) for CR and DL, respectively.

Primiparous Heifer Feed Efficiency

Data for primiparous heifers placed in the Calan Broadbent individual feeding system during late gestation are reported in Table 2. Pre-calving BW tended to be greater ($P = 0.08$) for DL compared to CR heifers at the end of the 84 day individual feeding period. There was no difference in DMI or DMI based on feed NE. Average daily gain and G:F tended to be greater ($P = 0.09$; = 0.07, respectively) for DL-compared to CR-developed heifers. Gestation length, calf birth BW, and calving ease did not differ among treatments. Pre-breeding BW did not differ between treatments as first-calf heifers and proportion pregnant at weaning was also similar for DL-compared to CR-developed heifers.

Traditional DL development systems would place heifers in DL shortly after weaning. In this experiment, developing heifers on dormant pasture followed by DL increased heifer BW from the end of the development period through pregnancy diagnosis compared to CR-developed heifers. However, reproductive and calving performance was similar between treatments. Reproductive performance was maintained by developing heifers with reduced harvested forage.

[1]Adam F. Summers, graduate student; T.L. Meyer, research technician; Stetson P. Weber, former graduate student; Rick N. Funston, professor, West Central Research and Extension Center, North Platte, Neb.

Effect of Development System on Heifer Performance and Primiparous Heifer Grazing Behavior

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Summary

The effect of heifer development system on primiparous heifer performance grazing corn residue during late gestation was investigated. Weaned heifers grazing corn residue tended to have reduced final BW after corn residue grazing compared to heifers grazing winter range. However reproductive performance for the two treatments was similar. When grazing corn residue as pregnant heifers during late gestation, heifers developed on corn residue had improved ADG compared to drylot-developed heifers and tended to have increased ADG compared to winter range-developed heifers. Adaptation to corn residue grazing as a developing heifer improves primiparous heifer performance grazing corn residue during late gestation.

Introduction

The greatest cost of heifer development is feed. Reducing harvested forage use could decrease heifer development costs. However, previous reports indicate heifers developed on dormant forages have reduced BW through pregnancy diagnosis compared to drylot-developed heifers, although overall pregnancy rate is similar (*Journal of Animal Science*, 2011, 89:1595-1602). Larson et al. (*Journal of Animal Science*, 2011, 89:2365-2372) reported a trend for increased ADG for heifers developed on winter range (WR) compared to corn residue (CR) in one experiment, but no difference was reported in the second experiment. Variation in results were attributed to differences in location and winter precipitation in which CR heifers were offered hay during CR grazing due to snow cover.

Grazing habits can be developed through social interaction, with young or naïve animals learning what to eat from their contemporary groups (*Applied Animal Behaviour Science*, 1990, 25:25-33; *Journal of Chemical Ecology*, 1993, 19:313-323). Furthermore, it is suggested cattle naïve to corn residue grazing require an acclimation period (*1989 Nebraska Beef Cattle Report*, pp. 11-15; *1990 Nebraska Beef Cattle Report*, pp. 51-53). This study was conducted to evaluate the effect of heifer development systems on ADG and reproductive performance, and to determine the effects of winter development system on subsequent adaptation to corn residue in late gestation.

Procedure

The University of Nebraska–Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in this experiment.

Heifer Development Management

Over a four-year period, 382 weaned crossbred heifers (Red Angus × Simmental) were blocked by BW and randomly assigned to either graze WR throughout development or graze WR and CR. Winter-range heifers grazed upland Sandhills pastures continuously through the 221-day development period at the Gudmundsen Sandhills Laboratory (GSL), Whitman, Neb. Corn residue-developed heifers grazed WR 30 days prior to being shipped approximately 90 miles to graze CR for 82 days. Following CR grazing, heifers were returned to GSL and managed similarly with WR-developed heifers for approximately 109 days prior to the breeding season. All heifers received 1 lb/day of 28% CP supplement throughout development.

Prior to the breeding season, blood samples were collected 10 days apart via coccygeal venipuncture to determine plasma progesterone concentration. Heifers with plasma progesterone concentrations >1.0 ng/mL were considered pubertal. Estrus was synchronized with a single 5 mL injection of prostaglandin (PGF) administered 108 hours after bulls were exposed to heifers. Bulls remained with heifers for 45 days (1 bull to 25 heifers). Heifers remained on Sandhills upland range through final pregnancy diagnosis in September.

Additionally, heifers were developed at the West Central Research and Extension Center (WCREC), North Platte, Neb., and grazed WR and CR or WR and placed in the drylot (DL). Heifers were fed MGA for 14 days and administered a single injection of PGF 19 days after the end of MGA feeding. Estrus detection was performed for five days following PGF administration and AI performed approximately 12 hours after standing estrus. Approximately 10 days following the last day of AI, heifers were exposed to bulls (1 bull to 50 heifers) for 60 days.

Primiparous Heifer Management

A subset of pregnant heifers from GSL (n = 200) and WCREC (n = 214) were blocked by weight and assigned to one of three CR fields based on previous development system: 1) a naïve group composed of WR- and DL-developed heifers with no previous CR grazing exposure, 2) a group developed on CR, and 3) a mixture of WR-, DL-, and CR-developed heifers. Heifers were transported to corn fields and grazed approximately 82 and 79 days for GSL and WCREC heifers, respectively, based on CR availability over the four years. While grazing, all heifers received the equivalent of 1 lb/day of 28% CP supplement three times weekly.

Table 1. Effect of winter heifer development system on ADG and reproduction in beef replacement heifers[1].

Item	CR[2]	WR[3]	SEM	*P*-value
n	192	190		
Initial BW, lb	479	481	7	0.71
Final BW, lb	517	533	11	0.09
Pre-breeding BW, lb	631	639	5	0.27
Pregnancy diagnosis BW, lb	786	794	4	0.28
Pregnancy diagnosis BCS	5.9	5.9	0.1	0.45
ADG, lb/day				
Winter grazing[4]	0.43	0.60	0.10	0.11
Pre-breeding[5]	0.82	0.84	0.07	0.51
Summer[6]	1.64	1.64	0.11	0.97
Range[7]	1.41	1.35	0.05	0.17
Cycling[8], %	47	43	6	0.41
Pregnancy rate, %	82	86	3	0.29

[1]Heifers developed at Gudmundsen Sandhills Laboratory Whitman, Neb.
[2]CR= heifers were developed grazing winter range 30 days, then corn residue 82 days and upland range 109 days and offered the equivalent of 1 lb/day 28% CP supplement three times per week.
[3]WR= heifers were developed grazing winter range 221 days and offered the equivalent of 1 lb/day 28% CP supplement three times per week.
[4]ADG while heifers grazed CR or WR.
[5]ADG in the period between weaning and the beginning of the breeding season.
[6]ADG in the period between the beginning of the breeding season and pregnancy detection.
[7]ADG in the period between CR removal and pregnancy detection.
[8]Considered cycling if blood serum progesterone concentrations were >1 ng/mL.

Table 2. Effects of heifer development system on ADG while grazing corn residue during late gestation[1].

Item	CR[2]	WR[3]	SEM	*P*-value
n	99	101		
Initial BW, lb	862	867	13	0.68
Final BW, lb	932	921	14	0.40
Initial BCS	5.4	5.4	0.1	0.16
Final BCS	5.3	5.2	0.1	0.24
BCS change	-0.17	-0.16	0.13	0.84
ADG, lb/day	0.95	0.74	0.17	0.07

[1]Heifers developed at Gudmundsen Sandhills Laboratory Whitman, Neb.
[2]CR= heifers were developed grazing winter range 30 days, then corn residue
82 days and upland range 109 days and offered the equivalent of 1 lb/day 28% CP supplement three times per week.
[3]WR= heifers were developed grazing winter range 221 days and offered the equivalent of 1 lb/day 28% CP supplement three times per week.

Statistical Analysis

Data were analyzed utilizing the MIXED and GLIMMIX procedures of SAS. Heifers were developed at two locations and treatments repeated four years. Year was considered the experimental unit, with development treatment the fixed effect. Year was also included as a random effect in the model. A *P*-value ≤ 0.05 was considered significant.

Results

Heifer Development Performance

Performance data for heifers developed at GSL are reported in Table 1. Final BW tended (*P* = 0.09) to be greater for WR-developed heifers compared to CR-developed heifers (533 vs. 517 ± 11 lb) after the 89 day CR grazing period. However, pre-breeding BW was similar for CR and WR heifers. Larson et al. (*Journal of Animal Science*, 2011, 89:2365-2372) reported similar findings, utilizing the same cow herd, with increased final BW after the CR grazing period for WR compared to CR-grazed heifers. Furthermore, WR heifer pre-breeding BW tended to be greater compared to CR-developed heifers, whereas in the current study pre-breeding BW did not differ. It has been reported that cattle grazing CR require an adaptation period (*1989 Nebraska Beef Cattle Report*, pp. 11-15; *1990 Nebraska Beef Cattle Report*, pp. 51-53). Winter range-developed heifers remained at GSL throughout the development period and did not need to adapt to new forages and grazing behaviors. These factors likely contributed to heavier BW in WR-developed heifers compared to CR heifers.

Although there was a tendency (*P* = 0.11) for ADG to be greater for WR heifers developed at GSL while CR heifers grazed CR, there were no differences in ADG while both WR and CR grazed WR prior to the beginning of the breeding season. Furthermore, the proportion of heifers attaining puberty prior to the breeding season and overall pregnancy rates were similar between WR and CR heifers. Heifer development data for WCREC heifers are reported in the *2013 Nebraska Beef Cattle Report,* pp. 5-7.

Primiparous Heifer Performance

There were no differences in primiparous heifer performance based on CR grazing groups from GSL or WCREC, thus data are reported based on heifer development system (WR vs. CR and CR vs. DL, respectively). There was no difference in initial or final BW between CR- and WR-developed heifers from GSL grazing CR during late pregnancy (Table 2). However, initial BW was 59 lb (± 8 lb) greater (*P* = 0.01) for DL compared to CR heifers developed at WCREC and final BW tended to be

(Continued on next page)

greater (1,033 vs. 1,000 ± 26 lb; $P = 0.06$) for DL compared to CR heifers (Table 3). Average daily gain was two times greater ($P = 0.03$) for CR compared to DL heifers while grazing CR as pregnant heifers (Table 3). Similarly, there was a trend ($P = 0.07$) for increased ADG for CR-compared to WR-developed heifers grazing CR (Table 3). Both DL- and WR-developed heifers were naïve to CR grazing as pregnant heifers, whereas CR heifers grazed CR during development. Reduced ADG in DL- and WR-developed heifers is likely due to increased adaptation time to grazing CR required by naïve cattle placed on CR (*1989 Nebraska Beef Cattle Report*, pp. 11-15, *1990 Nebraska Beef Cattle Report*, pp. 51-53).

Developing heifers on CR tended to reduce BW at the end of the grazing period compared to WR-developed heifers developed at GSL; however, reproductive performance was similar between treatments. Furthermore, grazing heifers on CR during development improves ADG of primiparous heifers placed on CR during late gestation compared to DL-developed heifers, and it tends to improve ADG of CR-developed heifers compared to WR-developed heifers supporting the hypothesis of a learned effect for grazing CR.

Table 3. Effect of heifer development system on ADG while grazing corn residue during late gestation[1].

Item	CR[2]	DL[3]	SEM	*P*-value
n	107	107		
Initial BW, lb	945	1004	8	0.01
Final BW, lb	1000	1033	26	0.06
ADG, lb/day	0.66	0.32	0.29	0.03

[1]Heifers developed at West Central Research and Extension Center North Platte, Neb.
[2]CR= heifers were developed grazing dormant pastures 33 days, corn residue 79 days, dormant winter pastures 66 days and were offered the equivalent of 1 lb/day 28% CP supplement three times per week prior to entering the drylot 40 days before AI.
[3]DL= heifers were developed grazing dormant pastures 98 days and were offered the equivalent of 1 lb/day 28% CP supplement three times per week prior to entering the drylot 112 days before AI.

[1]Adam F. Summers, graduate student; T.L. Meyer, research technician; Jacqueline A. Musgrave, research technician; Stetson P. Weber, former graduate student; Rick N. Funston, professor, West Central Research and Extension Center, North Platte, Neb.

Heifers with Low Antral Follicle Counts Have Low Birth Weights and Produce Progeny with Low Birth Weights

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Summary

To determine the relationship of antral follicle count and heifer BW, reproductive tract characteristics, and first-calf performance, Red Angus-composite heifers were used over three years. High antral follicle count heifers had greater BW from birth through pre-breeding. Progeny birth BW was greater for calves born to high antral follicle count heifers compared to low antral follicle count heifers. Taken together these data indicate a relationship between antral follicle counts and BW through the first breeding season and corresponding progeny, and continues to support a possible link between genes that influence growth and development and establishment of ovarian reserve.

Introduction

At birth, heifer ovaries contain 10,000 to 350,000 healthy follicles, and the number decreases approximately 20% within the first year of life (*Journal of Animal Science,* 1966, 25:800-805). Longevity of a beef cow is related to reproductive success (*Journal of Animal Science*, 2009, 87: 1971-1980) and thus cows with a smaller ovarian reserve may deplete their reserve sooner, resulting in earlier removal from the herd.

Size of the ovarian reserve has been predicted via ultrasonography and recorded as antral follicle count (AFC; *Biology of Reproduction*, 2008, 79:1219-1225). The size of the ovarian reserve has been correlated to fertility, with low AFC heifers having reduced pregnancy rates compared to high AFC heifers (*Journal of Animal Science*, 2009, 87: 1971-1980). Furthermore, maternal diet can impact progeny ovarian reserve. Initial reports indicated a correlation between birth BW and ovarian reserve in sheep (*Reproduction*, 2002, 123:769-777; *Placenta*, 2003, 24:248-257); however, recent reports demonstrate maternal diet can influence ovarian reserve without affecting birth BW in heifers (*Reproduction, Fertility, Development*, 2009, 21:773-784). The objective of this study was to determine the relationship between AFC and heifer BW, reproductive characteristics, and first-calf performance.

Procedure

The University of Nebraska–Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in this experiment.

Weaned MARC III (1/4 Angus, 1/4 Hereford, 1/4 Red Poll, 1/4 Pinzgauer) × Red Angus composite heifers (n = 264; year 1 = 91, year 2 = 90, year 3 = 83) were utilized in this experiment. Heifers grazed a common fall pasture and were offered 4.4 lb/day (10.5% CP, DM basis) supplement for 30 days prior to the initiation of winter development treatment. In year 1, heifers were randomly assigned to either graze corn residue (CR) or dormant winter range from mid-November through mid-February. Heifers were offered 1 to 2 lb/day (31% CP, DM basis) supplement while grazing corn residue or dormant winter range. After the 119-day treatment period, heifers were placed in a common group on dormant forage pastures and grazed for approximately 100 days until the initiation of the breeding season. Heifers were offered 1 lb/day protein supplement during the 100-day grazing period. If weather impeded grazing, heifers were offered free-choice brome hay with CR heifers consuming 9.3 lb/day and WR heifers consuming 7.7 lb/day.

In years 2 and 3, heifers were randomly assigned to one of two groups and received either a dried distillers grain-based or corn gluten feed-based supplement offered at 0.59% (27% CP, DM) and 0.78% BW (20% CP, DM), respectively, from mid-November through May. Supplements were formulated to be isocaloric but differed in rumen undegradable protein. All heifers were fed *ad libitum* meadow hay through winter while grazing dormant pasture.

Prior to breeding, heifers underwent transrectal ultrasonography. One technician scanned each ovary using an Aloka-500 linear array transrectal probe (7.5-MHZ transducer) and counted small (3-5 mm), medium (6-10 mm), and large (> 10 mm) follicles. Follicles counted on each ovary were summed to determine AFC. Heifers were assigned a categorical score based on AFC and were considered low (≤ 15 follicles; LOW), moderate (16-25 follicles; MOD), or high (≥ 26 follicles, HIGH). Uterine horn diameter, presence of CL, and ovarian length and height were also determined. Each heifer received a reproductive tract score (RTS) based on the methods reported by Martin et al. (*Journal of Animal Science*, 1992, 70:4006-4017).

Estrus was synchronized with two injections of prostaglandin $F_{2\alpha}$ (PGF) administered 14 days apart. Estrus detection was performed five days following the second injection. Heifers observed in estrus were artificially inseminated approximately 12 hours after initial estrus detection. Approximately 10 days after AI heifers were placed with fertile bulls for 45 days. In year 1, due to poor response of synchronization, all heifers not artificially inseminated were injected with PGF 10 days after the second injection was administered to resynchronize estrus. Conception rates for both AI and total pregnancy rates were determined via rectal palpation approximately 45 days following AI and bull removal, respectively.

Statistical Analysis

A mixed linear model that included the fixed effects of categorical AFC

(Continued on next page)

score and development treatment with year and heifer age fitted as random effects was used. The AFC classification x development treatment interaction was not significant and was removed from the model. Heifer progeny data model included maternal AFC classification as the fixed effect and calf sex and year as random effects.

Results

Data for the effect of heifer AFC classification on BW, ADG, and reproductive characteristics and performance are reported in Table 1. High AFC heifers had greater ($P = 0.04$) birth BW compared to LOW heifers (79.8 vs. 75.9 ± 1.4 lb). These data agree with Cushman et al. (*Journal of Animal Science*, 2009, 87: 1971-1980) reporting an approximate 7 lb increase in birth BW for HIGH compared to LOW heifers. Weaning BW was 30 lb (± 11 lb) greater ($P < 0.01$) for HIGH compared to LOW heifers. Furthermore, when using 205-day adjusted BW, BW remained greater ($P = 0.02$) for HIGH compared to LOW heifers. Body weight was greater ($P < 0.01$) at pre-breeding for HIGH compared to MOD and LOW heifers; however, at pregnancy diagnosis after summer grazing, BW was similar ($P = 0.77$) between AFC classifications. Previous literature regarding the relationship of birth weight and ovarian reserve has been reported for sheep and cattle (*Reproduction*, 2002, 123:769-777; *Placenta*, 2003, 24:248-257; *Journal of Animal Science*, 2009, 87: 1971-1980). However, these studies did not demonstrate a relationship between ovarian reserve and BW at weaning or pre-breeding as is reported in the current study. Although not correlating ovarian reserve and BW, Silva et al. (*Livestock Science*, 2006, 99:51-59) did report a genetic correlation of 0.15 for cow stayability and 550-day BW in Nelore cows.

Average daily gain, based on 205-day adjusted weaning BW was greater ($P = 0.04$) for HIGH heifers compared to LOW heifers prior to weaning (2.37 vs. 2.27 ± 0.08 lb/day). Furthermore, post-weaning ADG to pre-breeding tended ($P = 0.08$) to be greater for HIGH compared to LOW heifers. Reproductive tract score, proportion of heifers with a CL present at AFC, and AI pregnancy rates did not differ ($P > 0.30$) among AFC classifications. Overall pregnancy rates, although not significant, had a tendency ($P = 0.15$) to be approximately 9% greater for HIGH compared to MOD and LOW heifers. Our data are similar to previous reports of a significant increase in overall pregnancy rates for HIGH compared to LOW heifers (*Journal of Animal Science*, 2009, 87: 1971-1980) and cows (*Journal of Dairy Science*, 2012, 95: 2355- 2361).

At calving, HIGH heifers gave birth to larger ($P = 0.02$) calves compared to LOW heifers (Table 1). However, the effect of maternal AFC on calf birth BW appears to be sex specific. Heifer calves born to HIGH heifers had a 7 lb (±2 lb) increase ($P < 0.01$) in birth BW compared to heifers born to MOD and LOW heifers; however, there was no difference in bull calf birth BW due to maternal AFC (not reported). Birth weight has been reported to impact survivability in several species, with reduced birth BW causing increased mortality rates (*Australian Veterinary Journal*, 1956, 32:289-298; *Theriogenology*, 1987, 28:573-586). Too great an increase in birth BW, potentially causing dystocia, has more commonly been the cause of early death in beef calves than reduced birth BW (*Theriogenology*, 1987, 28:573-586).

Profitability of a beef cow-calf producer is related to longevity of cows, with most cows leaving the herd due to reproductive failure. Selecting heifers with high AFC has been reported to increase pregnancy rates. We report high AFC heifers have increased BW through pre-breeding, improved ADG prior to development, and give birth to larger heifer calves compared to low AFC heifers. Taken together these data indicate a relationship between AFC and BW through the first breeding season and progeny calf BW. The low birth BW in heifers with low AFC and in their progeny continues to support a possible link between genes that influence growth, development, and establishment of the ovarian reserve.

Table 1. Effect of antral follicle count[1] (AFC) classification on heifer BW, ADG, and reproductive performance.

Item	HIGH	MOD	LOW	SEM	*P*-value
n	103	113	48		
Birth BW, lb	80[a]	77[a,b]	76[b]	1	0.04
Weaning BW, lb	523[a]	518[a,b]	493[b]	10	< 0.01
Adjusted 205-day BW, lb	565[a]	553[a,b]	542[b]	17	0.02
Initial development BW, lb	562[a]	544[a,b]	524[b]	8	< 0.01
Pre-breeding BW, lb	852[a]	809[b]	800[b]	16	< 0.01
Preweaning ADG, lb/day	2.27[a]	2.21[a,b]	2.16[b]	0.07	0.02
Adjusted preweaning ADG, lb/day	2.37[a]	2.32[a,b]	2.27[b]	0.08	0.04
Post-weaning ADG, lb/day	1.38	1.29	1.32	0.04	0.08
AFC	32.5[a]	20.4[b]	12.3[c]	0.9	< 0.01
RTS[2]	4.27	4.29	4.12	0.17	0.24
Pregnancy diagnosis BW, lb	995	985	982	38	0.77
CL present, %	20	29	25	17	0.30
Mature BW at breeding, %	66[a]	63[b]	62[b]	0.1	< 0.01
AI conception rate, %	63	69	68	11	0.78
Pregnancy rate, %	96	89	89	4	0.15
Calving results					
Calf birth BW, lb	79[a]	78[a,b]	75[b]	3.1	0.02
Calving date, Julian	84	82	83	3.4	0.74
Calved first 21-day, %	77.9	75.9	67.8	8.6	0.57
Calf weaning BW, lb	476	478	458	25	0.30
Calf adjusted 205-day BW, lb	537	537	521	24	0.29

[a-b]Means with different superscripts differ $P \leq 0.05$.
[1]Heifer AFC determined via ultrasonography one month prior to breeding season; HIGH ≥ 26 follicles; MOD 16-25 follicles; LOW ≤ 15 follicles (Adapted from *Biology of Reproduction*, 2008, 79:1219-1225).
[2]RTS= reproductive tract score (*Journal of Animal Science*, 1992, 70:4006-4017).

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Effect of Two Estrus Synchronization Protocols on Reproductive Performance of May Calving Cows

John D. Harms
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Jacqueline A. Musgrave
Rick N. Funston[1]

Summary

The objective of this experiment was to determine the effectiveness of fixed-time AI utilizing one of two estrus synchronization protocols, CO-Synch or CO-Synch + CIDR, in May-calving cows. Cows synchronized with the CO-Synch + CIDR protocol had increased AI and overall pregnancy rates compared to cows synchronized utilizing the CO-Synch protocol. Due to increased AI pregnancy rates, CO-Synch + CIDR cows calved earlier, resulting in a greater proportion of cows calving within the first 21 days of the calving season compared to CO-Synch cows.

Introduction

In Nebraska, cow-calf producers primarily breed cows for spring calving. The breeding season for these cows coincides with high forage nutrient values. However, harvested forage inputs may be increased to support the cow maintenance demands during late gestation and early lactation. Moving the calving season to early summer could reduce harvested forage inputs, but requires cows to be bred during reduced forage nutrient quality and increased temperatures, possibly impacting reproductive performance. Estrus synchronization may allow more cows to become pregnant earlier as forage quality declines throughout the breeding season. Other benefits include a shortened calving season, increased calf uniformity, and a decrease in AI labor.

To achieve these benefits created by estrus synchronization, numerous protocols using $PGF_{2\alpha}$, GnRH, and/or a progestin have been developed that induce cyclicity and successfully synchronize estrus in beef cows (*Journal of Animal Science,* 1999, 77:1823-1832). Utilizing the CO-Synch protocol, 5-15% of cows will exhibit estrus before and immediately after $PGF_{2\alpha}$ administration, resulting in a recommendation for fixed-time AI (TAI) 48 hours after $PGF_{2\alpha}$ administration (*Journal of Animal Science*, 2010, 8:E181-E192). Previous studies have reported TAI 56+ hours after $PGF_{2\alpha}$ administration results in improved AI pregnancy rates with CO-Synch + controlled internal drug release (CIDR; *Theriogenology,* 2009, 72:1009-1016). CO-Synch and CO-Synch + CIDR protocols were compared and the addition of the CIDR increased pregnancy rates following TAI 60 hours after $PGF_{2\alpha}$ injection, which may not have been optimum timing for the CO-Synch protocol (*Journal of Animal Science*, 2006, 84:332-342). The objective of this study was to compare the effects of utilizing a CO-Synch or CO-Synch + CIDR TAI on reproductive performance of May calving cows.

Procedure

The University of Nebraska–Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in this experiment.

Cow Management

A two-year study utilized Red Angus × Simmental Cows (year 1 n=145; year 2 n=162) at the Gudmundsen Sandhills Laboratory (GSL), Whitman, Neb. Cows were randomly assigned to one of two estrus synchronization treatments (Figure 1): GnRH (100 µg; i.m.) on day 0, $PGF_{2\alpha}$ (25 mg; i.m.) on day 7, and GnRH (100 µg; i.m.) with TAI 48 hours after $PGF_{2\alpha}$ (CO-Synch); or GnRH (100 µg; i.m.) and CIDR insertion on day 0, $PGF_{2\alpha}$ (25 mg; i.m.) and CIDR removal on day 7, and GnRH (100 µg; i.m.) with TAI 60 hours after $PGF_{2\alpha}$ (CO-Synch + CIDR). Five days after TAI, cows were placed with bulls for 45 days.

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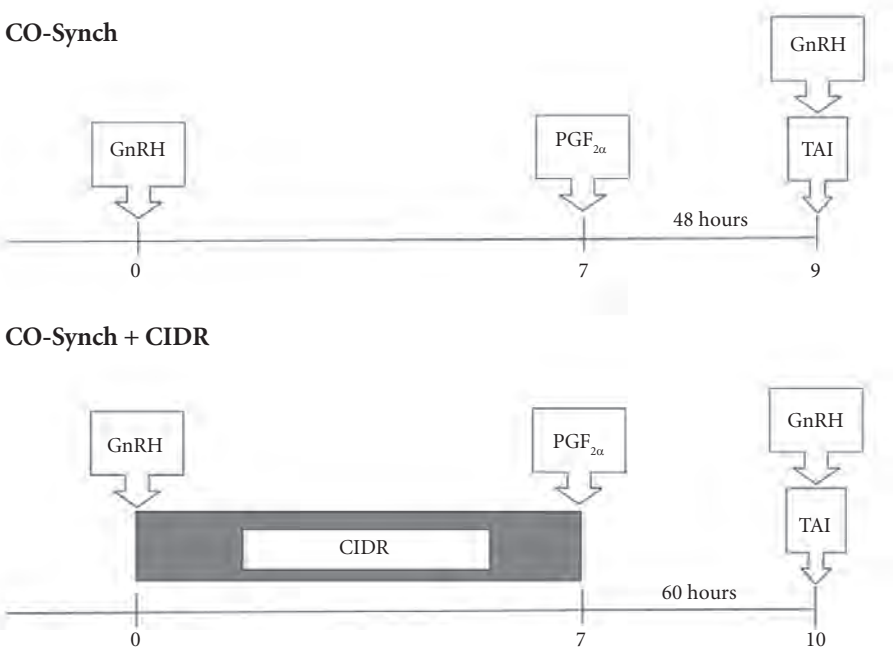

Figure 1. Estrus synchronization treatments, CIDR = controlled internal drug release; TAI = Time AI.

Final pregnancy rate was determined using transrectal ultrasonography 45 days after bull removal. Artificial insemination conception rates were determined based on calving date with days from TAI to calving calculated at 281 (± 4 days) based on average gestation lengths reported in previous literature (*Journal of Animal Science*, 2006, 84:332-342). Days to calving was calculated as days from TAI to calving for all cows that calved. Cow BW and BCS were measured at breeding, pregnancy determination, and calving.

Statistical Analysis

The study was replicated over a two-year period with cows being randomly assigned to one of two estrus synchronization protocols each year, thus animal was the experimental unit. Data were analyzed utilizing the MIXED and GLIMMIX procedures of SAS. The statistical model included synchronization protocol as the fixed effect with year and cow age as random effects. Calf sire and cow postpartum interval (calculated as calving date to TAI) were included in the original model, but were not significant sources of variation and were removed.

Table 1. Effect of CO-Synch vs. CO-Synch + CIDR estrus synchronization protocol on cow reproductive performance.

Item	CO-synch[1]	CO-synch + CIDR[2]	SEM	*P*-value
Cow age, year	4.5	4.5	0.3	0.86
PPI[3], day	109	110	28	0.61
Prebreeding BW, lb	1165	1153	55	0.30
Prebreeding BCS	5.5	5.6	0.2	0.25
Pregnancy diagnosis BW, lb	1006	1003	70	0.77
Pregnancy diagnosis BCS	4.6	4.7	0.2	0.19
Precalving BW, lb	1093	1076	43	0.11
Precalving BCS	4.8	4.7	0.2	0.57
AI pregnancy rate, %	32	54	4	<0.01
Final pregnancy rate, %	86	95	5	<0.01

[1]CO-Synch = 100μg of GnRH (i.m.; day 0), 25 mg of $PGF_{2\alpha}$ (i.m.; day 7) 100μg of GnRH and TAI 48 hours after $PGF_{2\alpha}$.
[2]CO-Synch + CIDR = 100μg of GnRH and CIDR insertion (i.m.; day 0), 25 mg of $PGF_{2\alpha}$ and CIDR removal (i.m.; day 7), 100μg of GnRH and TAI 60 hours after $PGF_{2\alpha}$.
[3]Postpartum interval.

Table 2. Effect of CO-Synch vs. CO-Synch + CIDR estrus synchronization protocol on calving performance.

Item	CO-synch[1]	CO-synch + CIDR[2]	SEM	*P*-value
Calving date, Julian day	145	140	1	<0.01
Days to calving[3], day	293	288	1	<0.01
Calved first 21day, %	76	90	3	<0.01
Calf birth BW, lb	79	77	2	0.09
Prebreeding calf BW, lb	216	223	4	0.14
Weaning calf BW, lb	433	431	14	0.76

[1]CO-Synch = 100μg of GnRH (i.m.; day 0), 25 mg of $PGF_{2\alpha}$ (i.m.; day 7) 100μg of GnRH and TAI 48 hours after $PGF_{2\alpha}$.
[2]CO-Synch + CIDR = 100μg of GnRH and CIDR insertion (i.m.; day 0), 25 mg of $PGF_{2\alpha}$ and CIDR removal (i.m.; day 7), 100μg of GnRH and TAI 60 hours after $PGF_{2\alpha}$.
[3]Days to calving from TAI for all cows that calved.

Results

Cow performance data are displayed in Table 1. Pregnancy by AI and final pregnancy rates were greater ($P < 0.01$) for CO-Synch + CIDR synchronized cows compared to CO-Synch synchronized cows. Previous research indicates progesterone from the CIDR increases pregnancy rates resulting in an earlier calving date (*Journal of Animal Science,* 2001, 79:2253-2259). Cow age, BW, and BCS were similar ($P \geq 0.13$) between synchronization treatments. Calving date and days to calving were greater ($P < 0.05$; Table 2) for the CO-Synch compared to the CO-Synch + CIDR protocols. However, no differences in calf birth BW, calf prebreeding BW, or weaning BW were observed ($P \geq 0.09$; Table 2). There was a 56-day difference ($P < 0.05$) in postpartum interval between year 1 and year 2 as the cows were converted from March calving to May calving the first year of the study; however, AI and final pregnancy rates were similar ($P \geq 0.09$) between years. There was no year × treatment interaction for AI pregnancy rate, but there was for final pregnancy rate, where final pregnancy rate was similar in year 1, but greater for CO-Synch + CIDR in year 2 ($P < 0.01$). Although the CO-Synch protocol is less expensive (*Journal of Animal Science,* 2001, 79:1-4), a disadvantage of this protocol is a small percentage of beef cows exhibit estrus prior to the $PGF_{2\alpha}$ injection. Unless these cows are detected in estrus and inseminated, they will fail to become pregnant to AI after the CO-Synch protocol. This is why the decreased time of AI (48 hours after $PGF_{2\alpha}$) has been recommended compared to the CO-Synch + CIDR (60 hours after $PGF_{2\alpha}$). The CO-Synch + CIDR protocol prevents estrus prior to CIDR removal (*Journal of Animal Science,* 2001, 79:2253-2259). In the current study, CO-Synch + CIDR resulted in greater AI and final pregnancy rates compared to CO-Synch alone.

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Efficacy of Newborn Bovine DNA Samples Taken Via Different Mediums in Assigning Paternity

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Summary

DNA samples from 25 newborn calves taken via hair, ear notch, and nasal swabs were used to determine the efficacy of sampling method in assigning parentage. Nasal swab samples were collected at six time points from birth to 120 hours post-birth. Calf samples and all candidate sires were genotyped with a 99 SNP parentage panel. Nasal swab collection time did not result in significant differences in the ability to assign the correct sire, although differences were seen in apparent cleanliness of the sample. Clean nasal swab samples are comparable in efficacy to hair and ear notch samples in assigning parentage.

Introduction

It is possible to extract DNA from multiple tissues including hair follicles, semen, blood, or nasal swabs. A preferred procedure for collecting DNA is one in which labor and cost are minimized and consistent high-quality genotypes are produced. Nasal swab samples are desirable because they require less labor and are an easier method for laypeople to use as compared to other procedures. The objectives of the study were to determine if nasal swabs (NS) were viable sources of DNA for paternity assignment in newborn calves and to determine how they compared to other standard sample types such as hair follicles (HF) and ear notches (EN).

Procedure

Tissue samples were obtained from randomly selected calves (n=25) and all potential candidate sires (n=8) from the University of Nebraska–Lincoln Teaching Herd. Three sample types were taken from each calf including HF, EN, and NS. At birth each calf had 25 to 30 HF taken from the tail switch and an EN sample taken from the tip of the ear using an appropriate sized ear notcher. Upon removal, hair follicles were placed on the hair card adhesive strip, put in a plastic bag and stored at room temperature (GeneSeek, Lincoln, Neb.). Once the EN was collected it was placed in a 2.0 ml plastic tube and stored at -20 C°. Nasal swab samples were obtained via a tube with stabilizer solution and a cotton swab attached to the outside of the cap. After gently swabbing the inside of a calf's nasal cavity with the cotton swab, the cap was unscrewed, inverted, and re-screwed so the cotton swab was inside the tube and submerged in the stabilizer solution (DNA Genotek Inc., Kanata, Ontario Canada). Nasal swab samples were taken at six different time points from each calf including 0 (birth), 6, 12, 24, 72, and 120 hours post birth and stored at room temperature. A categorical scale from 1 to 3 was used to assign a cleanliness score to each NS sample where 1 was defined as extremely clean and 3 as extremely dirty. DNA was extracted from the nasal swab sample using Promega's MegaZorb DNA mini prep kit protocol (DNA Genotek Inc., Kanata, Ontario Canada). DNA samples from candidate sires were obtained from semen samples. Semen samples have been shown to be a robust DNA collection technique. In the current study, the average (SD) percentage of SNP called was 89.6 (All DNA samples were genotyped at GeneSeek with a commercially available single nucleotide polymorphism (SNP) parentage panel that contained 99 highly polymorphic SNP.

Data edits were performed to remove samples that did not yield any genotypes (n=1 NS at hour 120), true sire could not be determined (n= 1 animal), and abnormally low SNP call rates (n= 1 EN). Missing data occurred for four NS due to one calf mortality before hour 12. The numbers of observations in the final analysis are described in Table 1.

The efficacy of the NS as a DNA sampling technique was evaluated based on the total number of SNP genotypes called and the number of exclusions (disagreement between SNP genotypes) between both the true sire and EN from the same animal. The number of exclusions was determined using SireMatch. Statistical analysis of differences in the number of exclusions for all sample types was performed by fitting two models, one for exclusions from the true sire (included EN, HF, and all NS samples)

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Table 1. Least-squares (LS) mean number of exclusions from the true sire and ear notch between all sample types.

	Exclusions from True Sire			Exclusions from Ear Notch		
Sample Type	N	LS Mean	Standard Error	N	LS Mean	Standard Error
Nasal Swab, hour 0	24	0.125	0.160	24	0.125	0.133
Nasal Swab, hour 6	24	0.083[a]	0.160	24	0.083	0.133
Nasal Swab, hour 12	23	0.043[a]	0.164	23	0.087	0.134
Nasal Swab, hour 24	23	0.174	0.164	23	0.087	0.134
Nasal Swab, hour 72	23	0.043[a]	0.164	23	0.087	0.134
Nasal Swab, hour 120	22	0.045[a]	0.168	22	0.046[a]	0.136
Hair	24	0.083[a]	0.160	24	0.375[b]	0.133
Ear Notch	24	0.458[b]	0.160	—	—	—

[a,b]Least-squares means with different superscripts within a column differ ($P < 0.10$).

and another for exclusions from the EN (included HF and all NS samples), which included the fixed effect of sample type. Statistical analysis of differences in the number of exclusions by NS collection time was performed by fitting a model for exclusions from the true sire (included all NS samples) that included fixed effects of NS collection time and cleanliness score. An exclusion can occur if the candidate sire is in fact not the true sire of the calf, or if the candidate sire is the true sire of the calf but either the sire or calf was mis-genotyped for a particular SNP giving rise to an incorrect SNP genotype being assigned ("missed call").

The true sire of each calf was determined by calculating the number of exclusions between each sire and each calf sample (HF, EN, and all NS samples). The true sire was then assigned to each calf if the majority of sample types had no more than one exclusion from a given sire.

Results

The least-squares (LS) mean numbers of exclusions by sample type are presented in Table 1. Sample type (HF, EN, and all NS samples) did not have a significant effect on the number of exclusions from the true sire (P=0.63) or EN (P=0.65). The mean number of exclusions from the true sire for HF and NS samples at time points 6, 12, 72, and 120 hours tended (P= 0.07 to 0.09) to be lower than EN samples.

Table 2. Least-squares (LS) mean number of exclusions from the true sire between cleanliness score.

	Exclusions From True Sire	
Cleanliness Score[2]	LS Mean[1]	Standard Error
1	0.017[a]	0.041
2	0.124[b]	0.039
3	0.182[b]	0.073

[1]Each least-squares mean has been adjusted for nasal swab collection time.
[2]A score of 1 being the cleanest and 3 being the dirtiest.
[a,b]Least-squares means with different superscripts within a column differ ($P < 0.10$).

This was unexpected as the hypothesis was that EN samples would prove to be the most robust sample type, and HF would perform the worst. In the current study, the hair sample and NS technique utilized during the experiment proved to be quite reliable, with 100 and 99.2 percent of the hair and NS samples, respectively, having less than two exclusions from the true sire. However, caution should be used when taking hair samples from young calves to ensure that enough fully formed hair follicles are obtained.

NS collection time did not have a significant effect on number of exclusions from the true sire (P=0.58). The cleanliness score tended to have a significant effect (P= 0.066) on the number of exclusions from the true sire. The LS mean numbers of exclusions from the true sire for each cleanliness score are presented in Table 2, which illustrate that as the cleanliness score increases (i.e., samples become dirtier), the number of exclusions from the true sire increases. Thus, swabbing an extremely dirty nasal cavity may lead to poorer quality DNA and an increase in the number of exclusions from the true sire. In the current project only 8 of the 146 NS samples had call rates less than 70%, and 107 of the 146 had call rates greater than 90%.

The time at which the NS sample was taken from a calf within the first 120 hours after birth did not significantly impact the number of exclusions from the true sire. However, the cleanliness of the sample did affect the number of exclusions, or missed calls, between an NS sample and the calf's true sire. Thus, while the quality of DNA obtained from the NS is vital to its efficacy, the time the swab is taken on a newborn or the type of sample (i.e., HF, NS, EN) seems irrelevant to assigning parentage. Consequently, the choice of sample type should be determined by cost of sample collectors and ease of collection.

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Effect of Winter Supplementation Level on Yearling System Profitability

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Summary

Calves backgrounded in a forage-based system at a high winter supplementation level maintained a performance advantage through finishing. High level supplemented cattle gained an additional 0.2 lb daily during finishing, consumed less total feed in the feedlot, required fewer days on feed to reach a common finish point and produced an additional 85 lb of saleable live weight compared to cattle backgrounded at a low supplementation level. High level supplemented cattle returned $56.01 more than cattle fed a low level of supplementation during the winter backgrounding phase.

Introduction

Backgrounding systems utilize readily available, inexpensive forages. By nutritionally restricting animals to varying degrees, available feeds can be used to achieve various levels of calf gains to create yearlings for summer grazing, target different marketing windows, and create a year-round beef supply.

Historically, backgrounding systems have centered on minimizing winter input costs to achieve a low rate of gain, but then attaining increased summer grazing gains (compensatory growth) during a period of higher nutrient intake (*1998 Nebraska Beef Cattle Report, pp. 63).* This philosophy may not have considered the benefits of a high supplementation level when cattle are retained through finishing, or when ethanol byproducts are available as a supplement. With ethanol byproducts readily available, it may be profitable to supplement growing cattle at a higher level than was previously believed.

Corn prices have risen considerably recently, changing previous economic analyses and potentially increasing the value of backgrounding programs. This study compared winter supplementation level economics in a forage-based backgrounding system, with distillers grains as a winter supplement.

Procedure

Five studies, completed from 1987 through 2011, examined a high (HI) and low (LOW) winter supplementation level within a forage-based backgrounding system, and subsequent feedlot performance. Four studies utilized long yearling steers, and one study used spayed heifers. Cattle were backgrounded on corn residue with varying supplementation levels, grazed through the summer, and then finished. Data from studies 1, 2, 4, and 5 were adjusted to an equal fat thickness to equitably compare studies. Within studies, treatment groups had identical implant procedures and finishing diets.

In study 1, each year for two years, 60 British breed yearling steers (initial BW = 522 lb) were wintered 106 days on crop residues beginning in early January. Different levels of supplemental protein and alfalfa hay were fed to achieve a high (1.09 lb) or low (0.62 lb) daily gain. Cattle then grazed cool-season followed by warm-season pastures 116 days until mid-August, and were then finished 113 days (*1989 Nebraska Beef Cattle Report, pp. 34-35).*

In study 2, 80 British-breed steers (initial BW = 497 lb), were fed to achieve winter gain levels of approximately 0.7 lb/day and 1.7 lb/day. Steers grazed corn residue and then were fed bromegrass hay and corn gluten feed during the 163-day winter period. Steers then grazed eastern Nebraska bromegrass or Sandhills range 124 days from May 6 until Sept. 6 (*1998 Nebraska Beef Cattle Report, pp. 63-65).*

In study 3, a design similar to study 2 was used with steers fed 163 days with 16 head per treatment. Steers then grazed Sandhills range or bromegrass pasture 124 days (*1999 Nebraska Beef Cattle Report, pp. 26-28).*

In study 4, 108 crossbred steers (initial BW = 535 lb) were wintered on cornstalks from Dec. 4 through Feb. 19 during phase I. In phase I, high level supplemented steers were fed 5 lb/head/day (DM basis) of wet corn gluten feed, and low level supplemented steers were supplemented with 1.4 lb/head/day (DM basis) of wet corn gluten feed. In phase II, steers were drylotted from Feb. 20 through April 28 with both treatments fed ad-libitum ammoniated wheat straw and HI steers also fed 5 lb/head/day (DM basis) of wet corn gluten feed (*2000 Nebraska Beef Cattle Report, pp. 23-26).*

In study 5, 118 heifer calves (initial BW = 455) grazed corn residue 138 days and were supplemented with 2 lb (LOW) or 5 lb (HI) wet distillers grains with solubles (WDGS) on a DM basis. Following the winter phase, spayed yearling heifers grazed smooth bromegrass 30 days, grazed native Sandhills range 128 days, and were then fed a common finishing diet. Study 5 data have not been previously reported, thus are included separately and in average performance values.

Performance values from each of the five studies were averaged and current economic assumptions (as of April, 2012) were applied to the two backgrounding gain levels to compare supplementation level profitability. Initial feeder calf cost was $170/cwt for a 500 lb calf. Grazing costs were assumed to be $0.31/day on cornstalks and $0.80/day for summer pasture. Modified distillers grains (MDGS) was the winter supplement fed at two lb/head daily for the low supplementation level and five lb/head daily for the high supplementation level, on a DM basis, and assigned a cost of $0.12/lb DM fed, to include equipment and labor costs. Finishing costs were

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assumed to be $0.13/lb of diet DM and yardage $0.45/day. Sale price was $120/cwt.

Results

In study 1, HI steers gained more during finishing (3.84 vs. 3.62 lb/d, $P < 0.05$) and had heavier final weights (1,193 vs. 1,159 lb, $P < 0.05$) than LOW. In study 2 during finishing, HI steers off summer bromegrass, had a greater ADG (5.03 vs. 4.48 lb/day, $P < 0.05$), greater DMI (31.7 vs. 28.6 lb/d, $P < 0.05$), and greater final weight (1,323 vs. 1,249 lb, $P < 0.05$) than LOW steers during finishing. For steers that grazed Sandhills summer range, there were no differences during finishing. In study 3, HI steers had greater final weights (1,375 vs. 1,236 lb, $P < 0.05$) and (1,371 vs 1,259 lb, $P < 0.05$) than LOW steers, for cattle from range and bromegrass summer treatments, respectively. In study 4, final weights were 51 pounds greater for HI steers (1,353 vs. 1,251 lb, $P < 0.05$) than LOW steers with no significant ADG, DMI, or efficiency differences during finishing.

In study 5, winter gains were greater for HI heifers (1.4 vs. 0.48 lb/day, $P < 0.01$) and summer gains were greater for LO heifers (1.42 vs. 1.18 lb/day, $P < 0.01$; Table 1; 25% compensation). Final BW was 111 lb greater for high level supplemented heifers; ($P = .0103$; Table 1). Finishing phase ADG was numerically greater for HI heifers at 3.97 lb compared to 3.79 lb for LO heifers ($P = 0.21$). Total DMI and efficiency were similar between treatments.

Cattle developed on a higher nutrition plane during the winter backgrounding phase had a 0.20 lb greater ADG during finishing and required five fewer days on feed to reach finish (Table 2). Total DMI was 20 lb less, resulting in $2.50/head lower total feedlot diet cost. The performance advantage of cattle supplemented at a high level resulted in an additional 85 pounds of saleable product, which provided $102.96 of additional revenue over the low level supplemented cattle. Profitability resulted in a $9.48 loss when backgrounding cattle at a 2 lb/head/day MDGS supplement level, and a $46.53 profit when backgrounding cattle at a 5 lb/head/day supplementation level (Table 3).

Table 1. Backgrounding and finishing performance of spayed heifers fed two levels of WDGS during winter backgrounding (study 5).

	Treatment			
	Low	High	SEM	*P*-value
Backgrounding phase				
Initial BW, lb	452[a]	453[a]	4.7	0.9600
Winter ADG, lb	0.48[a]	1.40[b]	0.04	<0.0001
Summer phase				
ADG	1.42[a]	1.18[b]	0.03	<0.0001
Finishing phase				
DOF	125[a]	126[a]	4.67	0.9199
ADG, lb	3.79[a]	3.97[a]	0.07	0.2084
Feed/gain	7.14[a]	6.94[a]	0.00	0.2155
Total DMI, lb	3391[a]	3468[a]	77.26	0.5517
Final BW, lb	1227[a]	1338[b]	8.00	0.0103

[ab]Means with different superscripts differ (*P*-value < 0.01).
Cattle supplemented at low level (2# WDGS/head/day) during backgrounding phase on cornstalks, then grazed bromegrass 30 days.
Cattle supplemented at high level (5# WDGS/head/day) during backgrounding phase on cornstalks, then grazed bromegrass 30 days.

Table 2. Performance summary of five winter supplementation trials at two supplementation levels.

	Low	High
Winter phase		
Initial BW, lb	500	500
Days	143	143
ADG, lb/day	0.49	1.41
Summer phase		
Days	135	135
ADG	1.46 (25%)[1]	1.09
Finishing phase		
DOF	112	107
ADG, lb/day	4.15	4.35
DMI, lb/day	28.2	29.2
Final BW, lb	1240	1325

Low = cattle supplemented during the winter phase for a low daily gain.
High = cattle supplemented during the winter phase for a high daily gain.
[1]Percent compensation, calculated as difference in total pounds of summer gain divided by difference in total pounds of winter gain.

Table 3. Profitability analysis of high and low winter supplementation levels.

	Low	High
Initial purchase cost, $/head	850.34	850.34
Winter phase		
Cornstalk grazing cost, $/head	45.76	45.76
MDGS cost, $/head	34.32	85.80
Summer phase		
Grazing cost, $/head	107.68	107.68
Finishing phase		
Finisher diet cost, $/head	408.72	406.22
Feedyard yardage, $/head	50.18	48.15
Total revenue, $/head	1487.52	1590.48
Profit, $/head	-9.48	46.53

Low = cattle supplemented during the winter phase for a low daily gain with 2 lb MDGS/head daily.
High = cattle supplemented during the winter phase for a high daily gain with 5 lb MDGS/head daily.

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Applying Corn Condensed Distillers Solubles to Hay Windrows Prior to Baling: I. Procedure and Effects on Bale Temperature and Nutrient Composition

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Summary

Two experiments investigated the effects of applying liquid corn condensed distillers solubles to grass-hay windrows prior to baling on storage, bale temperature, and nutrient composition. Application of the wet material did not impair the ability of hay to expel heat post-baling in either study. Increased CP and decreased NDF for hay treated with corn condensed distillers solubles indicated successful within-bale storage occurred. Results suggest application prior to baling is a feasible strategy for storing liquid co-products while improving forage quality.

Introduction

Previous research (*2009 Nebraska Beef Cattle Report,* pp. 11-12 and 30-32) demonstrated corn condensed distillers solubles (CCDS) can be ensiled in commercial silo bags by combining with low-quality forages. Although an effective method for storing liquid co-products, this technique requires equipment and facilities which may be inaccessible for some operations. In the summer, many Nebraska cow-calf producers harvest grass hay which can often be medium to low quality. A management strategy utilizing CCDS to improve hay quality while concurrently serving as a method of storage may be feasible. Therefore, our objectives were to: 1) evaluate the ability to store CCDS in large round bales by applying it to hay windrows prior to baling; 2) determine the influence of CCDS on internal bale temperature post-baling; and 3) characterize the effects of applied CCDS on hay nutrient composition.

Procedure

Both experiments described herein were conducted at the University of Nebraska–Lincoln Dalbey-Halleck Research Unit located near Virginia in southeast Nebraska.

Experiment 1

In 2010, one 40-acre field of native warm-season tallgrass prairie was windrowed in late July. Following a three-day drying period without raking, CCDS (Table 1) was applied directly to windrows prior to baling. Upon delivery, CCDS was off-loaded into a liquid fertilizer trailer equipped with a gasoline-powered engine. In order to apply CCDS to the windrows, the trailer was modified to include: 1) a ¾-inch diameter electric shut-off valve; 2) a 1½-inch diameter flow meter; and 3) and a 7 foot long by ¾-inch diameter spray boom. To the spray boom, ¼ -inch diameter drop holes were bored and spaced 1¼ inch apart. This boom was positioned at a 90 degree angle to the frame of the trailer and extended beyond the trailer's breadth, thereby allowing for a 3 foot spraying width to cover the windrow without applying CCDS directly on the ground (Figure 1).

A tractor, which was driven between windrows, was used to pull the trailer when applying CCDS. The shut-off valve and flow meter were wired to a 12-volt battery, which was positioned in the cab of the tractor, thus providing direct control of the flow and rate of CCDS applied by the operator. All windrows were baled using a large round baler within 24 hours of CCDS application. Bales were placed in rows, buffed end-to-end, and stored on the ground without covering.

Two levels of CCDS were applied to windrows: 1) 0 (0%); or 2) 20% (20%) CCDS of bale weight (DM basis), producing 0 (n = 45) or 20% (n = 36) bales, respectively. Application level was calculated using distance traveled to produce a large round bale, bale weight, driving speed, and CCDS

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Figure 1. Liquid trailer with modifications to apply CCDS to hay windrows.

Table 1. Nutrient analysis of CCDS applied to grass hay windrows prior to baling.

Item[1]	Experiment 1 (2010)	Experiment 2 (2011)
DM	37.5	39.3
CP	23.4	31.4
Fat	25.9	21.7
OM	89.9	90.2
S	1.1	1.2
P	1.9	1.9
pH	4.6	4.2

[1]% of DM.

Table 2. Inclusion rates of CCDS treated bales by year[1].

Year	n	Level[2]	Mean[3]	SD	Minimum	Maximum
2010	36	20	20.4	2.5	13.8	23.9
2011	31	16	16.1	2.5	10.7	21.4
	27	32	32.3	4.6	22.0	41.7

[1]% inclusion (DM basis) of bale weight.
[2]Projected inclusion level, %.
[3]Observed inclusion level, %.

Table 3. Effect of level of CCDS and sampling date on hay bale internal temperature in Experiment 1.

	2 week		3 week			*P*-value		
Item	0	20	0	20	SEM	Level[2]	Date[3]	L x D[4]
Temperature, °F[1]	94.1[a,b]	96.1[a]	94.3[a]	92.0[b]	0.74	0.85	<0.01	<0.01

[1]Measured using a digital hay probe.
[2]Fixed effect of CCDS level.
[3]Fixed effect of sampling date.
[4]CCDS level x sampling date interaction.
[a,b]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

Table 4. Effect of level of CCDS on hay bale nutrient composition in Experiment 1.

	Treatment			
Item[1]	0	20	SEM	*P*-value
DM	90.4	90.1	1.09	0.58
CP	7.2[a]	9.8[b]	0.20	<0.0001
NDF	69.2[a]	60.0[b]	0.36	<0.0001
Fat	1.7[a]	4.7[b]	0.14	<0.0001
S	0.1[a]	0.3[b]	0.01	<0.0001

[1]% DM basis.
[a,b]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

flow rate. Windrow lengths to produce each treated bale were measured. Therefore, the percentage CCDS inclusion (DM basis) was calculated for each bale retrospectively.

Bale temperatures were recorded using a digital hay probe at 2 and 3 weeks post-baling on a subset of eight bales within treatments. Core samples were collected using a drill-powered hay probe at 0, 2, 3, and 24 weeks post-baling from a subset of eight bales within each treatment. Samples were frozen, dried (140°F, 48 hours) to determine DM, and ground for analysis of CP, S, fat, and NDF. At application, CCDS samples were collected and frozen prior to DM determination. Samples were then freeze-dried prior to analysis for CP, fat, S, OM, P, and pH.

All data were analyzed as a completely randomized design. Temperature data were analyzed as a 2 x 2 factorial arrangement of treatments. Model fixed effects included CCDS level, date, and the level x date interaction. Nutrient composition data were analyzed with date as a random effect. The model for all analyses included the fixed effect of CCDS level. Because treatments were applied on a bale basis, the experimental unit for all analyses was bale.

Experiment 2

In 2011, a second trial was conducted using the same field to evaluate applying increasing levels of CCDS to windrows prior to baling. Date of hay harvest, length of drying time prior to application, application timing relative to baling, equipment, bale management post-baling, and calculations used to determine application rate were as described in Experiment 1. Three levels of CCDS (Table 1) were applied to windrows: 1) 0 (0%); 2) 16 (16%); and 3) 32% (32%) CCDS of bale weight (DM basis), producing 0 (n = 30), 16 (n = 31), and 32% (n = 27) bales, respectively.

Bale temperature was measured on a subset of six bales within treatments at 0, 2, and 3 weeks post-baling. Core samples were collected at 0 and 3 weeks post-baling from a subset of three bales within treatment, and samples were composited within date and level. Samples were frozen, dried to determine DM, and ground for analysis. Corn condensed distillers solubles samples were collected, prepared, and analyzed as in Experiment 1.

All data were analyzed as a completely randomized design. Temperature data were analyzed as a 3 x 3 factorial arrangement of treatments with bale as the experimental unit. Model fixed effects included CCDS level, date, and the level x date interaction. Orthogonal contrasts were constructed to test linear and quadratic effects of increasing CCDS levels within sampling date because an interaction was observed. For nutrient composition data, the effect of sampling date was tested, and determined nonsignificant. Therefore, pooled means across sampling date

Table 5. Effect of level of CCDS and sampling date on hay bale internal temperature in Experiment 2.

	0 week			2 week			3 week				*P*-value		
Item	0	16	32	0	16	32	0	16	32	SEM	Level[2]	Date[3]	L x D[4]
Temp., °F[1,5]	98.5[b,c]	105.2[a]	101.2[b]	94.7[d,e]	95.5[c,d]	94.3[d,e]	82.2[g]	88.0[f]	91.8[e]	1.28	< 0.01	< 0.01	< 0.01

[1]Measured using a digital hay probe.
[2]Fixed effect of CCDS level.
[3]Fixed effect of sampling date.
[4]CCDS level x sampling date interaction.
[5]Quadratic effect of level within 0 week bales, and linear effect within 3 week bales ($P \leq 0.01$).
[a-g]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

are reported and the experimental unit tested was level within date.

Results

Experiment 1

Variation in windrow density across the field produced differences in linear windrow lengths necessary to make a large round bale. Therefore, a range of 10.1% units of CCDS was observed among 20% CCDS bales (Table 2); however, the mean inclusion level equaled approximately 20%. Internal temperature data are summarized in Table 3. A significant CCDS level x sampling date interaction was noted. Interestingly, temperature declined ($P \leq 0.05$) from 2 to 3 weeks post-baling for 20% bales but remained constant for 0% bales. Level of CCDS had no effect on bale temperature suggesting typical heat elimination occurred.

Consistent with the temperature data, DM was not different between treatments (Table 4). This implies adding CCDS to hay prior to baling has minimal impact on the drying process. Significant increases in CP, fat, and sulfur were observed for 20% bales. In addition, NDF, an indicator of fiber, was reduced 13.3% by adding CCDS.

Experiment 2

Variation in CCDS inclusion among bales was directly proportional to the level of CCDS applied (Table 2). The greatest inclusion amount for a bale in the 16% group was less than the minimum for a 32% bale. Thus, inclusion rates for individual bales did not overlap across treatments. As in Experiment 1, a significant CCDS level x sampling date interaction existed for temperature (Table 5). A significant quadratic response of temperature in relation to increasing CCDS levels was observed immediately after baling; however, temperatures were not different at 2 weeks post-baling. Temperature linearly ($P \leq 0.01$) increased with greater CCDS levels when measured at 3 weeks post-baling. Despite internal temperature being greatest for 32% bales at 3 weeks after baling, temperature declined for all treatments across time. Similar to Experiment 1, results suggest applying up to 32% CCDS to hay prior to baling does not interfere with heat elimination nor does it cause excessive heat production in treated bales.

Table 6. Effect of level of CCDS on hay bale nutrient composition in Experiment 2.

	Level				
Item[1]	0	16	32	SEM	*P*-value
DM	92.3	93.1	91.4	1.33	0.68
CP	6.9[a]	11.5[b]	12.8[b]	0.48	<0.01
NDF	74.6[a]	63.7[b]	56.2[c]	1.05	<0.01
Fat	1.8[a]	4.2[b]	5.4[b]	0.52	0.03

[1]% of DM.
[a-c]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

Level of CCDS did not impact DM indicating sufficient drying had occurred pre-baling (Table 6). Fat and CP content were increased significantly by adding CCDS when compared to bales that had no CCDS added, but CP and fat were not different between bales that had 16 or 32% CCDS added to the bales. Compared to bales that had no CCDS added, fiber was decreased ($P \leq 0.01$) by 14.6 and 24.7% for 16 and 32% bales, respectively. Therefore, successful within-bale storage occurred.

Issues associated with applying CCDS to hay were not encountered, but 32% windrows were more difficult to bale. We had no baling issues when CCDS was applied at 16% or 20% rates. Additional drying time beyond that allowed in the current study may be necessary when levels greater than 25% are applied. In both experiments, bales wrapped, handled, and kept adequately for several months post-baling. Applying CCDS to grass hay windrows before baling had no impact on DM or subsequent heat production. Improvement of nutrient values implies windrow application is an effective storage method. This strategy could be utilized to increase the quality of low to medium quality forages.

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Applying Corn Condensed Distillers Solubles to Hay Windrows Prior to Baling: II. Effects on Growing Cattle Performance

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Summary

Two experiments evaluated the feeding value of grass hay bales previously treated with CCDS in growing cattle diets. In Experiment 1, heifers fed bales treated with 20% CCDS (DM) gained less than those fed an equal level of dried distillers grains plus solubles and non-treated hay. In Experiment 2, ADG and F:G linearly improved with increasing CCDS levels. Furthermore, supplementing cattle to meet metabolizable protein requirements when fed diets of CCDS and hay did not improve ADG at levels greater than 15% CCDS. Data indicate hay bales previously treated with CCDS are adequate for use in growing diets, confirming that within-bale storage is a viable method for CCDS.

Introduction

Corn condensed distillers solubles (CCDS) is an energy and protein dense co-product that can often be economically utilized in diets for cow-calf and backgrounding operations. Because this product is a liquid, incorporation with low-quality forages is an ideal strategy for both feeding and storage. Trials conducted in recent years (*2009 Nebraska Beef Cattle Report,* pp. 11-12 and 30-32) demonstrated mixtures of CCDS ensiled with either cornstalks or wheat straw result in high quality diets for growing cattle. Current experiments have investigated applying CCDS to hay windrows before baling as an alternative form of within-bale storage. Performance of cattle fed CCDS-treated bales can indicate the extent that storage was successful.

Because CCDS is an excellent source of degradable intake protein (DIP), it is attractive for use in forage-based diets. However, growing cattle have greater metabolizable protein requirements and may be deficient unless supplemented with by-pass protein (UIP). Thus, cattle fed CCDS in high-forage diets may respond to additional UIP supplementation. Therefore, our objectives were to: 1) evaluate the feeding value of hay bales previously treated with CCDS and thus determine the extent of within-bale storage; and 2) measure the effect of supplemental UIP on the performance of cattle fed CCDS.

Procedure

All procedures and facilities described in the following experiments were approved by the University of Nebraska–Lincoln Institutional Animal Care and Use Committee.

Experiment 1

Weaned, crossbred (Simmental x Angus), spring-born heifers (n = 66, initial age = 332 days) were utilized in a 62-day development trial conducted at the University of Nebraska–Lincoln Dalbey-Halleck Research Unit located near Virginia in southeast Nebraska. Heifers were weaned in October of the previous year and fed a common diet to target an approximate ADG of 1.22 lb prior to the experiment beginning in mid-winter. In February, heifers were stratified by BW and randomly assigned within strata to one of four pens (two pens per treatment, 16-17 heifers per pen). Pens were assigned randomly to one of two dietary treatments: 1) ad libitum intake of large round native grass hay bales treated with CCDS at 20% of bale weight (DM basis) (CCDS) or 2) ad libitum intake of native large round hay bales and fed dried distillers grains plus solubles (DDGS) at 20% of the diet (DM basis) (DDGS). The CCDS-treated bales used in the current study were produced the previous summer in a concurrent experiment at the same research location.

Treatment diets (Table 1) were formulated using the 1996 NRC model to contain a 20% dietary inclusion (DM basis) of ethanol co-products, thereby remaining similar in CP and TDN, to allow heifers to achieve approximately 60% of mature BW at the onset of breeding. This inclusion level was chosen based on previous data (*2007 Nebraska Beef Cattle Report*, p. 5) indicating DDGS fed at 0.57% of BW (DM basis) is sufficient to produce an ADG of 1.50 lb for developing heifers prior to breeding.

Large-round hay bales were offered to both treatment groups in metal bale-ring feeders, and hay DMI was not quantified. Limestone was added to DDGS prior to feeding to achieve a minimum Ca:P ratio of 1.5:1. Both

Table 1. Composition of dietary treatments fed to growing replacement heifers in Experiment 1.

	Treatment	
Ingredient[1]	CCDS[2,4]	DDGS[3,4]
Grass hay	80.00	80.00
Corn condensed distillers solubles	20.00	—
Dried distillers grains plus solubles	—	20.00
Total	100.00	100.00

[1]% of diet DM.
[2]CCDS = heifers fed ad libitum grass hay bales treated with solubles at 20% DM.
[3]DDGS = heifers fed ad libitum grass hay bales and DDGS at 20% DM.
[4]Salt, trace mineral, and vitamin supplement provided free choice.

treatments were offered ad libitum access to a mineral and vitamin supplement (18.7% Ca, 18.0% salt, 6% Mg, 5,500 ppm Zn, 2,500 ppm Cu, 26.4 ppm Se, 400,000.0 IU/lb vitamin A, and 400.0 IU/lb vitamin E). DDGS heifers were group-fed daily in metal feed bunks with at least 18 inches of bunk space per heifer.

Three-day consecutive initial and final BW measurements were recorded to determine performance. Weights (without restriction from feed and water) were collected after heifers had been fed a common diet of grass hay and DDGS for one week. Body condition score was assessed visually at the beginning and end of the experiment by the same experienced technician. Data were analyzed as a completely randomized design with pen as the experimental unit. The model for all analyses included the fixed diet treatment effect.

Experiment 2

A total of 60 crossbred steer calves (initial BW = 635 ± 26 lb) were utilized in an 84-day growing experiment conducted at the University of Nebraska–Lincoln Agricultural Research and Development Center (ARDC) feedlot located near Mead, Neb. The trial was a completely randomized design with a 3 x 2 factorial arrangement of treatments resulting in six dietary treatments (10 steers per treatment; Table 2). Treatment factors included: 1) inclusion of corn condensed distillers solubles (0, 15, and 30% of diet; DM basis) mixed with ground grass hay and 2) with (MP) or without (No MP) supplemental UIP to meet metabolizable protein requirements. The mixture of ground grass hay and previously-applied CCDS served as the basal diet ingredient with a supplement top-dressed at the time of feeding. Supplemental UIP was provided using a 1:1 ratio of Soypass® and corn gluten meal to meet predicted metabolizable protein requirements for all MP diets using the 1996 NRC model. Urea was added to diets containing 0% CCDS to meet DIP requirements. All supplements were formulated to provide 200 mg/steer daily of monensin sodium.

Table 2. Diet and supplement composition of treatments fed to growing steer calves in Experiment 2.

	No MP			MP		
Ingredient[1]	0	15	30	0	15	30
Grass hay	93.83	78.82	63.80	93.83	78.82	63.80
CCDS	0.00	15.01	30.03	0.00	15.01	30.03
Supplement	6.17	6.17	6.17	6.17	6.17	6.17
Total	100.00	100.00	100.00	100.00	100.00	100.00
Supplement[1]						
Corn gluten meal	0.000	0.000	0.000	2.240	1.680	1.680
Soypass	0.000	0.000	0.000	2.240	1.680	1.680
Soybean hulls	4.632	4.700	4.700	0.000	1.271	1.271
Limestone	0.413	0.963	0.963	0.502	1.032	1.032
Urea	0.320	0.000	0.000	0.480	0.000	0.000
Salt	0.300	0.300	0.300	0.300	0.300	0.300
Dicalcium phos.	0.298	0.000	0.000	0.201	0.000	0.000
Tallow	0.125	0.125	0.125	0.125	0.125	0.125
Trace mineral	0.050	0.050	0.050	0.050	0.050	0.050
Vitamin premix	0.015	0.015	0.015	0.015	0.015	0.015
Rumensin-90[2]	0.013	0.013	0.013	0.013	0.013	0.013
Total	6.17	6.17	6.17	6.17	6.17	6.17

[1]% of diet DM.
[2]Formulated to provide 200.00 mg/steer daily monensin sodium.

Table 3. Effect of diet on replacement heifer performance in Experiment 1.

	Treatment			
Item	CCDS[1]	DDGS[2]	SEM	*P*-value
Pens (n)	2	2		
Initial BW, lb	640.9	640.8	0.59	0.87
Initial BCS	5.1	5.1	0.04	0.42
Final BW, lb	682.1[a]	716.0[b]	2.45	0.01
Final BCS	5.1	5.5	0.14	0.18
ADG, lb	0.67[a]	1.22[b]	0.04	0.01

[1]CCDS = heifers fed ad libitum grass hay bales treated with solubles at 20% DM.
[2]CON = heifers fed ad libitum grass hay bales and DDGS at 20% DM.
[a,b]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

Table 4. Nutrient composition (DM basis) and daily protein balance of dietary treatments in Experiment 2.

	No MP			MP		
Item	0	15	30	0	15	30
CP, %[1]	6.2	9.2	13.2	9.0	10.9	14.9
TDN, %[1]	54.6	61.0	66.7	55.0	61.0	67.0
MP balance, g/day[2]	-151	-68	-37	-96	+3	+52
DIP balance g/day[2]	-15	+4	+195	+44	+25	+221

[1]Calculated using 1996 NRC model level 1.
[2]Predicted MP and DIP balances calculated using 1996 NRC model level 1 based on average BW, DMI, and ADG.

The CCDS-treated bales fed in the current study were produced the previous summer in a concurrent experiment at the Dalbey-Halleck Research Unit. In December, bales treated with 0, 16, or 32% (DM basis) CCDS were transported to the ARDC feedlot and ground through a 3-inch screen using a tub grinder. The mixture of ground grass hay and CCDS was stored prior to feeding in a partially enclosed commodity bay with concrete flooring.

Cattle were limit fed (2% of BW; DM basis) a diet of 50% alfalfa hay and 50% wet corn gluten feed for 5 days prior to initiation and upon completion of the trial to minimize variation in rumen fill. Initial and final BW measurements were the

(Continued on next page)

Table 5. Effect of level of CCDS and metabolizable protein on growing steer calf performance in Experiment 2.

	No MP			MP				*P*-value		
Item	0	15	30	0	15	30	SEM	Level[1]	Protein[2]	L x P[3]
Initial BW, lb	635	634	635	636	636	636	8.45	0.99	0.89	0.99
Final BW, lb[5]	700[c]	753[b]	839[a]	746[b]	767[b]	838[a]	10.46	<0.01	0.03	0.09
ADG, lb[6]	0.78[d]	1.41[b,c]	2.42[a]	1.31[c]	1.56[b]	2.41[a]	0.08	<0.01	<0.01	<0.01
DMI, lb/day[7]	12.4[c]	15.2[b]	17.9[a]	13.8[b,c]	14.5[b]	17.9[a]	0.54	<0.01	0.60	0.13
F:G[4,5]	17.00[d]	10.90[c]	7.39[a]	10.92[b,c]	9.35[b]	7.55[a]	—	<0.01	<0.01	<0.01

[1]Fixed effect of CCDS level.
[2]Fixed effect of metabolizable protein.
[3]CCDS level x metabolizable protein interaction.
[4]Analyzed as G:F, reported as F:G.
[5]Linear effect of CCDS level within No MP and MP diets ($P \leq 0.01$).
[6]Linear effect of CCDS level within No MP diets, and linear and quadratic effect within MP diets ($P \leq 0.01$).
[7]Linear main effect of CCDS level ($P \leq 0.01$).
[a-d]Within a row, least squares means without common superscripts differ at $P \leq 0.05$.

mean of 3 day consecutive weights. Steers were individually fed daily with Calan electronic gates. Bunks were evaluated daily, feed refusals collected weekly, and DM determination was conducted using a 60° C forced air oven for 48 hours. Dry matter intake was calculated by subtracting DM refused from DM offered.

Data were analyzed as a completely randomized design with individual animal as the experimental unit. Model fixed effects included CCDS inclusion level, supplemental metabolizable protein, and the level x protein interaction. Orthogonal contrasts were constructed to test the linear and quadratic effects of inclusion level within No MP and MP diets when an interaction occurred, or for the main effect of level no interaction was observed.

Results

Experiment 1

Heifer BW and BCS data are presented in Table 3. By design, initial BW and BCS were similar between treatments. Average daily gain was greater for DDGS than CCDS heifers (1.22 and 0.67 lb, respectively). As a result, DDGS heifers had increased final BW relative to CCDS females upon completion of the trial. Although not statistically different, BCS responded in similar fashion and was 0.40 units greater for DDGS than CCDS heifers.

Reasons for the difference in gain between treatments are not clear. DDGS heifers were bunk-fed and consumed essentially all their supplement daily, whereas CCDS heifers had ad libitum access to treated hay. Even though metal bale feeders were used, CCDS heifers appeared to waste a considerable amount of forage which may have produced differences in co-product intake. Differences in metabolizable protein also may have contributed to the gain response observed because DDGS contains more UIP than CCDS (65% vs. 20% of CP, respectively). Therefore, Experiment 2 was designed based on these results to further investigate contributing factors.

Experiment 2

The dietary nutrient composition and daily protein balance of treatments are shown in Table 4. Protein balances were calculated using the 1996 NRC model based on average BW, DMI, and ADG during the feeding period. Supplements for all MP diets were formulated to meet, but not greatly exceed, requirements for metabolizable protein.

Steer performance data are presented in Table 5. There was a significant level by protein interaction for ADG. Within No MP diets, daily gain increased linearly as CCDS inclusion level increased. However, the response to increased dietary CCDS was both linear and quadratic for MP diets. Supplemental metabolizable protein improved ADG and final BW, but only for cattle fed diets with no added CCDS. Final BW increased linearly with greater levels of CCDS regardless of supplemental protein.

Dry matter intake was not affected by supplemental metabolizable protein, but did increase linearly with elevated levels of CCDS. The level by protein interaction was significant for F:G; however, F:G improved linearly as CCDS inclusion level increased regardless of supplemental metabolizable protein. Cattle fed MP diets had improved F:G compared to those fed No MP diets but only up to 15% CCDS (DM basis).

The greatest response to supplemental metabolizable protein occurred for cattle fed diets with 0% CCDS. This is expected given those animals are the most deficient as predicted by the NRC model (Table 4). Supplementing to meet requirements had minimal impact for cattle fed 15% or 30% CCDS (DM basis). Apparently, the metabolizable protein deficiency at these inclusion levels was too small to elicit differences in gain. This suggests the results observed in Experiment 1 were likely due to other factors, not a metabolizable protein deficiency. In Experiment 2, cattle responded to greater levels of CCDS-treated hay implying successful within-bale storage occurred. Collectively, data indicate grass hay bales treated with CCDS have acceptable feeding value for use in growing diets which could minimize the need for additional protein or energy supplementation and storage facilities for CCDS.

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Effects of Feeding Condensed Distillers Solubles With and Without Oil Extraction on Growing Cattle Performance

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Summary

A growing study compared the effects of condensed distillers solubles (CDS) with and without corn oil removal at 20 and 40% inclusion in a grass hay diet and 40% inclusion in wheat straw or grass diets. Steers responded positively to increasing levels of CDS. Fat content had no effect on ending BW, DMI, or ADG but impacted F:G. Steers fed normal fat CDS had 13.6% greater F:G at 20% inclusion but only 1% greater F:G at 40% inclusion than de-oiled CDS. Normal CDS had greater value at 20% inclusion but at 40% inclusion, oil content likely hindered fiber digestion.

Introduction

Two recent studies conducted at the University of Nebraska–Lincoln have shown that condensed distillers solubles (CDS), which is typically added back to distiller grains, can be the sole byproduct in forage diets for growing cattle (*2009 Nebraska Beef Cattle Report*, pp. 30 and 35). The ethanol industry has the ability to remove a portion of the corn oil from CDS which produces a de-oiled byproduct for the livestock industry. The objectives of this study were to: 1) evaluate CDS with (normal) and without (de-oiled) corn oil at 20% and 40% inclusion; and 2) compare normal fat and de-oiled CDS in a grass diet to a wheat straw diet on growing performance.

Procedure

An 84-day growing trial utilized 60 crossbred steer calves (BW = 530 ± 31 lb) that were individually fed using the Calan gate system. Prior to initiation of the trial, steers were limit fed 50% wet corn gluten feed and 50% grass hay at 2% of BW for five days to minimize gut fill, and then weighed on three consecutive days to determine initial BW. Based on initial BW, steers were stratified and assigned randomly to one of seven treatments within strata. Of the seven treatments (Table 1), five of the treatments were designed as a 2x2+1 factorial consisting of 20% or 40% de-oiled (6.3% fat) or normal CDS (20.1% fat) and a control diet with no CDS (+1). These diets also contained a 80:20 blend of brome hay and sorghum silage (GRASS) that CDS replaced. The last two treatments were designed as a separate 2x2 factorial comparing de-oiled and normal fat CDS with different forage bases of either wheat straw or the GRASS diet in the previous treatments with 40% de-oiled or 40% normal CDS.

The six treatments containing CDS consisted of 8 steers per treatment with the control diet containing 12 steers. All diets were formulated to meet metabolizable protein requirements using the 1996 NRC model. Feed refusals were sampled weekly, weighed, and then dried in a 60°C forced air oven for 48 hours to calculate DMI. At the conclusion of the trial, steers were limit fed for five days receiving the 50% wet corn gluten feed and 50% grass hay diet. Steers were weighed on three consecutive days and averaged to determine ending BW. All diets were formulated to provide 200 mg/steer daily of monensin.

Data were analyzed using MIXED procedures of SAS as a completely randomized design with animal serving as the experimental unit. The 2x2+1 factorial design was analyzed for a fat (de-oiled, normal) by CDS level (20, 40) interaction, and using the control, orthogonal contrasts were used to evaluate level of either

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Table 1. Diet composition on a DM basis fed to growing steers.

	Control	De-oiled CDS[1]		Normal CDS[1]		De-oiled WS[1]	Normal WS[1]
Ingredient, % of DM	0	20	40	20	40	40	40
Brome Hay	77.1	59.6	42.2	59.6	42.2	—	—
Sorghum Silage	19.3	14.9	10.5	14.9	10.5	—	—
Wheat Straw	—	—	—	—	—	55.2	55.2
CDS: De-Oiled	0	20	40	—	—	40	—
CDS: Normal Fat	0	—	—	20	40	—	40
Supplement[2]	3.7	5.5	7.3	5.5	7.3	4.8	4.8
CGM[3]	2.0	3.4	4.8	3.4	4.8	2.5	2.5
Analyzed Composition, %							
Dietary Fat	1.47	2.39	5.15	3.23	8.83	2.91	8.42

[1]CDS = Condensed Distillers Solubles; WS = Wheat Straw.
[2]Formulated to provide 200 mg/steer daily of Rumensin.
[3]Corn gluten meal increases in supplement as CDS inclusion increases in diet.

Table 2. Effects of de-oiled and normal fat CDS fed at 20 or 40% in grass diets.

		De-Oiled		Normal					De-Oiled		Normal Fat	
	0	20	40	20	40	SEM	Int[1]	Fat[2]	Lin[3]	Quad[4]	Lin[3]	Quad[4]
Initial BW, lb	530	532	527	531	528	11	0.94	0.99	0.98	0.76	0.78	0.94
Ending BW, lb	637	702	770	712	783	15	0.93	0.54	<0.01	0.99	<0.01	0.99
DMI, lb/day	12.5	15.3	16.4	14.3	17.1	0.6	0.16	0.85	<0.01	0.14	<0.01	0.36
ADG, lb	1.27	2.01	2.88	2.15	3.03	0.10	0.94	0.21	<0.01	0.66	<0.01	0.93
F:G[5]	9.80	7.58	5.71	6.67	5.65		0.14	0.07	<0.01	0.56	<0.01	0.10

[1]Int = Effect of CDS level and fat content interaction.
[2]Main effect of oil removal.
[3]Lin. = *P*-value for the linear response to CDS inclusion.
[4]Quad = *P*-value for the quadratic response to CDS inclusion.
[5]F:G was analyzed as G:F, the reciprocal of F:G.

Table 3. Effect of forage and 40% distillers solubles (CDS) with or without oil on growing performance.

	40 GRASS		40 Wheat Straw			*P*-values		
	De-Oiled	Normal	De-Oiled	Normal	SEM	Int[1]	Fat[2]	Forage[3]
Initial BW, lb	527	528	527	529	11	0.94	0.89	0.97
Ending BW, lb	770	783	686	674	15	0.43	0.97	<0.01
DMI, lb/day	16.4[a]	17.1[a]	13.4[b]	11.5[c]	0.6	0.06	0.41	<0.01
ADG, lb	2.88	3.03	1.89	1.72	0.10	0.13	0.92	<0.01
F:G[4]	5.71	5.65	6.99	6.76		0.84	0.40	<0.01

[a,b,c]Within a row, means without a common superscript differ.
[1]Int = Effect of fat content and forage type interaction.
[2]Main effect of fat content.
[3]Main effect of forage type.
[4]F:G was analyzed as G:F, the reciprocal of F:G.

de-oiled or normal CDS. The other 2x2 factorial design was analyzed for a fat (de-oiled, normal) by forage type (GRASS or wheat straw) interaction.

Results

The fat contents of the de-oiled and normal CDS were 6.3% and 20.1%, respectively. Crude protein was slightly greater in the de-oiled CDS (28.0%) than in the normal fat CDS (26.4%), suggesting CP or nutrient concentration may slightly increase when corn oil is removed. The sulfur content for the de-oiled and normal fat CDS was 0.99% and 0.83%, respectively. The DM content of de-oiled and normal fat CDS was 27.0 and 27.5%, respectively.

Level of Solubles

Ending BW, DMI, and ADG increased linearly with increasing levels of CDS ($P < 0.01$), but fat content of CDS did not impact ($P > 0.21$) these variables (Table 2). There was a tendency ($P = 0.14$) for an interaction between solubles level and oil content for F:G. Feed conversion was 13.4% improved for normal CDS than de-oiled CDS when both were fed at 20% of the GRASS diet. When fed at 40% of the GRASS diet, feed conversion differed only 1%. When analyzed including the control, the de-oiled level response was linear ($P < 0.01$) while the normal CDS level response tended to be quadratic ($P = 0.10$). We conclude that a biological interaction exists due to a negative impact of dietary oil on fiber digestion at high inclusions of CDS in the diet. Past research has shown that unsaturated fat such as corn oil, is toxic to fiber digesting bacteria.

Forage Type

Analyzing the 2x2 factorial for forage type and oil content, an interaction was observed ($P = 0.06$) for DMI, tended to for ADG ($P = 0.13$), and no interaction for BW or F:G ($P > 0.43$) (Table 3). Dry matter intake was not different ($P = 0.43$) between de-oiled and normal fat CDS in GRASS treatments, but was lower ($P = 0.06$) for normal fat CDS compared to de-oiled CDS in wheat straw diets. Steers fed GRASS diets had greater DMI than either wheat straw treatment ($P < 0.01$). Ending BW was greater for steers fed GRASS diets compared to steers fed wheat straw due to greater ADG. Even though DMI was greater for GRASS diets, F:G was better (5.67) for GRASS fed steers than steers fed wheat straw (6.85). At 40% inclusion, fat content of CDS had no impact on F:G ($P > 0.40$) in either type of diet.

Growing calves fed CDS had greater ending BW and ADG with increasing inclusions of CDS. Fat content of CDS impacted F:G with steers fed the normal fat being 13.4% more efficient at the 20% inclusion level than the steers fed de-oiled diets, but there was no difference between the two at the 40% level of CDS. The response in F:G due to CDS inclusion suggests that oil may have hindered fiber digestion at 40% inclusion of CDS in forage diets.

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Replacement of Grazed Forage and Animal Performance When Distillers Grains are Fed in a Bunk or on the Ground

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Summary

A 120-day grazing experiment estimated forage savings, performance, and ground feeding efficiency when supplementing spayed yearling heifers with modified distillers grains with solubles (MDGS) at 0.6% of BW on native Sandhills range. Supplemented heifers had 1.28 lb greater ADG and consumed 15.9% less forage. Each 1 lb of MDGS supplement fed replaced approximately 0.7 lb of forage. Loss of MDGS when ground-fed was 4.3%. Supplementing spayed yearling heifers with MDGS at 0.6% BW decreased forage consumption 15.9% and increased gain.

Introduction

Distillers grains fits well into forage situations as it has a highly fermentable fiber source which does not hinder forage digestion, and also supplies undegradable intake protein (UIP) to meet metabolizable protein deficiencies common in grazing situations (*2004 Nebraska Beef Cattle Report,* p. 25).

Distillers grains supplementation increases ADG of growing cattle while reducing forage intake in a forage-based system *(2005 Nebraska E Beef Cattle Report,* p. 18). Forage intake was reduced 0.5 lb for each 1.0 lb of distillers grains fed, as summarized from six distillers grains supplementation studies (2007 *Nebraska Beef Cattle Report*, p. 10). Distillers grains loss when ground-fed appears to be affected by distillers grain form, animal type, and grazing situation. Wet distillers grains with solubles (WDGS) fed to yearling steers on Sandhills winter range resulted in a 13-20% loss (*2010 Nebraska Beef Cattle Report,* p. 17), while dried distillers grains with solubles (DDGS) fed to calves on a subirrigated meadow resulted in a 36-41% loss (*2012 Nebraska Beef Cattle Report*, p. 51). Thus, this study's objectives were to determine forage replacement rate and performance of spayed yearling heifers when supplemented with MDGS at 0.6% BW in a native Sandhills range situation, and calculate MDGS loss that resulted from ground feeding.

Procedure

Twenty-four spayed yearling heifers were stratified by initial BW (571 ± 32 lb) and randomly assigned to treatment. Treatments were no supplementation (control), MDGS supplementation fed at 0.6% of BW daily in a bunk, and MDGS supplementation fed at 0.6% of BW daily on the ground. Ground-fed heifers were fed at a different location within their paddock each day. There were two replications per treatment, with four heifers per replication. Treatments were randomly assigned to an east and west grazing block to minimize differences in plant species and topography. Heifers grazed upland Sandhills summer range 120 days at the Gudmundsen Sandhills Laboratory near Whitman, Neb., beginning May 18, 2011. At the conclusion of summer grazing, heifers were transported to the ARDC, limit fed five days at 1.8% BW (DM), and weighed. Final BW was the mean of consecutive two-day BW measurements.

Each replication rotated through six, 2.47 acre paddocks twice throughout the grazing season. Paddocks were stocked at 0.8 AUM/acre. Grazing days per paddock were increased during the second grazing cycle to account for additional forage growth. Based on previous research that distillers supplementation results in a 17% forage replacement rate when fed at 0.6% BW daily, paddocks were stocked for equal grazing pressure between treatments by allowing control cattle to graze each of their paddocks for 17% less time than supplemented cattle. This was achieved by moving control cattle one or two and one-half days earlier than supplemented cattle during a six- and 14-day grazing cycle, respectively, from their grazing paddock to a pasture of similar forage species composition. There, control cattle were managed separately until rotating into their next paddock on the same day that supplemented cattle rotated.

Forage diet samples were collected using esophageally-fistulated cows at the midpoint of each grazing rotation during the first, third, and fifth rotations of both grazing cycles, for 12 total collections. Extrusa samples were analyzed for CP, NDF, and IVDMD. *In vitro* dry matter digestibility was determined through two separate *in vitro* runs. Five forage standards of varying qualities with known *in vivo* DM digestibilities were included in both IVDMD runs. Regression equations were generated for each run by regressing the IVDMD values of the standards on their known digestibilities to then correct all the IVDMD to *in vivo* values.

Gains were estimated throughout the summer at 1.5 lb/head and MDGS feeding amounts were adjusted monthly to account for projected cattle gain. Samples of MDGS were collected twice monthly to calculate DM and used to adjust feeding amount to 0.6% BW on a DM basis. A MDGS

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Table 1. Forage quality over time[1].

Sample dates	5/20-21	6/1-2	6/13-14	6/23-24	7/21-22	8/18-19
CP%	10.6	10.3	11.1	8.8	8.4	8.7
NDF%	64.9	64.6	55.8	69.1	70.6	70.8
IVDMD%	65.5	64.8	64.5	66.9	56.0	50.5

[1]Sequence of grazing paddocks over summer, from May 20 through Aug. 19, 2011.

Table 2. Performance response of heifers to distillers grains.

	Treatment[1]				
	Control	Bunk-fed	Ground-fed	SEM	*P*-value
Initial BW, lb	575[a]	563[a]	577[a]	12	0.65
ADG, lb	1.17[a]	2.51[b]	2.39[b]	.08	<0.01
Ending BW, lb	726[a]	881[b]	878[b]	16	<0.01

[ab]Means with different superscripts differ (*P*-value < 0.01).
[1]Cattle received no supplementation or daily MDGS supplementation at 0.6% BW fed in a bunk or on the ground daily MDGS supplementation at 0.6% BW fed in a bunk or fed on the ground.

Table 3. Residual forage post-grazing (lb/ac)[1].

	Treatment[1]				
	Control	Bunk-fed	Ground-fed	SEM	*P*-value
Total live[3]	1202	1338	1210	127	0.38
Standing dead	448	559	420	56	0.22
Litter	918	950	687	114	0.24

Means with different superscripts differ (*P*-value < 0.01).
[1]Average post-grazing values from six paddocks per treatment over three clipping dates (early July, late July, late August).
[2]Paddocks grazed by control cattle, bunk-fed cattle, or ground-fed cattle.
[3]Total live represents live grass, forbs, and shrubs.

composite sample was analyzed to determine nutrient composition (31% CP, 12% fat, 25% NDF).

At the conclusion of grazing each paddock during the first, third, and fifth grazing periods of the second grazing cycle, 10 quadrats (2.69 ft^2) were hand clipped at ground level in each paddock. Forage was sorted by live material, standing dead, litter, forbs, shrubs, and cactus. Samples were dried in a forced-air oven for 48 hours at 60°C, weighed, and residual forage per acre was calculated to verify forage replacement and evaluate the equal grazing pressure hypothesis between treatments.

The 1996 NRC model was used to estimate range forage intake based on cattle performance and supplement intake. The model also was used to retrospectively calculate the MDGS intake difference between bunk and ground-fed treatments.

All data were analyzed using the MIXED procedure of SAS.

Results

During the grazing season, paddocks averaged 10% CP, 66% NDF, and 61% IVDMD. Table 1 shows range forage quality throughout the grazing season, illustrating a general decline in CP and IVDMD, and a general increase in NDF as forages matured. Supplemented cattle gained more (2.43 vs. 1.17 lb/day; $P < 0.05$) and had greater ending BW (880 vs. 726 lb; $P < 0.05$) than control cattle (Table 2). Heifers supplemented on the ground gained 0.12 lb/day less than those fed in bunks, a difference that was not statistically significant ($P = 0.28$). However, using the 0.12 lb/day difference, retrospective analysis estimated 4.3% of offered MDGS was lost when ground-fed. Each 1 lb of MDGS supplement fed replaced approximately 0.68 lb of forage intake, which equates to a 15.9% forage replacement rate.

There was no difference ($P = 0.38$) in residual forage among paddocks grazed by different treatment groups (Table 3). This lack of difference illustrates equal grazing pressure by supplemented and unsupplemented heifers, as grazing days had been adjusted assuming a 17% forage savings when supplementing MDGS at 0.6% BW to yearlings in a range situation.

Supplementing MDGS to spayed yearling heifers at 0.6% BW daily effectively increased summer grazing gains and reduced forage needs 15.9%. There was no performance advantage to bunk feeding over ground feeding.

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Field Peas as a Binder for Dried Distillers Grains-Based Range Cubes

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Summary

A grazing study was conducted to determine if field peas are a good natural binder for dried distillers grains-based range cubes. Cattle supplemented dried distillers grains in the bunk or a 25% field pea/75% distillers grains cube fed on the ground gained similarly and outgained cattle supplemented dried distillers on the ground. A 25.6% loss of the distillers grains fed loose on the ground was estimated. The similar performance of cattle fed distillers grains in the bunk and those fed pea/distillers cube on the ground suggests field peas reduced distillers grains loss and therefore are an acceptable binder for distillers grains based range cubes.

Introduction

Farmers in the Nebraska Panhandle are becoming more interested in the value of raising field peas as an option to reduce fallow time in dryland wheat rotations. The availability of this commodity has sparked interest in its value as a feed for beef cattle. Research has indicated that field peas are palatable, result in no reduction in animal performance, and enhance carcass tenderness. Dried distiller's grains (DDGS) are a good protein supplement for grazing cattle but when fed loose can result in substantial waste. Field peas are a good binder when making range cubes and supply degradable intake protein (DIP) to complement the undegradable intake protein (UIP) supplied by the distiller's grains. Feeding supplement on the ground as opposed to using stationary bunks allows producers to encourage more uniform grazing by supplementing in different locations throughout the pasture. Therefore, the objective of this study was to determine if field peas would make a good natural binder for DDGS cubes to prevent waste.

Procedure

A grazing experiment was conducted over two years. In year 1, 108 crossbred yearling heifers (initial BW = 744 ± 31 lb) were utilized in a randomized complete block designed grazing trial at the High Plains Agricultural Lab (HPAL) near Sidney, Neb. Heifers were weighed two consecutive days with the average of the two weights used as initial BW. Heifers were blocked by weight and assigned randomly to one of nine 105-acre pastures (12 head/pasture). Heifers grazed from June 22-Oct. 5, 2010. In year 2, 90 crossbred steers (initial BW = 706 ± 22 lb) were utilized in a complete randomized design in the same pastures as year 1 (10 head/pasture). The average of two consecutive day weights was used for initial BW. At the termination of the grazing period the average of two consecutive day BW was used as the ending BW. Steers began grazing May 17, 2011, and the second day final weight was taken Sept. 7, 2011.

In both years three pastures were assigned to each treatment. Treatments were DDGS fed on the ground (GROUND), DDGS fed in a bunk (BUNK), or a 25% field pea, 75% DDGS cube fed on the ground (CUBE). The amount of supplement fed was designed to supply 0.6 lb of CP daily for each treatment (Table 1). The variation in the CP content of the field pea/DDGS cube between years is likely due to variation in the CP content of field pea varieties. The weekly amount of supplement was prorated and fed three times per week. Cattle were rotated through the nine pastures every two weeks to minimize pasture effect. Forage samples were randomly clipped (Aug. 17, 2010 and July 5, 2011) at ground level and IVDMD and CP concentration of the

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Table 1. Crude protein content and amount of supplement fed (DM basis) to cattle grazing crested wheatgrass pastures.

	DDGS[1]	CUBE[2]
% CP		
Year 1 (2010)	30.7	20.6
Year 2 (2011)	30.7	27.1
Amount Fed (lb/head/day)		
Year 1 (2010)	2.0	3.1
Year 2 (2011)	2.0	2.2

[1]DDGS fed loose in a bunk or on the ground.
[2]25% field pea, 75% DDGS cube fed on the ground.

forage samples was determined.

Data were analyzed using the MIXED procedure of SAS with pasture as the experimental unit. The model included the fixed effect of treatment, year, and the treatment by year interaction. Cattle were individually weighed and weights averaged for each pasture. Effects were considered significant at a *P*-value of ≤ 0.05, with tendencies declared at *P*-values between 0.05 and 0.10.

Results

The year x treatment interaction was not significant ($P > 0.13$) for initial BW, final BW, and ADG so the main effects of treatment are presented. By design, initial BW was not different ($P > 0.50$; Table 2). Conversely, final BW and ADG were less ($P < 0.01$) for steers supplemented GROUND compared with CUBE and BUNK which were not different. In this study the National Research Council Nutrient Requirements of Beef Cattle (NRC 1996) was used to estimate waste. Using BUNK ADG (1.54 lb/day), DDGS fed (2.0 lb/day), and the TDN of the forage and DDGS (58% and 110%, respectively), forage intake was predicted. Forage TDN was calculated from ADF by Servi-Tech Laboratories. The TDN of the DDGS was estimated from earlier reported research (*Journal of Animal Science,* 2008, 86:3504). Holding forage intake constant (16.7 lb/day) and using GROUND gain (1.34 lb/day), the amount of DDGS consumed to result in the decreased gain was predicted to be 1.47 lb/day. This suggests an estimated 25.6% loss in DDGS when fed loose on the ground. The similar performance of CUBE and BUNK suggests the field pea served as an acceptable binder for the DDGS. Feeding supplement in a bunk reduces supplement waste but typically will cause overgrazing near the feeders. However, costs associated with purchasing and moving bunks are incurred using this management method. As a result, many producers prefer to feed supplement on the ground, which encourages cattle to move throughout the pasture for more uniform grazing. Additionally, the degradable CP (% of CP) of several field pea varieties has been determined to be between 46-74% (*Journal of Animal Science,* 2012 , 90:585). Conversely, the undegradable intake protein fraction is 73% (% of CP) for DDGS. Therefore, the combination of field peas and DDGS in a range cube may supply a good balance of UIP and DIP on dormant native range.

Crude protein and IVDMD of the crested wheatgrass are shown in Table 3. The CP and IVDMD of the crested wheatgrass were higher in the second year due to an earlier collection date and a greater amount of precipitation. The results of this study suggest field peas are an acceptable binder for DDGS based range cubes. A 25% field peas, 75% DDGS range cube can be fed on the ground as a protein and energy supplement to grazing cattle with minimal wastage. This would potentially allow producers to use supplementation to improve grazing distribution without the labor and expense of using bunks.

Table 2. Performance of cattle grazing crested wheatgrass pastures supplemented with DDGS on the ground, in a bunk, or a 25% field pea, 75% DDGS cube on the ground.

	GROUND	BUNK	CUBE[1]	SE
Initial weight, lb	735	737	733	24
Final weight, lb	800[a]	902[b]	900[b]	24
Daily gain, lb/day	1.34[a]	1.54[b]	1.56[b]	0.15

[1]GROUND = DDGS fed loose on the ground, BUNK = DDGS fed in a bunk, CUBE= 25% field pea, 75% DDGS cube fed on the ground.
[a,b]Treatment values with differing superscripts differ $P < 0.01$.

Table 3. Crude protein and *in vitro* dry matter disappearance of clipped samples from crested wheatgrass pastures.

	CP, %DM	IVDMD, %DM
Aug. 17, 2010[a]	4.8	46.7
July 5, 2011	6.9	56.0

[a]Samples clipped at approximately the midpoint of the grazing season.

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Strategic Supplementation of Dried Distillers Grains Plus Solubles to Yearling Steers Grazing Smooth Bromegrass

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Summary

Data from seven consecutive years were summarized from 2005 through 2011 to evaluate dried distillers grains plus solubles (DDGS) supplementation strategies on yearling performance when grazing smooth bromegrass pastures. Steers supplemented daily with DDGS on nonfertilized smooth bromegrass pastures had ADG 0.59 lb/day greater than unsupplemented steers. Steers strategically supplemented with DDGS gained 2.47 lb/day while steers supplemented daily at 0.6% of BW gained 2.68 lb/day, both greater than unsupplemented steers at 1.99 lb/day. Strategic supplementation with increasing levels of DDGS as forage digestibility declined did not improve cattle performance over steers supplemented at 0.6% of BW with DDGS daily.

Introduction

Supplementing dried distillers grains plus solubles (DDGS) to grazing cattle throughout the grazing season (April through September) has shown increased ADG and BW gain with decreased forage intake (*2005 Nebraska Beef Cattle Report,* p. 18; *2007 Nebraska Beef Cattle Report,* p. 10). As forage quality of smooth bromegrass declines with maturity, ADG response to DDGS supplementation increased quadratically (*2011 Nebraska Beef Cattle Report,* p. 24). We hypothesized overall ADG would increase for steers strategically supplemented with lower levels of DDGS early in the grazing season followed by greater levels of DDGS with the declining forage quality through the remainder of the season. The objective was to determine the effect of DDGS supplementation strategies of yearling steers grazing smooth bromegrass pastures in eastern Nebraska.

Procedure

One hundred and fifty yearling crossbred steers (BW = 659 ± 23 lb) were used to evaluate strategies of supplementing DDGS to cattle grazing smooth bromegrass during the 2010 and 2011 grazing seasons at the University of Nebraska–Lincoln Agriculture Research and Development Center (ARDC) near Mead, Neb. The four treatments of grazing and supplementation strategies tested were: 1) paddocks fertilized in the spring with 80 lb N/acre and stocked at 4 AUM/acre (FERT); 2) nonfertilized paddocks with steers supplemented at 0.6% of BW daily with DDGS (DM) and stocked at 4 AUM/acre (SUPP); 3) nonfertilized paddocks with steers strategically supplemented daily with DDGS (DM) at increasing amounts over the grazing season and stocked at 4 AUM/acre (STRAT); and 4) nonfertilized control paddocks with no supplementation and stocked at 2.8 AUM/acre, or 69% the rate of the other three treatments (CONT).

Annually, 75 yearling steers were stratified by BW and allocated to treatment paddocks. Pastures were grazed starting in late April for 147 days and 168 days in 2010 and 2011, respectively. Treatment paddocks were divided equally into six strips in which treatment steers grazed rotationally in each of five grazing cycles. Steers grazed 24 day during cycle 1. Cycles 2, 3, and 4 were 36 days in length. Cycle 5 was 24 days and 36 days in 2010 and 2011, respectively. Similar grazing pressures were maintained with the addition of "put-and-take" steers. Initial and ending BW were collected on three consecutive days following a 5-day limit feeding period. During the limit feeding period, steers were fed a 50:50 blend of alfalfa hay and *SweetBran*® at 2% BW to reduce variation in gut fill. In 2010 and 2011, steers were implanted with Revalor®-G on day 1. Interim BW were collected on the morning of the first day of each of the five cycles and shrunk 4%.

Steers supplemented at 0.6% BW received DDGS supplement (CP 28.9%, fat 11.9%, and NDF 31.7%) amounts based on BW collected over the grazing period. Strategically supplemented steers received 2.0 lb/day DDGS (DM) during cycle 1 to meet MP requirements and increased 1.5 lb/day (DM) during cycles 2, 3, and 4. Cycle 5 supplementation was adjusted so STRAT steers received an equal amount of DDGS lb/steer (DM) over the entire grazing season as SUPP steers (Table 1).Using ruminally fis-

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Table 1. DDGS treatment supplementation amounts (lb of DM/steer) for 2010 and 2011.

	2010		2011	
Cycle	SUPP[1]	STRAT[2]	SUPP[1]	STRAT[2]
1	3.88	2.00	4.07	2.00
2	4.24	3.50	4.48	3.50
3	4.82	5.00	5.08	5.00
4	5.42	6.50	5.17	6.50
5	5.77	7.15	5.65	6.77
Average	**4.83**	**4.83**	**4.95**	**4.95**

[1]SUPP – DDGS at 0.6% of BW supplementation.
[2]STRAT – Strategic DDGS supplementation.

tulated steers, diet samples were collected and analyzed for IVDMD for all treatments to estimate diet quality throughout the grazing season.

There were four replications of the FERT, SUPP, and CONT treatments. Three of these replications were established in 2005 with treatments applied to the same smooth bromegrass pastures throughout 2011. There were three replications of STRAT applied in 2010 and 2011. Treatment paddocks (with six strips) were the experimental unit and smooth bromegrass pastures were the block. Cattle performance was analyzed using the MIXED procedure of SAS.

Results

Ending BW and ADG were greatest for steers supplemented daily ($P < 0.01$, Table 2) with no statistical difference between supplementation strategies. Supplementation at 0.6% BW and strategic supplementation resulted in gains of 2.68 and 2.47 lb/day, respectively, compared to the unsupplemented steers gaining 1.99 lb/day. The increased ADG from DDGS supplementation resulted in a 111 and 77 lb (SUPP and STRAT, respectively) increased ending BW compared to unsupplemented steers.

Average daily gains were summarized for seven consecutive years from 2005 through 2011 (Table 3). Grazing cycles were combined into two periods to correspond with the changes that occur in IVDMD of smooth bromegrass throughout the growing season. Over the grazing season, diet IVDMD and cattle ADG declined with the lower gains corresponding to lower IVDMD (*2010 Nebraska Beef Cattle Report*, p. 38). Diet IVDMD was greatest during period 1 (cycles 1 and 2) at 66.9% and declined to 51.4% in period 2 (cycles 3, 4, and 5). Therefore, ADG of unsupplemented vs. supplemented treatments were compared during period 1 and period 2 across years. Overall, ADG for steers grazing in 2010 and 2011 were greater than ADG for steers grazing during 2005 through 2009. The increased ADG is attributed to the implants (Revalor-G) and adequate moisture for grass growth. In period 1, SUPP response was 0.40 lb/day for 2005 through 2009 and 0.53 lb/day for 2010 and 2011 more than ADG for steers on unsupplemented treatments. In period 2, the decline in IVDMD resulted in an increased response to supplementation of 0.85 lb/day in 2005 through 2009 and 0.81 lb/day in 2010 and 2011. The increased response to DDGS with declining IVDMD from 2005 through 2009 suggested supplementation at key points during the grazing season would increase ADG (*2011 Nebraska Beef Cattle Report*, p. 24). In period 1, STRAT resulted in 0.24 lb/day gain response compared to the 0.53 lb/day gain increase of SUPP. The lower gain response to DDGS in period 1 was expected given that STRAT received approximately 72 and 85 lb DDGS/steer less than SUPP in 2010 and 2011, respectively. During period 2, the gain response to DDGS for STRAT cattle was 0.64 lb/day, less than the 0.81 lb/day gain increase of SUPP. The ADG response for STRAT in period 2 was expected to be greater than that of SUPP given the cattle received approximately 66 and 85 lb/steer more DDGS in 2010 and 2011, respectively.

Overall, when compared to supplementing cattle with DDGS at a constant 0.6% of BW daily throughout the grazing season, there was no advantage in cattle performance by strategically supplementing DDGS at increased levels to steers grazing smooth bromegrass during periods of low forage digestibility. However, the combination of adequate moisture for quality forage growth, with the use of implants and supplementing DDGS to cattle grazing smooth bromegrass did markedly improve ADG.

Table 2. Performance of steers grazing smooth bromegrass during 2010 and 2011.

	Treatments[1]					
	CONT	FERT	SUPP	STRAT	SEM	*P* –Value
Days	158	158	158	158		
Initial BW, lb	663	660	660	662	16	0.71
Ending BW, lb	984[b]	964[b]	1083[a]	1051[a]	37	< 0.01
ADG lb/day	2.04[b]	1.93[b]	2.68[a]	2.47[a]	0.07	< 0.01

[a,b]Means in a row without a common superscript differ ($P < 0.05$).
[1]Treatments consisted of nonfertilized paddocks (CONT), fertilized with 80 lb N/acre (FERT), nonfertilized paddocks grazed by steers supplemented daily at 0.6% of BW DDGS (SUPP) or strategic DDGS supplementation (STRAT).

Table 3. Supplementation treatment and seven-year treatment comparison.

		Period 1[4]		Period 2[4]	
Years[1]	Treatment[2]	ADG, lb/day	Difference[3]	ADG, lb/day	Difference[3]
2005-2009	Unsupplemented	2.09	0.40	1.17	0.85
	SUPP	2.49		2.02	
2010-2011	UnSupplemented	2.55	0.53	1.64	0.81
	SUPP	3.08		2.45	
	STRAT	2.79	0.24	2.28	0.64

[1]Cattle performance treatment avg during 2005-2009 and 2010-2011 smooth bromegrass grazing seasons.
[2]Treatments consisted of unsupplemented = avg of the CONT and FERT, SUPP – DDGS supplemented at 0.6% of BW, STRAT – strategic DDGS supplementation within respective year.
[3]ADG difference between unsupplemented and supplementation treatments (SUPP or STRAT) during respective years.
[4]Period 1 – Cycle 1 and 2 (approximately late-April through mid-June); Period 2 – Cycle 3, 4, and 5 (approximately mid-June through late September).

[1]Stephanie K. Moore, graduate student; Cody J. Schneider, Brandon L. Nuttelman, Dirk B. Burken, research technicians; Terry J. Klopfenstein, professor; Galen E. Erickson, professor, University of Nebraska–Lincoln Department of Animal Science, Lincoln, Neb.; Kelly R. Brink, research technician; Walter H. Schacht, professor, UNL Department of Agronomy and Horticulture.

Economic Analysis Update: Supplementing Distillers Grains to Grazing Yearling Steers

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Galen E. Erickson
Walter H. Schacht[1]

Summary

A seven-year study from 2005-2011 was conducted to evaluate four grazing management strategies for backgrounding yearling steers on smooth bromegrass pastures. Economic budgets were used to calculate profit differences with current (April 2012) market prices. Overall, cattle receiving supplement had greater net returns, lower cost of gain, and lower breakeven prices. In recent years fertilizer prices have increased at a greater rate than land costs in Nebraska, making it more economical to use a lower stocking rate instead of fertilizing pastures. As land prices increase, the incentive to use either N fertilizer or DDGS supplementation increases.

Introduction

Over the past two years, prices for land, fertilizer, distillers grains, and cattle have all increased dramatically. Past data from a long-term grazing study show that from 2005-2009 supplementing grazing cattle at 0.6% of BW with distillers grains throughout the summer was more profitable than not supplementing cattle and fertilizing pastures (*2011 Nebraska Beef Cattle Report*, p. 26). The objective of this study was to re-evaluate the economics of these treatments using more recent prices. Net returns for four grazing management strategies were compared after seven years of collecting pasture and cattle performance data with yearling steers on smooth bromegrass pastures.

Procedure

Biological data were collected during two time periods: 1) a five-year period from 2005-2009 (*2011 Nebraska Beef Cattle Report*, p. 24) and 2) a two-year period from 2010-2011 (*2013 Nebraska Beef Cattle Report*, p. 31). Over the seven-year study, three grazing strategies were evaluated: 1) paddocks fertilized in the spring with 80 lb N/acre and stocked at 4 AUM/acre (FERT); 2) nonfertilized paddocks with steers supplemented daily with dried distillers grains plus solubles (DDGS) at 0.6 % of BW and stocked at 4 AUM/acre (SUPP); and 3) control paddocks with no fertilizer applied or cattle supplementation and stocked at 2.8 AUM/acre (CONT). During the two-year period, an additional grazing strategy was evaluated: 4) nonfertilized paddocks where steers were strategically supplemented with DDGS at increasing amounts over the grazing season and stocked at 4 AUM/acre (STRAT).

During the 2010 and 2011 grazing seasons, steers were implanted with Revalor®-G while no implant was used during 2005-2009. The initial five-year period was used to compare management strategies without any confounding effects due to implanting. During the following two-year period, cattle were managed the same and a response to the implant was seen across all treatments.

Economics

All prices were based on current markets (April 2012) in Nebraska (Table 1). Total costs for each system included initial steer price plus interest, yardage, health and processing fees, death loss, cash rent plus interest, and fertilizer or DDGS cost for FERT, SUPP, and STRAT treatments. Yardage was included at $0.10/steer/day to account for checking animals, maintenance of fences, and watering. An $8.33/steer health and processing fee was charged over the grazing period. Death loss of 0.5% was charged, based on initial steer cost. Cash rent was $30/AUM, the 2012 average cash rent price for eastern Nebraska. Fertilizer prices of $630/ton urea were used plus a $4/acre application fee. Dried DGS supplement was valued at $182/ton on a 90% DM basis. An additional $24/ton was added for delivery and handling of DDGS. Interest on calves and cash rent averaged 7.6%.

Cattle prices for initial costs and final live value were chosen in order that the CONT steers would break even over the seven-year study.

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Table 1. Input costs for economic analysis.

Initial steer cost	$1.58; 675-725 lb $1.62; 625-675 lb
Final steer value	$1.29; 1045-1095 lb $1.38; 950-1000 lb
Yardage	$0.10/steer/day; $15.81/steer
Health and processing	$8.33/steer
Death loss	0.5%
Implant	$2/steer for years 2010 – 2011
DDGS	$182/ton plus $24/ton delivery and handling fee
Fertilizer	$630/ton urea plus $4/acre application fee
Land cash rent	$30/AUM

Table 2. Economic evaluation of grazing management and supplementation strategies for steers grazing smooth bromegrass pastures. All values are reported as $/steer.

Treatment[1]	CONT	FERT	SUPP	STRAT	SEM	*P*-value
Two-year, 2010-2011						
Initial cost	1071.61	1066.34	1067.47	1069.70	11.80	0.98
Ending value	1356.03	1328.62	1395.03	1354.04	23.57	0.17
DDGS			79.81	79.81		
Fertilizer		64.08				
Land cash rent[2]	169.35	109.83	109.22	107.70		
Total cost	1304.28	1301.92	1318.21	1318.95	14.93	0.72
Net return	51.75[ab]	26.71[b]	76.82[a]	35.09[b]	15.43	0.07
Cost of gain, $/cwt gained	64.76[a]	68.85[a]	52.87[b]	57.13[b]	2.45	< 0.01
Breakeven, $/cwt end wt	132.75[a]	135.15[a]	121.76[b]	125.58[b]	1.51	< 0.01
Seven-year, 2005-2011						
Initial cost	1112.25	1109.20	1105.76		14.77	0.95
Final value	1333.76	1319.37	1364.00		15.24	0.12
DDGS			84.06			
Fertilizer		64.08				
Land cash rent[3]	158.51	104.17	101.60			
Total cost	1333.76	1338.99	1352.8		14.80	0.65
Net return	0.00	-19.62	11.20		12.72	0.23
Cost of gain, $/cwt gained	73.65[a]	78.85[a]	61.31[b]		2.36	< 0.01
Breakeven, $/cwt end wt	138.01[a]	139.92[a]	127.94[b]		1.22	< 0.01

[a,b]Means within a row with unlike superscripts differ ($P < 0.10$).
[1]Pastures were either nonfertilized (CONT), fertilized with N at 80 lb/acre (FERT), or nonfertilized and steers were supplemented with 0.6% of BW of DDGS daily (SUPP), or strategically supplemented at increasing incremental amounts (STRAT). Over the entire grazing period SUPP and STRAT cattle consumed the same amount of supplement.
[2]2010-2011 CONT = 7.16 acres stocked at 2.98 AUM/acre; FERT = 4.96 acres stocked at 4.60 AUM/acre; SUPP = 4.96 acres stocked at 4.64 AUM/acre; STRAT = 4.96 acres stocked at 4.74 AUM/acre.
[3]2005-2011 CONT = 7.16 acres stocked at 3.27 AUM/acre; FERT = 4.96 acres stocked at 4.96 AUM/acre; SUPP = 4.96 acres stocked at 5.11 AUM/acre.

When comparing stocker programs, the price slide used for buying and selling feeder calves becomes very important in order to appropriately value cattle gain. For 2010-2011, steers were 40 lb lighter, compared to calves from 2005-2009, entering the system and were bought for an additional $0.036/lb. Cattle receiving supplement throughout the summer were approximately 100 lb heavier at the end of the grazing season and were docked $0.09/lb.

Cost of gain (COG) over the grazing period was calculated by dividing total costs, minus initial steer cost and interest, by the total weight gained by the animal during the grazing season. Breakeven prices were calculated by dividing total costs by the ending shrunk BW of the animal at the end of the grazing season. Profitability was calculated as total live value of the animal in October minus total costs during the grazing season and was set at $0 for CONT steers over the seven-year period.

Results

Over the seven-year period, supplemented cattle consumed an average of 5.2 lb DDGS per steer daily which cost $84.06/steer. Each year fertilizer was applied at 80 lb N/acre and cost $64.08/steer. Cash rent values were based on stocking rate and differed among year and treatments (Table 2). Over the five-year period, all treatments had negative net returns (data not shown). In contrast, all treatments had positive net returns over the two-year period (Table 2). Initial cattle costs were lower for the two-year period because cattle were lighter. These cattle were then heavier at the end of the grazing season leading to greater ending live value. This increase in cattle performance was because of the use of implants and good moisture conditions for smooth bromegrass growth, and was the difference between positive or negative net returns over the seven years. These year effects emphasize the importance of good grass management and timely moisture for smooth bromegrass growth in order to improve cattle gains.

There were no statistical differences between treatments for profit in the seven-year analysis ($P = 0.23$; Table 2). Numerically, the SUPP cattle had the greatest returns every year, followed by CONT cattle with STRAT and FERT cattle having the lowest returns. The STRAT treatment was only evaluated during the two-year period. Cost of gain was lower ($P < 0.01$) for cattle supplemented with DDGS on either the SUPP or STRAT treatment compared to CONT or FERT cattle. Breakeven prices were also lower for supplemented cattle ($P < 0.01$).

If fertilizer prices are manipulated in order to make FERT and CONT have equal profits, a ratio of fertilizer price to grass price demonstrates when it is economical to fertilize grass instead of buying more grass. Using 2005-2009 prices and cattle

performance data, the price ratio of fertilizer to grass was 16.3. Using the five-year performance data, in conjunction with 2012 prices, gives a price ratio of 15.0. This means that if fertilizer prices are more than 15 times the price of grass, it is more economical to buy more grass instead of fertilizing existing pastures. Using the two-year performance data and 2012 prices further decreased the price ratio to 12.3. This suggests that cattle performance greatly affects the profitability of these treatments. Urea fertilizer prices have increased at a greater rate than land costs in Nebraska making it more economical to use a lower stocking rate on more acres instead of fertilizing pastures. However, this may not be a sustainable system and some N fertilizer may be required to maintain smooth bromegrass pastures in the long run. Also, pasture rent might increase substantially in the future.

Using the five-year performance data, and changing DDGS price in order to make SUPP and CONT have equal profits gives a price ratio of 6.3 for DDGS and grass price. Using the two-year performance data gives a ratio of 8.2. With grass prices of $30/AUM, this corresponds to DDGS prices of $190 or $247/ton, on a 90% DM basis. A price ratio of 2.7 for fertilizer and DDGS gives equal profits for FERT and SUPP cattle in the five-year analysis. This ratio decreases to 2.0 for the two-year analysis. The DDGS compared more favorably to grass price and fertilizer price with greater cattle gains in the 2-year analysis.

Current economics in the cattle industry are unlike any seen before. With high input costs, it is more important than ever to maximize cattle performance and trim costs where possible. In this study, an additional 80 lb gain on each animal, because of good forage growth and the use of implants, led to a $45 profit instead of $30 loss, emphasizing the importance of both cattle and forage management in backgrounding systems.

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Effect of Stocking Rate on Cow Performance and Grain Yields When Grazing Corn Residue

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Summary

Cattle grazing corn residue at a low stocking rate maintained body condition score (BCS) and gained more weight than cattle stocked at a heavy level. Corn plant part digestibilities ranged from 69% to 31% and amount of leaf, leaf sheath, and husk was about 15 pounds per bushel of grain. Subsequent grain yields show no difference between grazed, baled, or ungrazed treatments. Grazing corn residue provides a good way to maintain BCS on cows through the winter without effecting grain yield.

Introduction

Corn residue is an inexpensive way for producers to extend their grazing season and reduce the amount of stored forage needed to maintain their cows through the winter. However, with the rising costs of production and the increase in corn price, it becomes important to know how much residue is removed from a field by grazing and baling and how this impacts the grain yields in a continuous corn system. A study by Wienhold et al. (*2013 Nebraska Beef Cattle Report,* p. 40) suggests that removing 20-30% of the corn residue will leave enough residue to maintain soil health and increase soil organic matter. Therefore, the purpose of this study is to look at cattle performance at light and heavy stocking rates, and how much residue is removed with grazing compared to baling and no residue removal.

Procedure

A 130-acre center pivot irrigated corn field near Brule, Neb. was divided into eight paddocks and assigned one of four treatments: ungrazed (UG), baled (B), light grazing (LG, 1 AUM/ac), and heavy grazing (HG, 2 AUM/ac). These treatments have been maintained for four years. Cows were assigned randomly to each treatment, weighed and body condition scored before and after grazing. Cattle grazed the residue for 59 days in 2011 and 69 in 2012 days and were supplemented three times weekly with a 32% protein supplement at a level equivalent to 1 lb/head/day.

Corn plant samples were collected a week prior to harvest from 10 locations within each paddock. Each sample was 32 inches of row and all plants and litter were collected. Samples were separated into parts (stem, shank, leaf blade, leaf sheath, husk, and cob), weighed, dried in 60°C oven for 48 hours, and analyzed for organic matter digestibility. In 2011, the top 1/3 of stem was analyzed separately from the bottom 2/3 of stem and the shank was analyzed separately, but in 2012, the entire stem and shank are included in the same category. Ears from collected plants were shelled and grain yield was used to determine the amount of residue available per bushel of grain. Machine harvested grain yields were measured using the yield monitor on the combine and utilized to determine the effect of treatments on grain yields.

Results

For both 2011 and 2012 there was a significant difference ($P < 0.0001$) in final BCS for cattle assigned to the LG and HG treatments. Cattle in HG treatment lost on average 0.3 BCS and were 33 lb lighter than the LG treatment cattle coming off of the corn field (Table 1). There was no difference between treatments either year for percentage of the plant (2011 $P > 0.2036$; 2012 $P > 0.1981$), IVOMD (2011 $P > 0.3689$), or lb of residue/bu of grain (2011 $P > 0.2333$; 2012 $P > 0.0844$) (Table 2). The Bottom 2/3 of the stem makes up the largest part of the plant comprising 37% of the total followed by leaf blade(20%), cob (16%), leaf sheath (13%), husk (8%), and shank (2%). 2012 yielded

Table 1. Cow body weight and body condition scores for 2011 and 2012, pre and post corn residue grazing.

		Pre BW	Post BW	Pre BCS	Post BCS
Heavy Stocked	2011	896	943	5.5	5.1
	2012	948	1004	5.1	5.0
Light Stocked	2011	907	976	5.5	5.5
	2012	950	1039	5.2	5.3

Table 2. 2011 *In Vitro* organic matter disappearance, percentage of total plant mass, and forage to grain ratio.

	IVOMD	Percentage of Total Plant Mass		Lb of Forage DM/bu Grain	
	2011	2011	2012	2011	2012
Top 1/3 Stem	40.0	3.5	NA	1.3	NA
Bottom 2/3 Stem	31.3	37.0	41.8[1]	13.1	17.3[1]
Leaf Blade	48.8	20.2	22.6	7.4	9.3
Leaf Sheath	47.8	13.5	13.0	4.9	5.4
Husk	69.0	8.2	8.3	3.0	3.4
Cob	42.9	16.2	14.3	5.9	5.9
Shank	38.7	1.5	NA	0.6	NA

2012 Values for Bottom 2/3 include Top 1/3, Bottom 2/3 and Shank.

Table 3. Corn grain yields[1].

	2009	2010	2011
Control	124	141	166
Light Grazing	128	144	160
Heavy Grazing	133	141	170
Baled	124	142	166

[1]bu/ac at 15.5% moisture.

Table 4. Residue removal values.

Treatment	Year	AUM/acre	Lb Forage Available	Percent of Residue Removed
Heavy Grazed	2011	1.9	5157	25.0
	2012	1.9	7029	21.7
Light Grazed	2011	1.0	5303	13.1
	2012	1.0	6358	12.1

similar results with stem being the largest part (41.8%), followed by leaf blade (22.6%), cob (14.3%), leaf sheath (13.0%), and husk (8.3%). Husk was the most digestible part of the corn plant, being 69.0% digestible, and leaf blade was 48.8%, leaf sheath, 47.8%; cob, 42.9;top 1/3 stem, 40.0%; shank, 38.7%; and bottom 2/3 of stem, 31.3%. Grain yields over the past three years (Table 3) show no difference among treatments ($P = 0.9350$).

Conclusion

Stocking rate is such an important factor because of the large differences in nutrient content of the different parts of the corn plant. Fernandez-Riveria et al. (*Journal of Animal Science,* 67:597) determined cattle primarily eat leaf, leaf sheath, and husk. All the forage is available on the day the cattle are introduced to a corn field so the higher quality, more palatable parts, are consumed first. Because there is not any more residue being added, diet quality declines over time and the higher the stocking rate, the faster the decline occurs.

We measured 15.27 and 18.06 lb of palatable feed (leaf blade, leaf sheath, and husk) per bushel of grain yield in 2011 and 2012, respectively. An AU is defined as the amount of forage a 1,000 lb animal consumes, 680 lb DM/month or 22.7 lb/day. When the daily intake was multiplied by the number of grazing days, each AU consumed 1,337 lb DM in 2011 and 1,564 lb of DM in 2012. This is the equivalent of 1.9 and 1.0 AUM/ac for HG and LG respectively. By using the grain yields and lb of residue/bu of grain we can calculate 6,092 and 5,839 lb forage DM/acre for HG and LG respectively. Therefore, the cattle consumed an average of 23.4% and 12.6% of the residue for HG and LG respectively (Table 4). If we assume the diet was on average 55% digestible, 45% of the nutrients consumed are being returned to the field, so cattle are only removing 12.9% and 6.9% of the nutrients in the HG and LG treatments, respectively. These values fall within the acceptable range of residue removal suggested by Wilhelm et. al. The yields from this field support this as they show no effect on yield due to treatment over a three-year period, suggesting that grazing does not have a negative effect on grain yields in continuous corn cropping system. Since there is no negative effect of grazing on yield, this can be an economical alternative to drylot and winter range for cattle producers and provide an extra source of income to corn producers.

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Effect of Grazing Corn Residue on Corn and Soybean Yields

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Summary

Grazing corn residue in the fall/winter or spring in either a corn-soybean rotation or a continuous corn system shows generally positive effects on yields. Soybean yields for both fall/winter and spring-grazed corn residue when compared to ungrazed corn residue in a corn followed by soybean rotation show an increase in yields.

Introduction

Grazing corn residue is an inexpensive and attractive grazing opportunity for cattle producers as more and more land is being taken out of pasture and put into corn or crop production. Crop residues provide cattle producers with the opportunity to extend their grazing season and reduce the amount of stored forage needed to maintain cattle through the winter. One of the biggest concerns about grazing cattle on cropland is the effect that grazing and residue removal will have on subsequent grain yields.

Procedure

Numerous studies have been done at the University of Nebraska over the years to determine the effect of grazing crop residue on grain yields in the subsequent years. In 1996, a grazing trial was started on a linear move irrigation field in a corn-soybean rotation looking at the time of the year that crop residue is grazed and its effect on subsequent yield. This 100-acre field is divided into two sections with half of the field in corn and half in soybeans every year. Each year they switch sides so the soybean yields reflect the direct impact of the grazing of corn residue, and the corn yields are a year removed from the grazing treatment. Grazing has been initiated at two different times, fall/winter grazing and spring grazing. The fall/winter grazing typically is from November until February and is the time that most cattle are on crop residue. The field is typically frozen, and mud and compaction due to cattle in the field are at a minimum. Spring grazing in this field is typically from February through mid-April. This was designed to be the worst possible situation for grazing crop residue as the soil is thawing and spring rains will cause the fields to be muddy and the amount of compaction and trampling should be at its highest. To increase the possibility of trampling and compaction, starting in 2000 calves have been stocked at 2.5 times the normal level (9 head/3 ac). The three treatments, fall/winter grazed, spring grazed, and ungrazed, have been maintained in the same area since 1996.

Grain yields have been reported in previous beef reports (*2012 Nebraska Beef Cattle Report*, p. 11; *2001 Nebraska Beef Cattle Report*, p. 43; *1997 Nebraska Beef Cattle Report*, p. 27) and are updated and compiled in this beef report (Table 1). Several other studies looking at the effect of fall/winter grazing of crop residue have been reported by Lesoing in Nebraska Beef Reports (*1996 Nebraska Beef Cattle Report*, p. 40; *1997 Nebraska Beef Cattle Report*, p. 34). A study was conducted in 1993-95 on two center pivot irrigated corn fields in a corn-soybean rotation. Each center pivot was divided into halves with one-half in corn and one-half in soybeans each year. During the fall, half of the corn acres, resulting in one-quarter of the total center pivot area, was fenced off and grazed while the other half of the corn acres were left ungrazed. Each year 20 cows grazed 29 acres for 60, 69, and 60 days in 1993, 1994, and 1995, respectively. In the fall of 1992 a study was initiated looking at the effect of fall/winter grazing of corn, soybean, and grain sorghum residue in a dryland strip cropping system on subsequent grain yields. Exclosures were placed within grazed fields to provide an ungrazed section, and then five foot sections of rows were harvested both in the grazed and ungrazed sections. These exclosure locations were maintained from 1993-95 so the compounding effect of grazing could be seen. In this system corn followed soybean, grain sorghum followed corn, and soybeans followed grain sorghum. Eighty-one calves grazed this 27-acre field for 30 days in 1993; in 1994, calves grazed in November and December and then it was grazed throughout the winter by ewes; and in 1995, calves grazed periodically from late November until early March. Yields were collected for all three crops from 1993-95. In another study, from 1993-95, looking at the effect of fall grazing of corn residue on irrigated corn in a continuous corn system, exclosures were placed in two irrigated continuous corn fields and grazed and ungrazed sections were harvested as described earlier.

Results

Fall/Winter Grazed Residue

Fall/winter grazing of corn residue on the linear move irrigation field showed a significant ($P = 0.0010$) increase in soybean grain yields of 2 bu/ac due to grazing the year before, and no statistical effect ($P = 0.1808$) on corn yields with a numerical increase of about 3 bu/ac for the fall/winter grazed treatments. The center pivot irrigated corn-soybean rotation showed no significant difference ($P = 0.7418$) in yields in the grazed area compared to the ungrazed. In the dryland strip grazing trial there was no significant difference between

Table 1. Grain yields.

Years of Study[1]	Cropping System[2]	Crop	Grazed Yield	Ungrazed Yield	SEM	*P*-value
93-95	Irrigated Corn-Soybean[3] Rotation	Soybeans	54.6667	55	3.3747	0.7418
93-95	Dryland Strip Cropping[4]	Soybeans	39.3333	42.6667	17.5431	0.8289
93-95	Dryland Strip Cropping[4]	Grain Sorghum	106.33	107	17.5431	0.8289
93-95	Dryland Strip Cropping[4]	Corn	184.67	174.67	17.5431	0.8289
93-95	Irrigated Continuous Corn[5]	Corn	185.33	181.67	27.3272	0.5766
96-11	Fall Grazed Corn-Soybean[6]	Soybeans	62.4	60.4	2.1056	0.001
96-11	Fall Grazed Corn-Soybean[6]	Corn	208.9	205.8	7.8359	0.1808
96-11	Spring Grazed Corn-Soybean[6]	Soybeans	61.7	60.4	2.0156	0.001
96-11	Spring Grazed Corn-Soybean[6]	Corn	207.2	205.8	7.8359	0.1808

[1]Starting and ending year that the study was conducted.
[2]Type of cropping system that the field was managed in.
[3]Center pivot irrigation, corn residue grazed and soybean yields reflect impact of grazing on yields.
[4]This field was in a strip cropping study in a rotation where residue from all crops was grazed. Corn followed soybeans, grain sorghum followed corn, and soybeans followed grain sorghum.
[5]Was maintained in a continuous corn system.
[6]Fields are from linear move irrigation field and maintained in corn followed by soybean rotation for 14 years.

treatments for any of the crops ($P = 0.8289$). However, soybeans following the grazing of grain sorghum residue showed a numerical decrease of 3.3 bu/ac, grain sorghum yields following corn residue grazing showed a numerical decrease of 0.77 bu/ac, and corn grain yields following the grazing of soybean residue showed a numerical increase of 10 bu/ac. In the irrigated continuous corn cropping system there was no significant difference between treatments ($P = 0.5766$) but there was a numerical increase of 3.7 bu/ac due to fall grazing.

Spring Grazed Residue

Corn yields the second year of the spring grazing show no significant difference ($P = 0.1808$) but a 1.2 bu/ac numerical increase in yield on the grazed treatment. Soybean yields, planted the year following grazing of the corn residue, show a significant increase in grain yield ($P = 0.0010$) with a numerical increase of 1.3 bu/ac in the grazed treatment.

Conclusion

Irrigated corn grain yields in either a continuous corn or a corn-soybean rotation show no effect of grazing on grain yields and soybeans planted the year following corn residue grazing show a significant increase in yields due to grazing treatment. Timing of grazing, fall grazed or spring grazed, seems to have little effect on grain yields. Since the treatments in the linear move irrigation field have been maintained over an extended period of time any detrimental effects from grazing would have been picked up. With the statistical increase in yields of soybeans, especially in the spring grazing treatment, cattle grazing corn residue actually help the grain yields by working some of the nutrients and residue into the ground and removing some of the excess residue so the ground can warm up faster. In an article by Wilhelm et al. (*Agronomy Journal*, 2004, 96:1), the authors suggest that the removal of 20-30% of the corn residue will have little effect on the structure and fertility of the soil and leaving 70-80% of the residue will provide enough organic matter to add carbon back into the soil and maintain the integrity of the soil structure. An article in the *2013 Nebraska Beef Cattle Report,* pp. 36-37 by McGee et al., shows that cattle will remove between 10.5% and 25.5% of the residue on the field. From this same report we can find that the average digestibility of residue is 55%, meaning that the cattle are only able to utilize 55% of the organic matter, and the remaining 45% of the organic matter is returned to the soil surface where it can be reincorporated into the soil supplying organic matter for the soil microbes.

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Corn Residue Removal Effects On Subsequent Yield

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Summary

Corn residue is used for forage and feed, but residue removal effects on soil properties and yield is a concern. Residue removal effects on corn yields and soil organic carbon is site specific. Removing 50% of the residue from rainfed sites reduced corn yield by 1.9 bu/ac, whereas removing 40% of the residue from irrigated sites increased corn yield by 15.4 bu/ac. However, removing 53% of the residue increased soil erosion by 30%. Agronomic practices such as reduced tillage, cover crops, or manure may offset residue removal impacts. Residue removal should be based on site-specific characteristics and management, but is feasible when sufficient residue is retained to protect soil from erosion and sustain soil biota.

Introduction

Rapid growth of the ethanol industry in Nebraska has created a demand for roughage to be co-fed with distillers grain as a replacement for grain being used as a biofuel feedstock. Crop residue, mainly corn stalks, is being harvested to meet this demand. Crop residue also has been proposed as a future feedstock for cellulosic biofuel production. Crop residue protects the soil from wind and water erosion, contains nutrients that become available for subsequent crops, and sustains soil biota. Removal of crop residue can potentially have a negative effect on these critical functions, and additional field work to remove the residue increases the potential for soil compaction. As the practice of crop residue removal increases, concerns regarding its effect on subsequent crop yields arise. In high production systems crop residue is present in quantities that can hinder establishment of a subsequent crop and under these conditions the potential exists for removing a portion of the crop residue for other uses without negatively effecting soil function. Here we report results from experiments comparing crop yields and soil organic carbon when residue is removed or retained in rainfed and irrigated corn production systems and residue removal effects on runoff as well as sediment loss in an irrigated corn system.

Procedures

Two residue removal studies were conducted at the University of Nebraska Agricultural Research and Development Center (ARDC) near Mead, Neb. The first study was initiated in 1998 under rainfed (nonirrigated) conditions on a site that qualified for the Conservation Reserve Program. Treatments in this study were residue removed (50%) or retained in no-tillage corn receiving 54, 107, or 160 lb N/ac (*Biomass and Bioenergy*, 32:18, 2008). The second study was initiated in 2001 under irrigation on a productive soil. Treatments in this study were disk or no-tillage with 0, 40, or 80% residue removal. All treatments received 180 lb N/ac. Removal rates in both studies are more intensive than what would be expected with grazing but less intensive than harvest for silage. Corn grain and residue production were measured annually in both studies. Soil samples were collected to a depth of 5 feet, in 1 foot increments, when each experiment was initiated and again after 10 years to determine carbon content.

An erosion study was conducted on a cooperator field near York, Neb. in 2009 (*Agronomy Journal,* 102:1448). This field was in continuous corn under irrigation. Beginning in 2006, residue was removed (53%) from four 24-row strips following grain harvest. Residue was retained in four additional 24-row strips. Within each strip, a set of paired plots were placed in a portion of the field having an 8% slope. For each pair of plots, one had cobs removed and one had cobs retained. Each pair of plots was then subjected to simulated rainfall (1.7 inches in 30 minutes) under antecedent soil moisture and again the following day under saturated soil moisture. Runoff and sediment from each plot was measured.

Results

Grain Yield

Under rainfed conditions, annual removal of crop residue resulted in slightly lower 10-year average yields than when residue was retained (Table 1). Averaged across nitrogen treatments, yields were 106.1 bu/ac where residue was retained and 104.2 bu/ac where residue was removed.

In the irrigated study, grain yields were nearly double those of the rainfed study. In the irrigated study, grain yields were greater under disk tillage than under no-tillage. In both tillage treatments, grain yields increased as residue removal increased (Table 1).

In rainfed production systems yield is limited by water availability. Under these conditions a layer of crop residue reduces evaporation losses and increases the amount of water that is available for the crop resulting in greater yields where residue is retained.

In irrigated systems, production is much greater and crop residue can cause problems with soils warming in the spring and establishment of a uniform stand. In these systems, tillage that incorporates the residue into the soil and residue removal when no-tillage is used improves stand establishment and subsequently yield.

Table 1. Corn grain yield (bu/ac) for rainfed and irrigated crop residue removal studies.

Site – Treatment	Yield
Rainfed – Residue Retained – 54 lb N/ac	88.4[b]
Rainfed – Residue Removed– 54 lb N/ac	81.6[a]
Rainfed – Residue Retained – 107 lb N/ac	116.0[c]
Rainfed – Residue Removed– 107 lb N/ac	115.3[c]
Rainfed – Residue Retained – 160 lb N/ac	113.9[c]
Rainfed – Residue Removed– 160 lb N/ac	115.8[c]
Average – Residue Retained	106.1
Average – Residue Removed	104.2
Irrigated – Disk Tillage, 0% removal	201.7[b]
Irrigated – Disk Tillage, 40% removal	207.5[c]
Irrigated – Disk Tillage, 80% removal	212.4[c]
Irrigated – No-Tillage, 0% removal	180.9[a]
Irrigated – No-Tillage, 40% removal	205.9[b]
Irrigated – No-Tillage, 80% removal	202.0[b]

[a,b,c]Values within a column followed by different letters are significant at ($P < 0.05$).

Table 2. Soil organic carbon content (tons/ac) in the 0- to 1-foot increment for rainfed and irrigated crop residue removal studies.

Site – Treatment	1998	2008
Rainfed	20.6[a]	24.1[b]
	2001	2010
Irrigated – Disk Tillage, 0% removal	34.4[a]	32.2[b]
Irrigated – Disk Tillage, 40% removal	35.1[a]	32.5[b]
Irrigated – Disk Tillage, 80% removal	34.1[a]	31.4[b]
Irrigated – No-Tillage, 0% removal	34.7[a]	33.5[a]
Irrigated – No-Tillage, 40% removal	33.1[a]	32.1[b]
Irrigated – No-Tillage, 80% removal	34.5[a]	30.9[b]

[a,b,c]Values within a column followed by different letters are significant at ($P < 0.05$).

Soil Organic Carbon

In the rainfed study soil organic carbon was similar among treatments in 1998. In 2008 there were no differences among the treatments but averaged across treatments soil organic carbon had increased (Table 2). Increases in soil organic carbon were greatest in the 0 to 1 foot increment but increases were measurable throughout the 0- to 5-foot profile. Use of no-tillage resulted in sequestration of 710 lb/ac/year of organic carbon even with up to 50% removal of crop residue.

In the irrigated study soil organic carbon was similar among treatments in 2001 (Table 2). In 2010, soil organic carbon in the 0- to 1-foot increment was less than in 2001 in all treatments except the no-tillage treatment where no residue was removed. Soil organic carbon in 2001 and 2010 was similar among treatments in the remaining depth increments.

The response to residue removal differed between the sites used in this study. Initial soil organic carbon content at the rainfed site was less than at the irrigated site. Under no-tillage continuous corn, soil organic carbon increased at the rainfed site but remained the same with no residue removal or declined with residue removal at the irrigated site. We speculate that the difference in response between the two sites is related to differences in soil water status at the two sites. Under irrigation, soil water content would be greater and more favorable for soil microbial activity for a greater portion of the year than under rainfed conditions. Greater microbe activity would decompose residue more quickly. Results from related studies support this hypothesis. Preliminary measurements of carbon dioxide emissions show greater losses from irrigated plots than from rainfed plots during the growing season, and in a litter decomposition study we observed more rapid loss of dry matter in residue buried in irrigated plots than in rainfed plots (*Agronomy Journal,* 103:1192).

Runoff and Sediment Loss

Plots where residue was removed had less cover (50%) than plots where residue was retained (77%). Runoff from plots where residue was removed began more quickly (196 seconds) than in residue-retained plots (240 seconds). Residue removal did not affect the amount of runoff from the plots (6% of simulated rainfall). Residue removal resulted in 30% greater loss of sediment (321 lb/ac with residue removal vs. 242 lb/ac with residue retained). Removal of the cob fraction had no effect on runoff or sediment loss. These results demonstrate the importance of crop residue in protecting the soil from raindrop impact. The impact of falling rain is the mechanism that detaches soil particles making them susceptible to loss in runoff.

The results presented in this report complements previous work that has quantified the distribution of corn stover biomass and nutrients as a function of height (*Bioenergy Research*, 3:342, 4:11), the relationship between the cob and other biomass components (*Bioenergy Research,* 1:223), and estimates of residue retention needed to protect the soil against wind and water erosion and to sustain soil biota (*Agronomy Journal,* 99:1665). While the effect of residue removal on crop production and soil properties is site specific, results suggest that a portion of crop residue can be harvested for other uses without negatively impacting subsequent yields. It is essential that sufficient crop residue be retained to protect the soil from wind and water erosion and to sustain soil biota. Implementing management practices such as reduced tillage, cover crops, or applying manure in concert with residue removal may be necessary to reduce the potential for negatively affecting future productivity while meeting current demands for food, forage, and feedstock.

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Effects of Corn Hybrid, Plant Density, and Harvest Time on Yield and Quality of Corn Plants

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Summary

Corn plants were collected to determine the effects of hybrid and season length, plant density, and harvest timing on grain and whole corn plant DM yield and nutritive value. Although whole corn plant DM yield decreased with delayed harvest timing, whole corn plant TDN increased linearly due to increasing grain concentration. Increasing plant density improved yields of grain and whole corn plant DM. This experiment suggests that hybrid and season length selection, planting density, and harvest timing affect whole corn plant DM yield and quality characteristics.

Introduction

Interest in the use of corn silage has increased due to the high price of corn grain and roughages. Current research (*2013 Nebraska Beef Cattle Report*, pp. 74-75) has reported that corn silage inclusion in finishing diets is economical, with more incentive in times of high priced corn and in diets containing distillers grains. With rising land costs and costs of production, corn silage production by farmer/feeders must be accomplished to optimize both yield and nutritive value; but have the flexibility for corn grain harvest with or without stover harvest if market conditions dictate. Therefore the objectives of this experiment were to determine the effects of hybrid and season length, plant density, and harvest timing on whole corn plant DM yield as well as plant part yield and nutritive value.

Procedure

Corn plants were harvested from an irrigated research plot near York, NE. Five moderately early maturity corn hybrids (MEM; 107 to 111 day maturity; Hoegemeyer Hybrids) and five moderately late maturity corn hybrids (MLM; 112 to 117 day maturity; 1, Pioneer; 4, Hoegemeyer Hybrids) were planted at 4 populations (20,000, 26,000, 32,000, and 38,000 plants/acre) in a split plot design with 3 replications per hybrid X population combination. Five competitive corn plants were cut 6 inches above ground level and collected at three harvest dates (September 1, early harvest, EH; September 15, late harvest, LH; September 29, grain harvest, GH). Grain, husk, and cob fractions were separated and weighed at time of harvest. The remaining plant parts (stem, leaf, and shank) were ground through a wood chipper, collected into one sample, and weighed at time of harvest. A subsample from the stem, leaf, and shank sample, as well as grain, husk, and cob samples were dried in a 105°F forced-air oven and weighed for DM determination and yield/acre calculations. Another subsample of the stem, leaf, and shank sample was freeze dried and ground through a 2-mm screen for laboratory analysis. Oven-dried husk and cob were also ground through a 2-mm screen for laboratory analysis. Concentration of NDF and in situ NDF digestibility (28 hour incubation; NDFd) was analyzed for husk, cob, and the stem, leaf, and shank freeze-dried sample.

A value for plant residue digestible NDF was calculated using DM percentage, NDF, and NDFd for husk, cob, and the stem, leaf, and shank sample. Total plant residue cell soluble concentration was determined summing (1-NDF) for husk, cob, and the stem, leaf, and shank sample. Addition of plant residue digestible NDF and total plant residue cell soluble concentration resulted in a value for true digestibility, with TDN of residue calculated from this true digestibility – 12% (metabolic loss assumption). Percentage TDN of plant residue multiplied by the DM percentage of residue (sum of all plant residue components or 1 – percent corn grain) resulted in a value for digestible plant residue. Digestible grain content was calculated as corn grain percentage multiplied by 0.9. A final TDN for each hybrid x density x harvest x repetition corn silage was calculated as digestible plant residue + digestible grain content.

Yield and nutritive value data were analyzed using the mixed procedure of SAS (SAS Inst., Inc., Cary, N.C.). The experimental unit consisted of a composite of 5 corn plants. Season length, plant density, and harvest timing were fixed effects. Orthogonal contrasts were used to test the effects of harvest timing and plant density. Statistical interactions between fixed effects, although biologically plausible, were ignored due to extent of replication and for clarity of data interpretation.

Results

Harvest dates were chosen to simulate corn silage harvest (EH and LH) and corn grain with corn stover harvest (GH). There was a quadratic response to whole corn plant DM yield ($P < 0.01$; Table 1) as harvest time was delayed until later in the season, with DM yield increasing between the first two corn silage harvest dates, but then decreasing from then to grain and stover harvest. As expected, grain percentage of the corn plant increased linearly ($P < 0.01$) with delayed harvest. There

Table 1. Effect of harvest timing on corn plant characteristics.

Item	Harvest[1]				*P*-value[2]	
	1	2	3	SEM	Lin.	Quad.
Grain Yield[3]	195.0	195.0	195.0			
Corn Plant Yield[4]	11.00	12.18	10.25	0.10	<0.01	<0.01
Grain, %	51.36	52.40	62.23	0.23	<0.01	<0.01
Residue NDF, %	65.42	62.51	66.65	0.30	<0.01	<0.01
Residue TDN, %	49.29	50.22	41.74	0.31	<0.01	<0.01
Corn Plant TDN, %	70.22	71.10	71.75	0.15	<0.01	0.52

[abc]Means with different superscripts differ ($P < 0.05$)
[1]Harvest dates: 1= September 1, 2011; 2=September 15, 2011; 3=September 29, 2011.
[2]Lin. = *P*-value for the linear response to plant density. Quad. = *P*-value for the quadratic response to plant density.
[3]Grain yield in bushels per acre.
[4]Corn plant yield in DM tons per acre.

Table 2. Effect of plant density on corn plant characteristics.

	Plants per acre					*P*-value[1]	
Item	20,000	26,000	32,000	38,000	SEM	Lin.	Quad.
Grain Yield[2]	166.4	198.9	203.5	211.2	3.6	<0.01	<0.01
Corn Plant Yield[3]	9.84	10.93	11.67	12.14	0.12	<0.01	<0.01
Grain, %	54.25	55.71	55.94	55.42	0.26	<0.01	<0.01
Residue NDF, %	63.07	63.98	65.82	66.58	0.35	<0.01	0.84
Residue TDN, %	48.17	47.40	46.79	45.96	0.35	<0.01	0.92
Corn Plant TDN, %	71.10	71.30	71.13	70.55	0.17	0.02	0.02

[1]Lin. = *P*-value for the linear response to plant density. Quad. = *P*-value for the quadratic response to plant density.
[2]Grain yield in bushels per acre.
[3]Corn plant yield in DM tons per acre.

Table 3. Effect of season length on corn plant characteristics.

	Season Length[1]			
Item	MEM	MLM	SEM	*P*-value
Grain Yield[2]	190.7	199.3	2.5	0.02
Corn Plant Yield[3]	10.95	11.34	0.08	<0.01
Grain, %	56.00	54.67	0.18	<0.01
Residue NDF, %	64.18	65.54	0.24	<0.01
Residue TDN, %	47.26	46.90	0.24	0.28
Corn Plant TDN, %	71.35	70.69	0.12	0.01

[1]MEM=Moderately early maturity hybrids (107-111 day maturity), MLM=Moderately late maturity hybrids (112-117 day maturity).
[2]Grain yield in bushels per acre.
[3]Corn plant yield in DM tons per acre.

was a quadratic response ($P < 0.01$) for residue NDF due to harvest time, with NDF decreasing between the first two harvests and then increasing thereafter. There was also a quadratic response for residue TDN ($P < 0.01$) with the highest quality residue found during the midpoint harvest. Total corn plant TDN was linearly increased ($P < 0.01$) due to the added TDN from greater grain concentrations. Although there was increased TDN concentration of the whole corn plant with GH; there was 15% more total TDN yield/acre for harvesting silage at LH than harvesting the crop for corn grain and corn stover (GH harvest).

Yield of grain and total DM increased quadratically ($P < 0.01$; Table 2) with increasing plant density, with corn planted at 38,000 plants/acre yielding 44.8 more bushels of grain and 2.3 more tons DM /acre than corn planted at 20,000 plants/acre. Grain percentage slightly increased quadratically ($P < 0.01$; range of 1.69 percentage units) with increased plant density. Residue NDF content increased linearly ($P < 0.01$), while TDN content of the residue decreased linearly ($P < 0.01$) with increasing plant density. There was a quadratic response for whole corn plant TDN content due to planting density ($P = 0.02$), but only with a numerical difference of only 0.75 TDN percentage units.

Grain and whole corn plant DM yield increased 4.3% and 3.4%, respectively for MLM hybrids in comparison to the MEM hybrds ($P < 0.05$; Table 3). Grain percentage in the whole corn plant decreased with MLM hybrids ($P < 0.01$). Residue NDF concentration was slightly increased for MLM hybrids ($P < 0.01$). Residue TDN content was not different ($P = 0.28$), however overall TDN of the whole corn plant was slightly higher for the MEM hybrids ($P = 0.01$).

This experiment suggests that whole corn plant yield and nutritive value is affected by decisions made both in the spring (hybrid selection and planting density) and fall (harvest timing), with harvest timing (corn silage or corn grain with stover harvest) having the most profound impact on yield and quality characteristics. In general, as management decisions increase corn grain yield, corn plant DM yield also increases with little effect on nutritive quality.

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Nitrogen Fertilization and DDGS Supplementation Reduces Annual Weeds in Pastures

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Summary

Ongoing research has found body weight (BW) gains of steers supplemented with corn dried distillers grains plus solubles (DDGS) on unfertilized smooth bromegrass pasture (SUPP) to be greater than unsupplemented steers on N fertilized (FERT) and unfertilized, control (CONT) smooth bromegrass pasture. In the seventh year of the study, annual weeds increased to 20%, 9%, and 2% of relative cover within CONT, SUPP, and FERT pastures, respectively. Supplementation of DDGS on unfertilized pastures improves steer BW gains and reduces N inputs while providing intermediate resistance to annual weed invasion. Annual N fertilization maximizes forage yield and minimizes annual weeds in pasture.

Introduction

Research conducted at the Agricultural Research and Development Center (ARDC) near Mead, Neb., since 2005 has found ADG and total BW gain per acre of steers in DDGS supplemented pastures (SUPP) exceed those of steers in control (CONT) and fertilized (FERT) pastures (*2012 Nebraska Beef Cattle Report*, p. 49). Steers consumed less forage in SUPP, but total N intake and retention was greater on per steer and per acre bases in SUPP than in CONT and FERT pastures thereby improving N use efficiency (*Journal of Animal Science,* 89:1146).

A remaining unknown in this research was the impact of treatments on pasture vegetation. Nitrogen input is known to influence vegetation dynamics, and in this experiment, annual N input from DDGS and fertilizer averaged 44 and 80 lb/ac in SUPP and FERT, respectively. In 2010 and 2011, we examined how the previous six years of management in CONT, SUPP, and FERT treatments affected vegetation by measuring relative basal and aerial cover of plant species along with forage yield in the pastures. We hypothesized that declining N inputs from FERT to SUPP to CONT would result in increasing cover of Kentucky bluegrass, a perennial grass known to increase in low-input pastures.

Procedure

Research was conducted in smooth bromegrass pastures at ARDC. Treatments included unfertilized, control (CONT) pasture stocked initially with steers at 2.5 animal unit months (AUM)/ac, unfertilized SUPP pasture stocked initially at 3.7 AUM/ac with steers supplemented with 5 lb/head daily of DDGS, and FERT pasture stocked initially with steers at 3.7 AUM/ac. Urea was surface applied to FERT pasture at 80 lb N/ac in late March to early April of each year. Each treatment also received an estimated 6 lb N/ac annually from atmospheric deposition resulting in total N input of 6, 50, and 86 lb/ac in CONT, SUPP, and FERT, respectively. Each treatment was replicated three times, split into six paddocks and rotationally grazed from late April through September of each year (160 d). With the six paddocks, each FERT and SUPP pasture was 4.9 acres, while each CONT pasture was 7.2 acres. There were five cycles of grazing per year in each set of six paddocks. Stocking density varied across the season as put-and-take cattle were used to maintain an end-of-season standing crop of 1,070 lb/ac or a 4-inch stubble height across treatments and years. Stocking rates after adjustments for put-and-take cattle averaged 3.5, 5.6, and 5.4 AUM/ac in CONT, SUPP, and FERT, respectively. With the exception of digging out thistles and spot spraying around feed bunks and water tanks, broadleaf weed control was minimal.

Relative basal and foliar cover of plant species was measured within one of the six paddocks contained within each experimental unit on Oct. 7 2010 and Oct. 13 2011. Forage yield of smooth bromegrass and other species also was measured through clipping of forage at ground level within each treatment in June and October, 2009 through 2011. Dry matter yields were determined after drying forage samples for 60 hours in a forced-air oven at 140°F. Analysis of variance was conducted with mixed model procedures.

Results

Relative basal and foliar cover of plant species depended on treatment and year. From 2010 to 2011, relative basal cover of smooth bromegrass decreased by 24, 11, and 4 percentage points in CONT, SUPP, and FERT treatments, respectively (Figure 1). Contrary to our hypothesis, treatment did not affect relative basal cover of Kentucky bluegrass. Although an increase of Kentucky bluegrass cover from 5% in 2010 to 8% in 2011 was observed, the increase was not enough to compensate for reductions of smooth bromegrass cover. Increasing the most from 2010 to 2011 in CONT and SUPP was relative basal cover of annual weeds, particularly foxtail species (Figure 1). Relative foliar cover, although more variable, followed patterns similar to those of relative basal cover with differences between treatments observed in 2011 (data not shown).

Forage yield also depended on treatment and year (Table 1). Smooth bromegrass yield was greater in FERT than either SUPP or CONT treatments in all years, while yield of other species was similar between these treatments in 2009 and 2010 but not in 2011. Overall yield of other species consisted of 2%, 1%, and 1% of total forage yields in CONT, SUPP, and FERT treatments in 2009 and 2010. In 2011, however, overall yield of other species accounted for 20%, 7%, and 1% of total forage yields in CONT, SUPP, and FERT treatments, respectively. Yield of smooth bromegrass was similar between CONT and SUPP treatments in 2009 and 2010 but was significantly

greater in the SUPP than CONT treatment in 2011. Overall, results complement those of other studies where N input had been found to increase mass and density of perennial cool-season grasses thereby limiting light penetration and establishment of other species in grasslands.

Timing and form of N input may have contributed to vegetation changes, but compared to differences in total N inputs, their effects appear small. The FERT treatment received most N input (86 lb/ac) during late spring in the form of 80 lb N/ac from urea fertilizer and 6 lb N/ac through atmospheric deposition. Total N consumed in forage, retention, and excretion across the grazing season was estimated at 93, 7, and 86 lb N/ac, respectively. On the other hand, N input in SUPP (50 lb N/ac) occurred throughout the grazing season through daily feeding of DDGS (44 lb N/ac) and atmospheric deposition (6 lb N/ac). Total N consumed in forage and DDGS, retention, and excretion were estimated at 110, 10, and 100 lb N/ac, respectively. Thus, although relative cover of annual weeds species, such as the warm-season foxtail species, was greater in SUPP compared to FERT, their invasion appears to be predominantly caused by differences in total N input rather than N excretion. Difference between these two systems in total N excretion over the grazing season was 14 lb/ac in favor of SUPP whereas the difference in total N input was 36 lb/ac in favor of FERT.

Annual weeds such as foxtail species are well adapted to pastures but often lie dormant in the soil seed bank until favorable disturbances and environmental conditions promote germination and emergence. Our study revealed annual N fertilization at 80 lb/ac maintained excellent cover of smooth bromegrass and provided nearly complete suppression of annual weeds. The progressively greater N input in CONT, SUPP, and FERT treatments also resulted in overall forage yields of smooth bromegrass that across years averaged 5,543, 6,013, and 9,015 lb/ac, respectively. Although SUPP did not maintain as much cover and yield of smooth bromegrass as FERT, smooth bromegrass cover and yield in SUPP were greater than CONT. In addition, SUPP resulted in better animal gains than CONT and FERT (*2012 Nebraska Beef Cattle Report*, p. 49) while improving N use efficiency on per animal and per acre bases (*Journal of Animal Science,* 89: 1146).

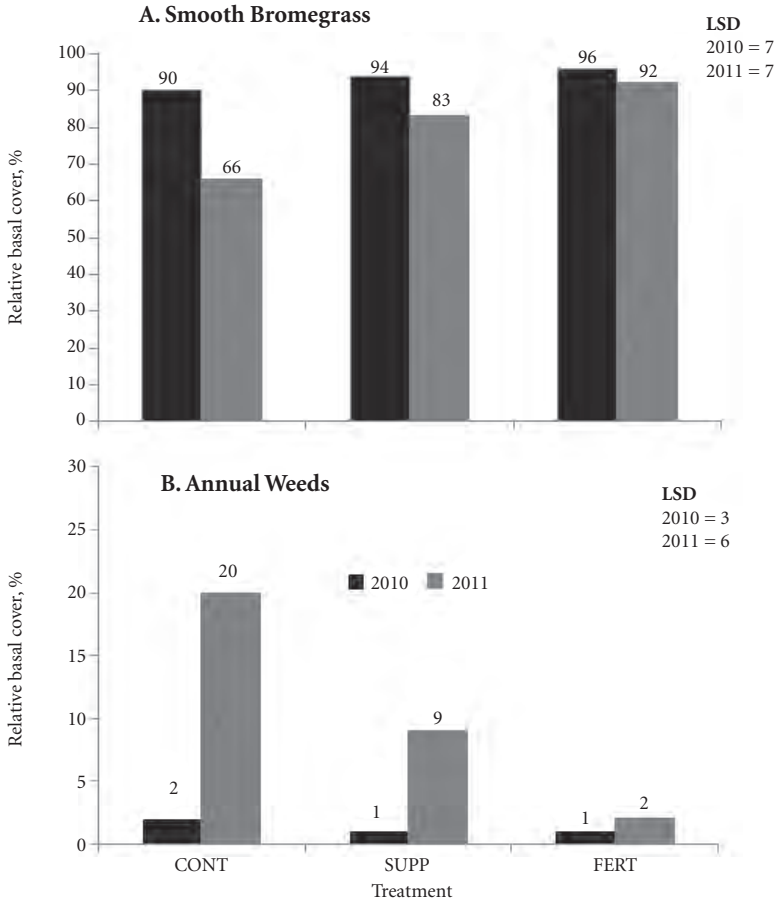

Figure 1. Cover of smooth bromegrass (A) and annual weeds (B) in unfertilized (CONT), unfertilized with cattle supplemented with dried distillers grains plus solubles (SUPP), and N-fertilized (FERT) pastures at Mead, Neb.

Table 1. Forage yield of smooth bromegrass and other species in unfertilized (CONT), unfertilized with cattle supplemented with corn dried distillers grains plus solubles (SUPP), and N-fertilized (FERT) pastures at Mead, Neb.

		Forage Yield	
Year	Treatment	Smooth Bromegrass	Other Species
		lb/ac	
2009	CONT	5849	135
	SUPP	6490	41
	FERT	8549	6
	LSD	739***	138
2010	CONT	5179	58
	SUPP	4784	13
	FERT	8096	155
	LSD	1979*	241
2011	CONT	5624	1387
	SUPP	6792	522
	FERT	10503	116
	LSD	1008***	700*

* Significant at the 0.05 probability level.
*** Significant at the 0.001 probability level.

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Evaluation of a New Chemistry for Rangeland Grasshopper Control

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Summary

A grasshopper control study was conducted to evaluate the effectiveness of a new class of systemic chemical. The new pesticide Prevathon® (high and low levels) was compared to Coragen®, Dimilin®, and a nontreated check. Grasshoppers were numerically reduced the most by Coragen and Prevathon, though not significant. The highest level of Prevathon did not numerically impact beneficial insects in general. Biomass and forage quality were not significantly impacted by chemical treatment. However, forage biomass was numerically greatest for the highest level of Prevathon. Prevathon appears to be an acceptable systemic pesticide for grasshopper control with minimal impact on other insects.

Introduction

More than 100 species of grasshoppers have been documented in Nebraska. Roughly 10 of these species are considered "outbreak species" that periodically cause substantial losses to rangeland in western Nebraska. The western two-thirds of Nebraska remains largely rangeland, mainly due to low annual precipitation and highly erodible topography. As a result, this region is largely devoted to cattle production. It is within this region that grasshoppers are a major agricultural pest in Nebraska. Several grasshopper outbreaks have been reported in Nebraska in the last century and caused economic losses exceeding $2 million dollars per year due to lost grazing days for livestock. Grasshoppers tend to feed on the most desirable rangeland plants and tender regrowth, reducing root depth and causing long-term damage to the range. Chemical control programs have successfully reduced both costs and environmental impacts over much of the controlled acres. However, some sensitive areas remain challenging to control grasshoppers due to the potential for collateral damage to protected insect species.

The most common insecticides used for treatment of rangelands in the case of grasshopper infestations are carbaryl (Sevin®), diflubenzuron (Dimilin), and malathion. These chemicals can be applied using several treatment options, most of which involve using reduced agent area treatments, or RAATs. By using RAATs, alternating strips of rangeland are sprayed, thereby reducing the treated area by one half. RAAT's also reduce costs and conserve beneficial insects.

A widely adopted chemical, Diflubenzuron (Dimilin), acts as an insect growth regulator and efficiently suppresses grasshopper populations; however, it also poses potential risks for beneficial insects (e.g., the endangered American burying beetle). Malathion and carbaryl (Sevin) are also effective in treatment of rangeland grasshopper infestation. Unfortunately, because malathion is nonselective, nontarget effects on natural enemies can have many negative impacts. Persistent treatment with nonselective insecticides such as malathion has been shown to increase the frequency, duration, and intensity of grasshopper outbreaks. Thus, a more benign chemical control strategy would be desirable.

Insecticides with systemic properties (compounds that are taken up by plants and require ingestion by insects) may serve as a more ecologically benign, yet effective, control strategy. The compound, Rynaxypyr®, tested in this study, has been shown to have some systemic properties and is an Anthranilic diamide (a new class of insecticide). Therefore, our objectives were to evaluate a compound that uses a new class of chemical and mode of action as an insecticide for rangeland grasshopper control and to evaluate the effects of grasshopper control on biomass and forage quality in rangeland.

Procedure

Field plots were laid out in a completely randomized experimental plot design at the High Plains Agricultural Laboratory in Sidney, Neb. Dryland range plots were subdivided into 100 x 50-foot blocks to be used as replicates. Each replicate was then subdivided into a 35 x 100 foot area to receive treatment. Four treatments were applied once on June, 22, 2011 (following a pre-treatment sample on the same date). Treatments were: Coragen (2 oz/A), Dimilin (2 oz/A), Prevathon (7.8 oz/A), and Prevathon (13.6 oz/A). Applications were made with water carrier at 23 gal/ac. Applications were made with a two-nozzle boomless, ATV-mounted sprayer (Boominator with two #1160 nozzles). Two spray passes were necessary to reach the target rates. Plots were evaluated by taking 50 sweep-net samples per plot on six dates (June 22, June 27, July 5, July 11, July 18, and July 25). Samples were brought back into the lab and counts were taken of spider, lacewings,

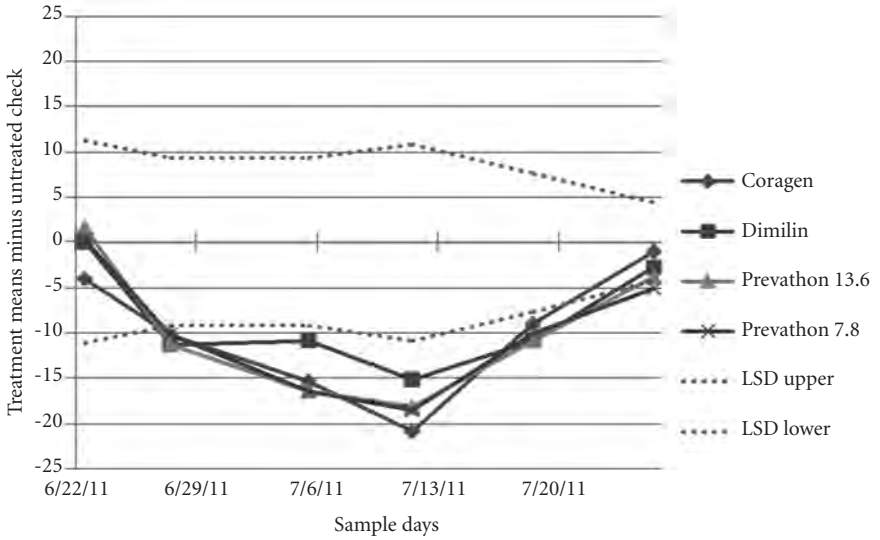

Figure 1. Grasshopper numbers as affected by insecticide applications. Estimates = [check – treatment]; thus, dotted lines represent the Least Significant Difference (LSD) for treatment means to be either significantly greater (LSD upper) or lower (LSD lower) than the untreated check (origin). That is, points that fall below the lower dotted gray line are significantly less than the untreated check.

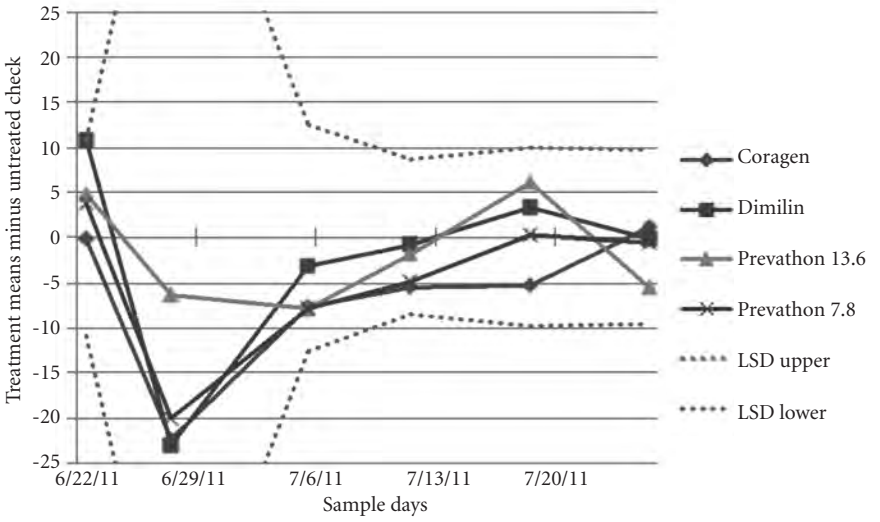

Figure 2. Beneficial arthropod numbers as affected by insecticide applications. Estimates = [check – treatment]; thus, dotted lines represent the Least Significant Difference (LSD) for treatment means to be either significantly greater (LSD upper) or lower (LSD lower) than the untreated check (origin). That is, points that fall below the lower dotted gray line are significantly less than the untreated check.

Table 1. *In vitro* **dry matter disappearance (IVDMD) and crude protein (CP) of forage under insecticide treatment or untreated check ($P > 0.41$).**

Treatment	IVDMD	CP
Prevathon 7.8	49.3	7.2
Prevathon 13.6	49.3	7.4
Dimilin	50.6	7.4
Coragen	49.9	7.6
check	52.1	7. 4

grasshoppers, spittlebugs, parasitoid wasps, and lady beetles. Grasshoppers were the control target, spittlebugs were counted as a nontarget herbivore, and the remaining insects were evaluated as a group to represent nontarget predators/parasitoids.

The chief rangeland plant in the study area was crested wheatgrass. Each plot was randomly sampled with standard quadrats (four quadrats per plot) of 5.4 ft^2 on July 2, 2011 to estimate standing crop. Each sample was brought back to the lab and dried and weighed. Additionally, the outer edge of each quadrat was sampled and submitted to the ruminant nutrition lab at UNL in Lincoln for IVDMD analysis. Data were analyzed using SAS 9.2 using PROC GLM and Fisher's protected LSD for multiple comparisons.

Results

A significant reduction in grasshopper numbers was measured for all chemicals following the initial chemical applications (Figure 1) and residual suppression appeared to last for at least three weeks. The Coragen and Prevathon (low and high rate) applications had the numerically lowest grasshopper populations; however, no treatments were significantly different relative to each other. No treatments significantly reduced the beneficial arthropods as evaluated in this study (Figure 2). However, there was a slight suppression of beneficial insects in response to insecticide application in the sample week immediately following the application date. Dimilin appeared to have the quickest recovery of beneficial organisms relative to the other beneficial-affecting treatments. It is unclear why the high rate of Prevathon would have a more benign impact on beneficials. However, this treatment also appeared to show a numerical resurgence in the beneficial insect populations toward the end of the sampling period. No significant reduction in nontarget sucking insects (i.e., spittlebugs) was detected. There was no significant increase in available plant biomass (Figure 3). Crude protein and IVDMD (similar to TDN) (Table 1) were not different ($P > 0.41$) across treatments. These results indicate that the new class of insecticide, Anthranilic diamide (Prevathon), could reduce rangeland grasshoppers at least as well as other standard products.

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Furthermore, insecticide applications (as applied in this study) appeared to have minimal impact on the non-target or beneficial insects sampled in this study. This study did not find any statistically significant effects of grasshopper control on plant biomass or quality.

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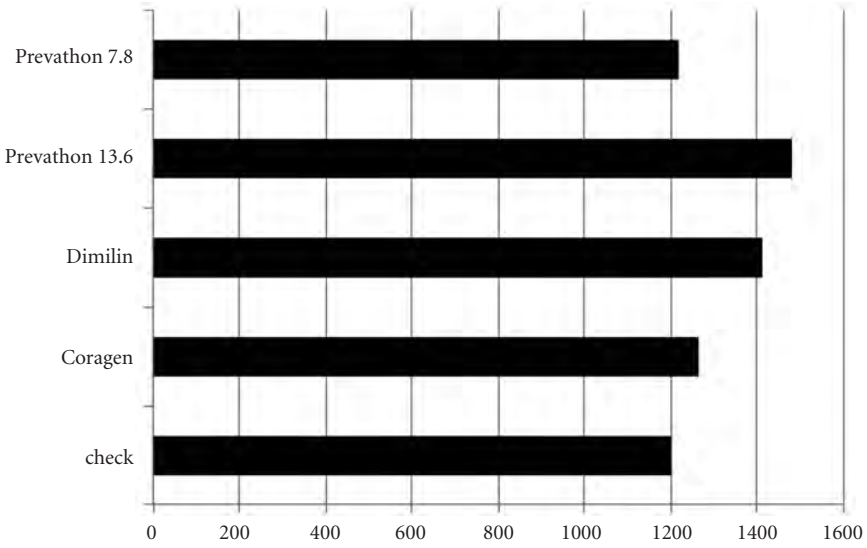

Figure 3. Standing crop (lb/acre) by insecticide treatment and untreated check.

Influence of Pre-Collection Diet and Preparation Technique on Nutrient Composition of Masticate Samples

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Summary

Squeezing masticate samples to remove excess saliva skews forage nutrient composition of high quality, vegetative grass. Lower quality grass or harvested hay is less affected. Mastication increases ash content. Pre-collection diet of fistulated animals has no effect on nutrient content of the masticate.

Introduction

Fistulated animals have been used extensively to quantify nutrient content of diets consumed by grazing cattle. Unlike clipping, using fistulated cattle accounts for a grazing animal's selectivity and provides a representative sample of grazed forage quality. However, factors such as salivary contamination and sample handling technique could influence how well the masticate represents the actual diet consumed by grazing cattle. Diet masticate samples can be squeezed post-collection to remove excess saliva which decreases the time required for freeze drying. However, this technique could result in a loss of nutrients causing misrepresentation of diet nutrient composition. Therefore, the objectives of these studies were to evaluate the influence of salivary contamination and squeezing masticate samples on ash, crude protein, NDF, and IVDMD values of samples collected from fistulated cattle.

Procedure

Six studies were conducted. Ruminally and esophageally fistulated cattle were used to sample vegetative and harvested forages. In studies where ruminally fistulated steers were utilized, steers were held without access to feed overnight then the contents of the rumen were completely evacuated. Following evacuation, steers were either presented with forages of known nutrient composition or allowed to graze for about 30 min. Next, the entire contents (forage and liquid) were collected and finally, the rumen contents previously evacuated were returned. In studies utilizing esophageally fistulated cows, cows were fitted with screen bottom bags after removal of the esophageal plug and were either presented with forages of known nutrient composition or allowed to graze for about 20 minutes. In all studies, masticate samples were then divided and either squeezed by hand until no more saliva could be removed (SQZ), or left un-squeezed (UNSQZ).

In study 1, 12 esophageally fistulated cattle were maintained on either vegetative subirrigated meadow (HI, 24% CP, n = 6) or fed meadow hay in a dry lot (LO, 7.7% CP, n = 6) for eight days prior to the start of the study. Blood samples were collected and analyzed for urea nitrogen content. In study 2, three esophageally fistulated cows sampled Sandhills upland range 12 times from May 21 to Aug. 18, 2011. In studies 3 and 4, ruminally fistulated steers were presented with either harvested ground hay or fresh clipped, mid-May vegetative smooth bromegrass. In studies 5 and 6, ruminally fistulated steers grazed two smooth bromegrass pastures during the grazing season from May through Oct. 2011.

Results

In study 1, pre-collection diet did not affect ($P = 0.49$) CP content of masticate samples (Table 1). Serum urea nitrogen levels tended to be higher for HI cows (27.6 ± 4.0 vs. 23.5 ± 3.2 ml/dl; HI vs. LO, respectively; $P = 0.08$). Although a small amount of N is contained in the saliva, it was too small to influence the total nitrogen content of the sample in this instance. Type of forage offered (vegetative grass vs. hay) interacted ($P = 0.01$) with preparation technique for CP, where CP was lost when vegetative grass masticate samples were squeezed (20.0 vs. 21.5% CP for SQZ vs. UNSQZ, respectively; $P < 0.05$) but there was no difference between squeezed and un-squeezed hay masticate samples (7.6 vs. 7.6% CP for SQZ vs. UNSQZ, respectively; $P > 0.05$). The pre-ingestion CP value for vegetative grass was 24% and 7.7% for the hay. Type of forage offered (vegetative grass vs. hay) also interacted ($P = 0.001$)

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Table 1. Crude protein, NDF, and ash values of squeezed (SQZ) and unsqueezed (UNSQ) vegetative grass and hay masticate samples collected from esophageally fistulated cattle fed high or low levels of CP pre-collection (study 1).

	High				Low								
	Hay		Vegetative		Hay		Vegetative			*P*-values			
	SQZ	UNSQ	SQZ	UNSQ	SQZ	UNSQ	SQZ	UNSQ	SE	Previous	Type	Process	T x P
CP	7.5^{d}	7.5^{d}	20.2^{bc}	21.9^{a}	7.6^{d}	7.6^{d}	19.7^{c}	21.0^{ab}	0.5	0.49	< 0.001	0.01	0.01
NDF	68.4^{ab}	64.5^{b}	51.3^{c}	50.8^{c}	72.8^{a}	67.7^{ab}	50.8^{c}	42.7^{d}	2.4	0.89	< 0.001	0.01	0.01
Ash	10.8^{c}	13.0^{b}	18.8^{a}	15.6^{a}	12.1^{c}	14.2^{b}	17.2^{a}	17.5^{a}	0.7	0.39	< 0.001	0.56	0.01

^{abc}Means lacking a common superscript letter differ ($P < 0.05$).

with preparation technique for NDF. Squeezing masticate samples increased the NDF content of both forage types but to a greater extent for vegetative grass than for hay (52.2 vs. 44.1% NDF for VEG and 71.0 vs 67.3 for HAY; $P < 0.05$). The pre-ingestion NDF value for vegetative grass was 40% and 66% for the hay. Cell solubles from fresh vegetative grass may go into solution more rapidly than those of the dry hay, possibly accounting for some of the differences observed.

In study 2, squeezing increased NDF content (69.7% vs. 66.0% for SQZ vs. UNSQZ, respectively; $P < 0.01$) and decreased ash content (8.0% vs. 9.0% for SQZ vs. UNSQZ, respectively; $P < 0.01$) but did not impact CP content (9.5% vs. 9.6% for SQZ vs. UNSQZ, respectively; $P = 0.42$; Table 2).

In study 3, harvested ground hay masticate samples, both SQZ and UNSQZ, had significantly increased ($P < 0.01$) CP levels from PRE samples (Table 3). However, in study 4, there was no difference in CP ($P = 0.20$) between the pre-ingested and masticate samples.

In studies 5 and 6, UNSQZ masticated samples collected from fistulated steers had greater CP content ($P = 0.06$ and $P < 0.01$, respectively) compared to SQZ (Table 3). The inconsistency in the effect of squeezing on CP content of the sample among studies utilizing ruminally fistulated steers could be due to increased salivary contamination with mature and grazed forages.

Neutral detergent fiber (as a percent of OM) varied among studies utilizing ruminally fistulated cattle. In study 4, mastication increased ($P < 0.01$) NDF (% of OM) of SQZ and UNSQZ samples by 31.1% and 25.7%, respectively, compared to PRE (Table 3). In studies 5 and 6, squeezing masticate samples significantly increased NDF by 8.2% and 11.7%, respectively compared to UNSQZ. In contrast to the fresh forages, neither mastication nor preparation technique impacted ($P = 0.17$) harvested ground hay NDF content in study 3.

In studies that used ruminally fistulated steers, handling technique had no effect ($P > 0.06$) on the IVDMD of masticated diet samples. Similar to NDF and CP, IVDMD differences depend on forage type and maturity. There was no IVDMD difference ($P = 0.79$) between the pre-ingested and masticate samples of the harvested ground hay sample (study 3) which is likely attributable to the increased maturity of the harvested forage (Table 3). However, IVDMD of pre-ingested high quality, vegetative forage samples decreased ($P < 0.01$) with mastication, but with no difference between SQZ and UNSQZ preparation techniques. Mastication of the offered vegetative forage decreased ($P < 0.01$) IVDMD compared to the SQ and UNSQ samples by 7.3 and 4.6%, respectively.

The results of these studies indicate squeezing masticate samples has a large effect on high quality, vegetative grass but a lesser effect on low quality grass or harvested hay. Squeezing diet samples increased the NDF content in all studies, except the harvested ground hay in study 3. Squeezing also impacted the CP levels of high quality forage but had little effect on CP content of lower quality forage. Mastication increased ash content and ash content was lower in samples that were squeezed compared to unsqueezed samples. Cell solubles are lost with the historical diet sampling methods of screen bottom bags with esophageally fistulated cows and also squeezing the masticate sample. With cell solubles lost, nutrient compositions are skewed. Previous diet did not impact N level of samples. This is the first research to test the effects of squeezing high quality, vegetative masticate samples and further work is warranted in this area.

Table 2. Crude protein, NDF, and ash values of squeezed (SQZ) and unsqueezed (UNSQ) masticate samples collected from esophageally fistulated cattle grazing Sandhills upland range from May to August (study 2).

	SQZ	UNSQ	SE	*P*-value
CP	9.5[a]	9.6[a]	0.3	0.42
NDF	69.7[a]	65.98[b]	0.008	< 0.0001
Ash	8.0[a]	9.0[b]	0.2	< 0.0001

[ab]Means with different superscripts differ (*P*-value < 0.01).

Table 3. Nutrient composition of pre-ingested (PRE) forage, squeezed (SQZ), and un-squeezed (UNSQ) masticate samples collected from ruminally fistulated steers (studies 3 and 4).

		PRE	SQZ	UNSQ	SEM	*P* – value
Study 3[1]	Ash, %	7.71[b]	8.67[b]	12.41[a]	0.36	< 0.01
	CP, %	20.64	18.55	20.15	0.80	0.20
	NDF, %	53.09[b]	69.58[a]	66.73[a]	1.47	< 0.01
	IVDMD, %	66.50[a]	61.65[b]	63.42[b]	0.61	< 0.01
Study 4[2]	Ash, %	5.98[c]	7.53[b]	8.97[a]	0.32	< 0.01
	CP, %	6.29[b]	9.16[a]	9.83[a]	0.53	< 0.01
	NDF, %	71.58	74.56	72.72	1.06	0.17
	IVDMD, %	53.05	52.95	53.33	0.41	0.79
Study 5[3]	Ash, %	—	10.74	13.88	0.60	< 0.01
	CP, %	—	15.02	16.81	0.66	0.06
	NDF, %	—	69.76	64.50	1.09	< 0.01
	IVDMD, %	—	54.76	57.79	2.34	0.36
Study 6[4]	Ash, %	—	12.71	15.28	0.75	0.02
	CP, %	—	15.56	17.16	0.39	< 0.01
	NDF, %	—	69.29	62.06	1.50	< 0.01
	IVDMD, %	—	54.17	56.39	2.17	0.47

[1]Offered freshly clipped, vegetative smooth bromegrass of known nutrient composition.
[2]Offered hay of known nutrient composition.
[3]Grazed smooth bromegrass pasture.
[4]Grazed smooth bromegrass pasture.

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Replacing Steam-Flaked Corn and Dry Rolled Corn With Condensed Distillers Solubles In Finishing Diets

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Summary

The interaction between corn processing method and condensed distillers solubles (CDS) was evaluated using either steam-flaked corn (SFC) or dry rolled corn (DRC). As CDS replaced corn at either 15 or 30% of the diet DM, DMI intake decreased quadratically for both SFC and DRC. Within DRC- based diets, ADG increased quadratically with 15% CDS being greatest and F:G improved quadratically with 30% inclusion being best. When SFC was used as the grain source, ADG increased linearly and F:G improved quadratically with increasing levels of CDS. A greater performance response was observed with SFC compared to DRC when feeding increased levels of CDS.

Introduction

Condensed distillers solubles (CDS) is a byproduct from the dry milling ethanol process. Feeding increased levels of CDS in finishing rations improved performance in diets containing a blend of dry rolled (DRC) and high-moisture corn (*2012 Nebraska Beef Cattle Report*, pp. 64-65). Wet distillers grains with solubles (WDGS) interacts with corn processing methods (*2007 Nebraska Beef Cattle Report*, pp. 33-35). This interaction revealed a greater response to higher levels of WDGS in DRC diets compared to SFC based diets. It is unknown how CDS interacts with different corn processing methods. Therefore, the objective of this study was to determine if an interaction exists between corn processing method (DRC or SFC) and level of CDS in finishing diets.

Materials and Methods

Four hundred sixty-two crossbred steers (initial BW = 869 ± 35 lb) were utilized in a finishing trial at the Panhandle Research Feedlot located near Scottsbluff, Neb. Five days prior to the start of the experiment, cattle were limit fed a diet consisting of 25% corn silage, 25% beet pulp, and 50% alfalfa hay (DM basis). Two day initial weights were recorded on days 0 and 1, and the average was used as initial BW. Cattle were blocked (n = 3) based on initial BW and assigned randomly to one of 42 feedlot pens (11 steers/pen). Pens were assigned randomly to treatments which allowed for seven replications per treatment.

A randomized block design was utilized with a 2 x 3 factorial arrangement of treatments. The first factor was corn processing method (DRC or SFC), and the second factor was level of CDS (0, 15, 30%; DM basis) which replaced a portion of corn, soybean meal, and urea (Table 1). Cattle were adapted to the finishing diets over a 20-day period with corn replacing alfalfa hay, while inclusion of CDS remained the same in all diets. The CDS used in this trial (Colorado Agri Products, Bridgeport, Neb.) contained 24.3% DM, 16.0% CP, 20.3% EE, and 0.39% S. Diets included soybean meal and urea in order to meet or exceed MP requirements. All diets contained 4.0% supplement which was formulated to provide 360 mg of Rumensin® and 90 mg of Tylan® per steer daily (Elanco Animal Health).

Steers in the light block were implanted on day 1 with Component TE-IS. Steers in the mid and heavy block were implanted with Component TE-S (Elanco Animal Health). The lightweight block was re-implanted on day 70 with Component TE-S. The middle and heavy BW blocks were harvested on day 119 and the light BW block on 132 (Cargill Meat Solutions, Fort Morgan, Colo.). Hot carcass weight and liver scores were recorded on the day of slaughter. Fat thickness, LM area, and USDA marbling score were recorded after a 48-hour chill. Final BW, ADG, and F:G were calculated using HCW adjusted to a common 63% dressing percentage.

Performance and carcass characteristics were analyzed using the MIXED procedure of SAS (SAS Inst., Inc., Cary, N.C.). Corn processing method, CDS inclusion level, and corn processing method x CDS inclusion level were included in the model. Pen was the experimental unit and BW block was included as a random effect. Orthogonal contrasts were used to test linear and quadratic effects of

(Continued on next page)

Table 1. Experimental diets[1] (DM basis).

	SFC[2]			DRC		
	CDS, % Diet DM			CDS, % Diet DM		
	0	15	30	0	15	30
Ingredient %						
DRC	—	—	—	83.59	69.54	55.50
SFC	82.19	68.70	55.34	—	—	—
CDS	—	15.0	30.0	—	15.0	30.0
Corn silage	7.0	7.0	7.0	7.0	7.0	7.0
Alfalfa hay	3.5	3.5	3.5	3.5	3.5	3.5
Supplement[3]	4.0	4.0	4.0	4.0	4.0	4.0
Soybean meal	2.7	1.4	—	1.3	0.65	—
Urea	0.61	0.40	0.16	0.61	0.31	—

[1]SFC = Steam-flaked corn, DRC = dry rolled corn, CDS = condensed distillers solubles.
[2]Flake density was 28 lb/bu.
[3]Formulated to provide 360 mg Rumensin and 90 mg of Tylan per head daily.

Table 2. Effect of corn processing method and condensed distillers solubles (CDS) inclusion level on performance and carcass characteristics.

	Steam-flaked corn			Dry rolled corn				*P*- value[1]		
CDS level:	0	15	30	0	15	30	SEM[2]	Corn	CDS	Inter
Performance										
Initial BW, lb	869	869	870	869	869	869	36.4	0.91	0.34	0.83
Final BW, lb[3,4,5]	1377	1389	1407	1337	1389	1350	18.2	< 0.01	< 0.01	< 0.01
DMI, lb/day[6]	26.1	25.5	23.6	26.7	25.9	23.2	0.66	0.30	< 0.01	0.14
ADG, lb[3,4,5]	4.15	4.26	4.39	3.84	4.25	3.95	0.01	< 0.01	< 0.01	< 0.01
F:G[3,4,5,7,8]	6.29	5.99	5.35	6.99	6.10	5.85	0.26	< 0.01	< 0.01	0.03
Carcass Characteristics										
HCW, lb[4,5]	867	875	886	842	875	850	11.4	< 0.01	0.01	< 0.01
12th rib fat, in[4]	0.55	0.60	0.60	0.56	0.55	0.56	0.01	0.02	0.23	0.07
LM area, in sq.	13.0	13.0	13.0	12.9	13.1	12.8	0.18	0.34	0.53	0.42
Marbling score[9]	553	555	559	551	558	554	13.8	0.79	0.65	0.81
Yield grade[4,10]	3.39	3.57	3.61	3.43	3.43	3.45	0.11	0.09	0.12	0.16
Liver abscess, %	7.9	11.8	3.9	14.3	9.2	8.0	—	0.29	0.26	0.38

[1]Corn = main effect of corn processing method, CDS = main effect of condensed distillers solubles inclusion level, Inter = corn processing method and condensed distillers solubles inclusion level interaction.
[2]SEM = standard error of the mean for the interaction.
[3]Final BW calculated from hot carcass weight, adjusted to a common dressing percentage of 63.
[4]Linear effect of CDS within SFC ($P < 0.05$).
[5]Quadratic effect of CDS within DRC ($P < 0.05$).
[6]Quadratic effect of CDS across all treatments ($P < 0.05$).
[7]Linear effect of CDS within DRC ($P < 0.05$).
[8]Quadratic effect of CDS within SFC ($P = 0.07$).
[9]Marbling score: 400 = Slight 0, 500 = Small 0
[10]Yield grade = 2.5 + 2.5(fat thickness, in) – 0.32(LM area, in^2) + 0.2(KPH fat, %) + 0.0038(hot carcass weight, lb).

CDS inclusion level across both corn processing types when no interaction was observed. In the case of a significant ($P < 0.05$) interaction, linear and quadratic effects were tested within corn processing method.

Results

Dry matter intake for both SFC and DRC fed cattle decreased quadratically ($P < 0.04$) as CDS level increased (Table 2). Corn processing method did not have an effect ($P = 0.30$) on DMI although numeric differences were observed. There were corn processing method x CDS level interactions ($P < 0.05$) for carcass adjusted final BW, ADG, and F:G. Quadratic increases ($P < 0.01$) in final BW and ADG were observed for DRC based diets, where final BW and ADG increased at 15% CDS level and decreased at the 30% level. There was a quadratic improvement ($P < 0.03$) in F:G as CDS level increased in DRC-based diets. A 14.6% improvement in F:G was observed when increasing CDS inclusion from 0 to 15% in DRC-based diets, but a smaller increase was observed (4.3%) when increasing CDS inclusion from 15 to 30%. These results are similar to previous data when feeding increased levels of CDS in DRC and high-moisture corn based diets at a 1:1 ratio (*2012 Nebraska Beef Cattle Report*, pp. 64-65). However for SFC- based diets, final BW and ADG increased linearly ($P = 0.01$) as CDS level increased. Similar to DRC-based diets a quadratic improvement ($P = 0.07$) in F:G was observed for SFC fed steers. When CDS was included at 15% in SFC diets, there was a 5% improvement in F:G. When comparing the 15% to 30% CDS in SFC diets there was an additional 12% improvement in F:G. When comparing corn processing methods with no CDS, an 11.2% improvement in F:G was observed for SFC compared with DRC.

There was no effect on LM area from corn processing method ($P = 0.34$) or CDS level ($P = 0.53$). There tended to be an interaction ($P = 0.07$) for 12th rib fat thickness. Steam flaked corn diets had greater ($P = 0.02$) 12th rib fat thickness compared to DRC diets. Fat thickness increased linearly ($P = 0.02$) for SFC diets, but for DRC based diets it was not different ($P = 0.88$) across inclusions of CDS. Diets with SFC tended ($P = 0.09$) to have greater yield grades than DRC based diets. There was a linear increase ($P = 0.01$) for yield grade in SFC diets; however, there was no difference across inclusions of CDS in DRC- based diets. There were no effects ($P > 0.65$) from corn processing method or CDS level on marbling score. No effects were observed for liver abscess incidence due to corn processing method ($P = 0.29$) or CDS level ($P = 0.26$).

Results from this study suggest corn processing method interacts with level of CDS. This response is somewhat different compared with WDGS, increasing level of CDS did not reduce ADG and F:G in SFC based diets. The response reported with SFC suggests that more than 30% CDS may be fed and warrants investigation.

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Association of Inactive Myostatin in Piedmontese-Influenced Steers and Heifers on Performance and Carcass Traits at Different Endpoints

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Summary

Performance and carcass traits were evaluated using Piedmontese-influenced calf-fed steers and yearling heifers genotyped for zero, one, or two copies (homozygous active, heterozygous, or homozygous inactive, respectively) of the inactive myostatin allele. Steers and heifers had similar responses across genotypes in performance and carcass traits evaluated at different endpoints. Inactive myostatin decreased DMI, final BW (live), and ADG (live). Increased dressing percentage resulted in increased carcass-adjusted ADG and improved feed conversion for cattle with inactive myostatin. Cattle with inactive myostatin are leaner with larger LM area when finished to equal carcass weight.

Introduction

Myostatin regulates the development and maturation of skeletal muscle mass. Mutations found within this gene produce inactive myostatin (IM) protein which leads to dramatic increases in muscle development through hyperplasia and hypertrophy of muscle fibers (i.e., double muscling). The objective was to investigate the potential association of inactive myostatin on the performance and carcass traits of Piedmontese-influenced steers and heifers.

Procedure

Two years of Piedmontese-influenced calf-fed steers (n = 117; 590 ± 66 lb) and yearling heifers (n = 119; 776 ± 119 lb) on an all-natural program were fed common finishing diets for an average of 211 and 153 days, respectively. Animal genotypes were confirmed by DNA testing as having zero, one, or two copies of the inactive myostatin allele, which corresponds to homozygous active (ACTIVE), heterozygous (HET), and homozygous inactive (INACTIVE), respectively. Calf-fed steers included 39 ACTIVE, 50 HET, and 28 INACTIVE. Yearling heifers included 44 ACTIVE, 46 HET, and 29 INACTIVE.

Cattle were individually-fed using Calan electronic gates in groups of 60 steers (calf-feds) or 60 heifers (yearlings). Common finishing diets consisted of 35% wet distillers grains plus solubles, 52% high-moisture:dry-rolled corn blend, 8% grass hay, and 5% supplement (year 1; DM basis); and 20% *Sweet Bran*®, 20% modified distillers grains plus soluble, 48% high-moisture:dry-rolled corn blend, 8% grass hay, and 4% supplement (year 2; DM basis). Cattle received no implants and diet supplements contained no feed additives.

Cattle were limit fed for 5 days on a diet with a 1:1 ratio of alfalfa hay:*Sweet Bran*® and 5% supplement (DM) at 2% BW which was then followed by three consecutive days BW collection for an average initial BW. Limit feeding followed three to four weeks of training to the Calan gates. Steers and heifers were serially weighed and scanned by a certified ultrasound technician at initiation and 28-day intervals throughout each feeding period. Carcass ultrasound measurements collected included LM muscle area, 12th rib fat thickness (uRIBF), rump fat thickness and intramuscular fat percentage.

Animal final BW were calculated as 1) a live final BW basis with two days consecutive BW shrunk 4% prior to shipment for harvest, and 2) a carcass-adjusted final BW basis at a common dressing percentage of 63%. Cattle were harvested at a commercial packing plant where HCW was collected and used to determine dressing percentage and carcass-adjusted final BW. After a 60-hour chill, LM area, USDA marbling, 12th rib fat thickness, and estimated KPH were recorded. A calculated USDA yield grade was determined from HCW, LM area, 12th rib fat thickness, and estimated KPH. Average daily gain and feed conversions were calculated for both live final BW and carcass-adjusted final BW.

Statistical Analysis

Within group, serial ultrasound data and BW were used to develop regression equations within genotype class. Regression equations were used to adjust individual animals to common endpoints determined by the overall mean of animals within gender for age, live BW, and uRIBF. Evaluations of endpoint adjustments demonstrate the dramatic differences between genotypes at a common age, BW, or fatness. All traits were analyzed using orthogonal contrasts based on genotype (HET vs average of ACTIVE and INACTIVE to test for a dominance effect, and ACTIVE

(Continued on next page)

vs INACTIVE to test for an additive genetic effect) in the MIXED procedure of SAS (SAS Inst., INC., Cary, N.C.). Individual animal was the experimental unit, with genotype was treated as a fixed effect. Year was considered a random effect. Steer age was used as a covariate in the model for performance, carcass, and carcass-adjusted performance (Table 1) due to differences in age at the start. No covariate was used in heifer analysis (Table 2) due to lack of significance.

Results

Steers

Steers with inactive myostatin were younger calves ($P < 0.01$). There was a quadratic response ($P = 0.04$) in initial BW with HET and ACTIVE being heavier than INACTIVE steers. Homozygous inactive steers had lower ($P < 0.01$) live final BW, live ADG and DMI than ACTIVE with HET intermediate. Homozygous inactive steers had the lowest ADG but the decrease in DMI resulted in a quadratic tendency, or dominance effect, ($P = 0.07$) for improved F:G for INACTIVE steers, with HET more similar to ACTIVE. Hot carcass weights were similar ($P = 0.18$) between all genotypes, although numerically lower for INACTIVE.

Regardless, dressing percentage was dramatically increased for INACTIVE steers (67.3%) compared to HET (63.7%) and ACTIVE (63.0%). LM area responded quadratically ($P = 0.05$) with IM presence, which was greatest for INACTIVE, intermediate for HET, and smallest for ACTIVE. Rib fat thickness, marbling and calculated yield grade linearly decreased ($P < 0.01$) with increasing inactive myostatin. Due to similar HCW between genotypes, ADG calculated from carcass-adjusted final BW responded quadratically ($P = 0.05$) with greatest gains for INACTIVE, followed by ACTIVE, and the lowest gains for HET. Carcass-adjusted feed conversion improved quadratically ($P < 0.01$) with

Table 1. Steers live BW performance, carcass-adjusted BW performance, and carcass traits.

	Myostatin[1]				*P*-value[2]	
Performance traits	ACTIVE	HET	INACTIVE	SEM	Lin.	Quad.
Age, day	480	472	464	29	< 0.01	0.96
Initial BW, lb	591	601	544	98	0.04	0.04
DMI, lb/day	18.9	17.1	15.0	0.9	< 0.01	0.69
Live BW[3]						
Final BW, lb	1132	1099	1015	22	< 0.01	0.27
ADG, lb/day	2.56	2.35	2.26	0.07	< 0.01	0.43
F:G[7]	7.30	7.25	6.67	—	< 0.01	0.07
Carcass-adjusted BW[4]						
Final BW, lb	1131	1110	1085	23	0.18	0.93
ADG, lb/day	2.53	2.39	2.58	0.08	0.72	0.05
F:G[7]	7.41	7.09	5.88	—	< 0.01	< 0.01
Carcass traits						
HCW, lb	712	699	684	15	0.18	0.93
Dress, %	62.98	63.69	67.26	1.43	< 0.01	< 0.01
Marbling[5]	597	453	283	34	< 0.01	0.57
LM area, in^2	12.42	14.55	15.51	2.21	< 0.01	0.05
12th rib Fat, in	0.51	0.28	0.13	0.03	< 0.01	0.26
CYG[6]	2.98	1.68	0.71	0.58	< 0.01	0.31

[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), and homozygous inactive (INACTIVE)
[2]*P*-value: Lin. = linear response to inactive myostatin and Quad. = quadratic response to inactive myostatin
[3]Live BW collected on two consecutive days prior to shipment, shrunk 4%
[4]Carcass-adjusted BW calculated at 63% dressing
[5]Marbling score: 500 = SM, 400 = SL, 300 = TR, 200 = PD
[6]Calculated Yield Grade = 2.5 + (2.5*12th rib fat, in.) + (0.0038*HCW, lb.) – (0.32*LM area, in.^{2}) $^+$ + (0.2*estimated KPH, %)
[7]F:G calculated as 1/(G:F)

Table 2. Heifers live BW performance, carcass-adjusted BW performance, and carcass traits.

	Myostatin[1]				*P*-value[2]	
Performance traits	ACTIVE	HET	INACTIVE	SEM	Lin.	Quad.
Age, day	629	622	626	33	0.59	0.13
Initial BW, lb	780	775	769	94	0.52	0.95
DMI, lb/day	21.1	19.5	16.7	0.7	< 0.01	0.06
Live BW[3]						
Final BW, lb	1177	1121	1041	28	< 0.01	0.48
ADG, lb/day	2.54	2.23	1.79	0.21	< 0.01	0.27
F:G[7]	8.30	8.77	9.35	—	< 0.01	0.75
Carcass-adjusted BW[4]						
Final BW, lb	1193	1157	1138	53	0.03	0.67
ADG, lb/day	2.59	2.43	2.41	0.31	0.08	0.41
F:G[7]	8.20	8.06	6.94	—	< 0.01	< 0.01
Carcass traits						
HCW, lb	751	729	717	33	0.03	0.67
Dress, %	63.80	64.95	68.92	1.39	< 0.01	< 0.01
Marbling[5]	585	495	368	43	< 0.01	0.28
LM area, in^2	13.59	15.18	18.05	0.95	< 0.01	0.04
12th rib Fat, in	0.56	0.31	0.16	0.07	< 0.01	0.10
CYG[6]	2.84	1.63	0.23	0.13	< 0.01	0.49

[1]Myostatin: homozygous active (ACTIVE), heterozygous (HET), and homozygous inactive (INACTIVE).
[2]*P*-value: Lin. = linear response to inactive myostatin and Quad. = quadratic response to inactive myostatin.
[3]Live BW collected on two consecutive days prior to shipment, shrunk 4%.
[4]Carcass-adjusted BW calculated at 63% dressing.
[5]Marbling score: 500 = SM, 400 = SL, 300 = TR, 200 = PD.
[6]Calculated Yield Grade = 2.5 + (2.5*12th rib fat, in.) + (0.0038*HCW, lb.) – (0.32*LM area, in.^{2}) $^+$ + (0.2*estimated KPH, %).
[7]F:G calculated as 1/(G:F).

INACTIVE being lowest, and HET more similar to ACTIVE.

Heifers

Heifers were similar in age and initial BW ($P = 0.13$ and 0.52, respectively) across genotypes. Similar to steers, INACTIVE heifers had decreased ($P < 0.01$) live final BW, live ADG, and DMI. Feed conversions linearly increased ($P < 0.01$) as IM presence increased with ACTIVE heifers having the lowest F:G. Heifers HCW linearly decreased ($P = 0.03$) for ACTIVE to INACTIVE. Carcass-adjusted ADG was slightly ($P = 0.08$) decreased for INACTIVE compared to ACTIVE. Interestingly, F:G based on carcass growth was dramatically improved ($P < 0.01$) for INACTIVE heifers compared to ACTIVE and HET heifers, which were more similar. Heifers had a quadratic increase ($P < 0.01$) in dressing percentage with INACTIVE heifers greater than HET and ACTIVE, similar to steers. There was a quadratic response in LM area ($P = 0.04$) with INACTIVE heifers increased relative to ACTIVE and HET. Marbling, 12th rib fat, and calculated yield grade linearly decreased ($P < 0.01$) for heifers with IM presence.

Being on an all-natural program, liver abscesses were recorded at 30.8 and 27.7% (steers and heifers, respectively), and were not influenced by genotype ($P > 0.33$). At common finishing endpoints, the influence of IM was similar for steers and heifers. Cattle with 1 or 2 copies of IM, at a common finishing age, had lighter live BW and leaner carcasses, but had increased LM area compared to their ACTIVE counterparts. To reach a common finishing fat thickness, a significant increase in days fed for increased live BW will be necessary for cattle with IM. Homozygous inactive cattle that are finished at a common live BW or fat thickness will have an even larger difference in LM area when compared to the HET or ACTIVE cattle.

Inactive myostatin effects on performance and carcass characteristics were generally similar between Piedmontese-influenced steers and heifers. Cattle with IM are lighter in live BW and have decreased DMI with leaner carcasses across all fat depots. Inactive myostatin increased LM area, dressing percentage, carcass-adjusted ADG and, when evaluated on a carcass-adjusted basis, improved F:G. When comparing cattle with IM influence, differences in performance evaluations are best to be considered on carcass weight, carcass-adjusted basis, or at the same finishing endpoints.

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Varying Proportions and Amounts of Distillers Grains and Alkaline-Treated Forage as Substitutes for Corn Grain in Finishing Cattle Diets

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Summary

A 124-day individually fed finishing study was conducted to evaluate corn grain replacement by distillers grain and 5% CaO treated crop residue. Dietary treatments were two ratios (2:1 or 3:1) of modified distillers grains and treated crop residues (DGCR), two types of treated crop residue (corn stover or wheat straw) at 3:1 ratio, and then with three dry rolled corn (DRC) levels (10%, 25%, 40%; DM basis). Steers fed diets containing as little as 25% corn and 3:1 ratios of distillers grains and CaO treated crop residues can achieve similar F:G compared with cattle fed diets containing 5% roughage and 56% corn.

Introduction

Previous studies have reported similar ADG and F:G when replacing up to 15 percentage (Shreck et al., *2012 Nebraska Beef Cattle Report*, pp. 105-107; pp. 108-109) units of corn with inclusion of 20% CaO treated corn stover or wheat straw in diets containing 40% wet or modified distillers grains. The objective of this trial was to test the maximum amount of corn that could be replaced by distillers grains and treated forage, and whether the ratio of distillers grains to treated residue is an important factor.

Procedure

Sixty yearling steers (initial BW: 885 ± 90.9 lb) were individually fed using Calan gates for 124 days. Steers were blocked (n = 2) by BW and assigned randomly to treatments. Steers were limit fed a 50% sweet bran 50% alfalfa hay (DM basis) diet, at 2% of BW for 5 days, and weighed on three consecutive days for initial BW determination. Steers were implanted with Revealor®-S on day 1. Ten dietary treatments (Table 1) were designed as two 2 x 3 factorials. In the first factorial, factors were ratio of distillers grain and corn stalks (2:1 or 3:1; DG:Stalks) with three dry rolled corn (DRC) levels (10%, 25%, 40%; DM basis). In the second factorial, factors were two types of treated crop residue (corn stalks or wheat straw at 3:1 DGCR), with three DRC levels (10%, 25%, 40%; DM basis). Ratios of DGCR replaced DRC and consisted of modified distillers grains plus solubles (MDGS) and treated corn stover at 2:1 or 3:1 of MDGS and treated wheat straw at 3:1. A control was included that contained 35% MDGS, 5% untreated corn stover, and 56% DRC. All diets contained 4% supplement and were formulated for adequate dietary Ca. Chemical treatment consisted of water, CaO (Granular Standard Quicklime, Mississippi Lime Co, Kansas City, Mo.), and ground residue (3-inch screen) weighed and mixed in Roto-Mix feed trucks. The mixture was calculated to be 50% DM (treated wheat straw and corn stalks used during experiment were: 52.7 and 54.7% DM, respectively) with calcium oxide added at 5% of the forage DM. Feed trucks dispensed treated residue into a silage bag and the treatment process was completed at least seven days prior to feeding. The pH of treated wheat straw and corn stalks averaged 8.16 and 7.29, respectively, throughout the feeding period. Calcium oxide treatment solubilized (relative to untreated) 13.6 and 13.7% of the NDF for treated wheat straw and corn stover, respectively. Orts were assessed weekly and the amount of DM refused was subtracted from the DM offered to calculate DMI. Steers were weighed on the day prior to slaughter and live BW was used to calculate dressing percent [HCW/(live BW*0.96)]. Carcass adjusted final BW was calculated from HCW and a 62% dressed yield was assumed. Carcass adjusted final BW was used to calculate ADG. Data were

Table 1. Diet composition offered to individually fed steers.

		2:1 Stalks			3:1 Stalks			3:1 Wheat Straw		
Ingredient, % of DM	Control	Low	Mid	High	Low	Mid	High	Low	Mid	High
DRC	56.00	10.00	25.00	40.00	10.00	25.00	40.00	10.00	25.00	40.00
Stalks-treated[1]	—	28.66	23.66	18.66	21.50	17.75	14.00	—	—	—
Straw-treated[1]	—	—	—	—	—	—	—	21.50	17.75	14.00
MDGS	35.00	57.33	47.33	37.33	64.50	53.25	42.00	64.50	53.25	42.00
Untreated stalks	5.00	—	—	—	—	—	—	—	—	—
Supplement	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

[1]Treated with 5% CaO and 50% DM.

Table 2. Effect of 2:1 or 3:1 distillers grains:corn stalks on steer performance and carcass characteristics.

		2:1 Stalks			3:1 Stalks						
		DRC level, % of DM							DRC[1]		
Item	Control	10%	25%	40%	10%	25%	40%	SEM	Linear	Quad	F-Test
Performance											
Initial BW, lb	882	880	888	885	890	888	879	12.9	—	—	0.99
DMI, lb/day	24.9	25.3	25.2	25.0	24.7	24.3	24.1	0.67	0.52	0.99	0.81
ADG, lb[2]	3.77	3.12	3.27	3.46	3.00	3.48	3.40	0.21	0.07	0.46	0.45
F:G[3]	6.60	8.11	7.71	7.23	8.23	6.98	7.09	—	0.04	0.46	0.27
Live BW[4], lb	1368	1345	1369	1397	1339	1359	1364	23.7	0.08	0.84	0.54
Carcass Characteristics											
HCW, lb	836	799	815	828	795	831	819	17.4	0.12	0.38	0.57
Dressing, %[5]	60.9	59.6	59.6	59.3	59.5	61.3	60.2	0.0068	0.77	0.20	0.36
LM area, in[2]	13.08	13.77	14.65	14.55	15.17	14.07	13.30	0.68	0.34	0.73	0.22
12th Rib fat, in	0.45	0.36	0.40	0.30	0.42	0.42	0.47	0.063	0.86	0.59	0.05
Calc YG	3.20	2.52	2.40	2.23	2.22	2.72	2.97	0.2993	0.36	0.74	0.05
Marbling[6]	500	468	452	452	487	503	472	29.9	0.56	0.73	0.63

[1]Contrast of DRC level pooled across ratio (no interaction found between ratio and corn level; $P > 0.10$).
[2]Calculated from carcass adjusted final BW by HCW/0.62.
[3]Analyzed as G:F, reciprocal of F:G.
[4]Pencil shrink of 4% applied.
[5]Calculated as HCW/Live BW.
[6]400=Slight [00], 500=Small [00].

Table 3. Effect of 3:1 distillers grains:corn stalks or wheat straw on steer performance and carcass characteristics.

		3:1 Stalks			3:1 Wheat Straw						
		DRC level, % of DM							DRC[1]		
Item	Control	10%	25%	40%	10%	25%	40%	SEM	Linear	Quad	F-Test
Performance											
Initial BW, lb	882	890	888	879	891	887	893	12.9	—	—	0.99
DMI, lb/day	24.9	24.7	24.3	24.1	22.8	24.2	24.8	0.64	0.28	0.15	0.29
ADG, lb[2]	3.77	3.00	3.48	3.40	3.17	3.44	3.60	0.22	0.04	0.02	0.41
F:G[3]	6.60	8.23	6.98	7.09	7.19	7.03	6.89	—	0.16	0.13	0.55
Live BW[4],lb	1368	1339	1359	1364	1355	1359	1375	23.2	0.24	0.13	0.82
Carcass Characteristics											
HCW, lb	836	795	831	819	808	827	844	17.2	0.08	0.05	0.46
Dressing, %[5]	60.9	59.5	61.3	60.2	59.8	60.8	61.1	0.0074	0.15	0.18	0.57
LM, area in[2]	13.08	15.17	14.07	13.30	13.28	13.73	13.73	0.73	0.21	0.51	0.29
12th Rib fat, in	0.45	0.42	0.42	0.47	0.45	0.47	0.44	0.070	0.73	0.49	0.99
Calc YG	3.20	2.22	2.72	2.97	2.96	2.91	2.92	0.323	0.15	0.56	0.31
Marbling[6]	500	487	503	472	518	482	470	33.7	0.25	0.23	0.91

[1]Contrast of DRC level pooled across ratio (no interaction found between ratio and corn level; $P > 0.10$).
[2]Calculated from carcass adjusted final BW by HCW/0.62.
[3]Analyzed as G:F, reciprocal of F:G.
[4]Pencil shrink of 4% applied.
[5]Calculated as HCW/Live BW.
[6]400=Slight [00], 500=Small [00].

analyzed using the MIXED procedure of SAS (SAS Inst., Inc.; Cary, N.C.). Initial BW block was considered as a fixed effect. The following tests were included in the data analysis: F-test (used to compare control to the set of each six diets in each factorial), the interaction term of each factorial, which if not significant, data were pooled across corn level, to test linear and quadratic contrasts of corn across 2:1 or 3:1 DG:stalks (factorial 1.) or DG:CR (factorial 2.). An alpha of $P < 0.10$ was considered significant.

Results

No interactions were detected in either factorial; therefore, data were pooled across corn level. Increasing DRC improved ($P = 0.04$) F:G and increased ADG ($P = 0.07$) linearly in treated stalks diets (Table 2). Increasing DRC quadractically increased ($P=0.02$) ADG and HCW ($P = 0.05$), but had no effect on F:G ($P \geq 0.15$) with 3:1 ratios (Table 3). No differences were detected compared to the control. The results of this study suggest that a 3:1 ratio of distillers grains and treated stover or straw, a maximum of 20% treated residue (DM basis), and at least 25% DRC are needed to support feed efficiency similar to that of a 56% DRC, 5% roughage diet.

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Evaluation of Rumen Metabolism and Digestibility when Treated Crop Residues are Fed in Cattle Finishing Diets

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Summary

A metabolism trial was conducted to evaluate rumen pH, digestibility, and ruminal VFA concentrations of steers fed 25% CaO treated or untreated cobs, wheat straw, and corn stover. Treated diets had greater digestibility of DM, OM, and NDF compared to untreated diets. Substituting 15 percentage units of corn and 10% roughage with 25 percentage units of 5% CaO treated cobs, wheat straw, or corn stover resulted in similar DM digestibility, rumen pH and VFA concentrations.

Introduction

A previous trial (Shreck et al., *2012 Nebraska Beef Cattle Report*, pp. 105-107) compared treated or native cobs, wheat straw, and corn stalks and noted no difference in performance or carcass characteristics between treated residues and a control diet that contained 10% units more dry rolled corn (DRC) and 10% roughage. In the same study, treated forages had greater ADG and lower F:G than native. The objective of this trial was to compare digestibility and rumen metabolism of treated and untreated crop residues as replacements for corn grain.

Procedure

This experiment was designed as a 5 x 7 incomplete Latin square with a 2 x 3 + 1 factorial arrangement of treatments. Ruminally fistulated steers (n = 5) were assigned randomly and acclimated to each diet for seven 15-day periods, with a 10-day adaptation period and a 5-day collection period. Factors were chemical treatment (treated or native) and forage fraction (cobs, corn stalks, and wheat straw). Chemical treatment consisted of water, CaO (granular Standard Quicklime, Mississippi Lime Co, Kansas City, Mo.), and ground residue weighed and mixed in Roto-Mix feed trucks. The mixture was targeted for a 50% final DM (treated cobs, wheat straw, and corn stalks used during experiment were: 52.1, 51.6, and 45.6% DM, respectively) with calcium oxide added at 5% of the forage (DM basis). Feed trucks dispensed treated residue into a silage bag and the treatment process was completed at least seven days prior to start of experiment. Untreated residue was only ground and fed in its native form (cobs, wheat straw, and corn stalks used during experiment were: 93.0, 87.2, and 72.8% DM, respectively). The pH of treated cobs, wheat straw, and corn stalks were 8.05, 7.90, and 7.79, respectively, when sampled over the feeding period. Cobs were ground through a 0.75-inch screen while wheat straw and corn stalks were ground through a 3-inch screen. Treated and untreated forage residues were fed at 25% of diet DM and replaced DRC (Table 1). Wet distillers grains plus solubles (WDGS; 33.9% DM) was included in all diets at 40% (DM basis). The control contained 46% DRC and an equal blend of the three native forage residues, totaling 10% of diet DM. All diets contained 4% dry meal supplement and were formulated to supply similar diet Ca (1.47% limestone in control and native diets and treated diets contained no added limestone). Diets were mixed twice each week and kept in a cooler (32°F) until used to ensure fresh feed for the entire experiment. The diets provided 320 to 360 mg/steer of monensin, 90 mg/steer of tylosin, and 150 mg/steer of thiamine daily.

Steers were ruminally dosed with 7.5 g of Cr_2O_3 twice daily at 0800 and 1600 hours. Fecal grab samples were collected at 0800, 1200, and 1600 hours from day 11 to day 15. Within a day, fecal samples were composited on a wet basis into a daily composite, then freeze-dried. From daily composites, a steer within period fecal composite sample was made and analyzed for NDF, OM, and Cr percentage. Samples for NDF were first prepared by removal of fat by biphasic ether extraction. Ruminal pH was recorded every minute using wireless pH probes (Dascor Inc; Escondido, Calif.) from day 11 to day 15. Rumen contents were sampled on day 15 at 0800, 1100, 1400, 1700, 2000, and 2300 hours using the suction strainer technique and a composite sample of steer within period was analyzed for VFA, using gas chromatography. Feeds offered and refused were analyzed for DM, OM, and NDF percentage. Dry matter was determined using a forced-air oven set at 60°C for 48 hours. Digestibility and VFA data were analyzed using the MIXED procedure of SAS (SAS Inst., Inc., Cary, N.C.) with steer as a random effect and period as a fixed effect. Ruminal pH was analyzed as a repeated measure using the GLIMMIX procedure with day as the repeated measure. Means

Table 1. Diet composition of diets offered to steers during experiment.

		Cobs		Straw		Stalks	
Ingredient, % of DM	Control	Treated	Native	Treated	Native	Treated	Native
DRC	46.0	31.0	31.0	31.0	31.0	31.0	31.0
Cobs-treated[1]	—	25.0	—	—	—	—	—
Straw-treated[1]	—	—	—	25.0	—	—	—
Stalks-treated[1]	—	—	—	—	—	25.0	—
Cobs-not treated	3.33	—	25.0	—	—	—	—
Straw-not treated	3.33	—	—	—	25.0	—	—
Stalks-not treated	3.33	—	—	—	—	—	25.0
WDGS	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Supplement	4.0	4.0	4.0	4.0	4.0	4.0	4.0

[1]Treated with 5% CaO and water added to equal 50% moisture.

Table 2. Digestibility and intake of nutrients.

									P-value			
		Corn Cobs		Wheat Straw		Corn Stover			All diets		Factorial	
Item	Control	Treated	Native	Treated	Native	Treated	Native	SEM	F-test	T[1]	F[2]	TxF[3]
DM intake, lb/day	21.6	21.6^{yz}	22.9^{xy}	22.2^{xy}	19.8^{z}	20.7^{yz}	22.9^{xy}	1.25	0.46	0.36	0.08	0.01
DM digestibility, %	70.3^{abc}	71.9^{abxy}	68.9^{abcxyz}	74.7^{ax}	66.2^{bcyz}	74.5^{ax}	63.2^{cz}	2.95	0.11	0.001	0.51	0.29
OM intake, lb/day	20.7^{ab}	20.7^{abxy}	21.8^{ax}	20.9^{abxy}	18.7^{bz}	19.6^{abyz}	21.8^{ax}	0.55	0.02	0.06	0.01	0.001
OM digestibility, %	72.1^{abc}	74.1^{ab}	69.8^{bc}	78.4^{a}	69.3^{bc}	78.4^{a}	66.3^{c}	2.86	0.04	0.001	0.80	0.33
NDF intake, lb/day	4.8^{c}	6.8^{b}	7.9^{ab}	6.8^{b}	7.3^{ab}	6.8^{b}	8.1^{a}	0.22	0.003	0.001	0.21	0.57
NDF digestibility, %	43.9^{d}	63.7^{ab}	55.3^{bc}	68.7^{a}	54.5^{bcd}	68.1^{a}	44.8^{cd}	4.58	0.002	<0.001	0.61	0.14

[1]Main effect of chemical treatment.
[2]Main Effect of forage fraction.
[3]Interaction of chemical treatment x forage fraction.
[abcd]From the F-test, means lacking common superscripts, differ $P < 0.10$.
[xyz]From the interaction of chemical treatment x forage fraction, means lacking common superscripts, differ $P < 0.10$.

Table 3. Ruminal VFA and pH.

									P-value			
		Corn Cobs		Wheat Straw		Corn Stover			All Diets		Factorial	
Item	Control	Treated	Native	Treated	Native	Treated	Native	SE	F-test	T[1]	F[2]	TxF[3]
Maximum pH	6.49^{bc}	6.52^{b}	6.38^{c}	6.56^{b}	6.60^{b}	6.85^{a}	6.76^{a}	0.07	<0.001	0.94	<0.001	0.24
Average pH	5.99^{ab}	5.98^{bxy}	5.84^{by}	5.81^{by}	6.05^{abxy}	6.23^{axy}	5.95^{bxy}	0.114	0.11	0.98	0.43	0.08
Minimium pH	5.44	5.49^{xy}	5.42^{xy}	5.30^{y}	5.57^{x}	5.52^{x}	5.28^{y}	0.116	0.47	0.88	0.97	0.03
Total VFA, mM	109.1^{ab}	109.6^{a}	92.3^{bcd}	102.3^{abc}	92.8^{abcd}	82.6^{d}	89.6^{cd}	6.74	0.03	0.15	0.05	0.15
Molar proportion, mol/ 100 mol												
Acetate	57.7	61.7	61.5	56.6	59.7	60.3	60.4	1.81	0.12	0.48	0.08	0.38
Propionate	23.1^{abc}	20.6^{c}	23.8^{ab}	24.5^{a}	24.2^{ab}	21.0^{bc}	24.3^{a}	1.71	0.05	0.03	0.15	0.15
Butyrate	12.5	11.1	10.7	12.4	10.0	12.5	9.74	1.11	0.15	0.03	0.85	0.44

[1]Fixed effect of chemical treatment.
[2]Fixed Effect of forage fraction.
[3]Interaction of chemical treatment x forage fraction.
[4]Acetate:Propionate ratio.
[abcd]Within a row, values lacking common superscripts, differ $P < 0.10$.
[xyz]From the interaction of chemical treatment x forage fraction, means lacking common superscripts, differ $P < 0.10$.

across all diets were separated using the pdiff option when the F-test was significant. Main effects of chemical treatment and forage type and the interaction were tested as well with simple effects presented but discussed as main effects (no interaction) or simple effects (with significant interaction).

Results

Greater DM (73.7 vs. 66.1%; $P = 0.001$), OM (77.0 vs. 68.5%; $P = 0.001$), and NDF (66.8 vs. 51.5%; $P < 0.001$) digestibilities (Table 2) were noted for treated compared to untreated. However, no difference ($P > 0.10$) was found between control and treated diets for DM (70.7 vs. 73.7%) or OM (72.1 vs. 76.9%) digestibility. An interaction ($P = 0.01$) for DMI was observed where untreated cobs and corn stalks had greater DMI compared to treated, whereas untreated straw had lower DMI compared to treated. Lower ($P = 0.001$) NDF intake was observed for treated diets (6.8 vs. 7.7 lb/day), suggesting that CaO treatment partially solubilized NDF thereby decreasing measurable NDF intake. Analysis of treated residues showed that CaO treatment solubilized (relative to untreated) 16.6, 21.0, and 15.6% of the NDF for treated cobs, wheat straw, and corn stover, respectively. An interaction was noted for average ruminal pH (Table 3.) as treated cobs (6.52 vs. 6.38) and stover (6.23 vs. 5.95) had greater pH but treated straw (5.81) had lower ($P = 0.08$) rumen pH compared to untreated (6.05). An interaction ($P = 0.06$) was observed for acetate:propionate (A:P) ratio (Table 3.). Chemical treatment of cobs (3.1 vs. 2.6) and corn stover (2.9 vs. 2.6) resulted in greater A:P but treated wheat straw had lower A:P (2.4 vs. 2.6) compared to untreated. No difference ($P > 0.10$) was observed between treated straw or stover compared to control (2.6) for A:P. Chemical treatment increased ($P = 0.03$) butyrate concentration. Propionate concentration tended to interact ($P = 0.15$). Lower propionate concentration was observed for treated cobs and corn stalks compared to untreated, but propionate was similar for straw diets. Results suggest that treated crop residues can substitute for a portion of grain in feedlot diets and result in similar nutrient supply to the animal. The improvements in digestibility when treated residues are fed compared with untreated residues are related to fiber solubilization and improved fiber digestibility.

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Effects of Feeding 44 g/ton Rumensin® During Grain Adaptation on Animal Performance and Carcass Characteristics

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Summary

Cattle were adapted to a finishing diet over 20 days while feeding 33 or 44 g/ton (DM) of Rumensin. Following grain adaptation, all cattle were fed a common finishing diet containing 33 g/ton Rumensin for the remainder of the feeding period. Feeding 44 g/ton of Rumensin during the adaptation period did not affect performance during the adaptation period or over the entire feeding period when compared to the 33 g/ton adaptation level.

Introduction

Rumensin is widely used in the feedlot industry to improve feed efficiency. Reduced incidence of acidosis is likely a contributing factor to observed improvements in feed efficiency when feeding Rumensin. University of Nebraska research suggests Rumensin reduces the area of ruminal pH below 5.6, ruminal pH change, and variance when cattle are offered ad-libitum access to feed (1997 *Nebraska Beef Cattle Report,* p.49). Another study found that feeding 44 g/ton Rumensin led to a 3% improvement in feed efficiency over the feeding period and an 8% improvement in feed efficiency over the first 56 days of the trial when compared to 33 g/ton (*2010 Plains Nutrition Council Proceedings,* p. 112). More substantial performance improvements observed early in the feeding period may be due to a reduction in acidosis because of a decrease in intake variability as a result of feeding a higher level of Rumensin during grain adaptation. The objective of this trial was to evaluate the effects of feeding either 33 or 44 g/ton Rumensin during the grain adaptation period to evaluate the influence of higher Rumensin levels on animal performance and carcass characteristics over the entire feeding period.

Procedure

Yearling crossbred steers (n = 197; BW = 827 ± 64 lb) were separated into three weight blocks, stratified by BW, and assigned randomly within strata to 18 feedlot pens, with 10 or 11 steers per pen and nine pens per treatment. Treatments were imposed during grain adaptation (20 days) feeding 33 or 44 g/ton (DM) of Rumensin. Excluding Rumensin level, the grain adaptation program was the same for all cattle. The adaptation program (Table 1) involved three grain adaptation diets fed for six days each which increased dry rolled corn (DRC) inclusion while alfalfa hay inclusion was decreased. All step diets and the finishing diet contained 25% wet distillers grains with solubles (WDGS), 12% corn silage, and 6% liquid supplement (DM basis). Subsequent to grain adaptation, all steers were fed a common finishing diet that contained 33 g/ton of Rumensin. In addition, 90 mg of Tylan® was fed per steer daily during the trial. All additives were incorporated into step diets and the common finishing ration using a micro machine. All cattle were offered *ad libitum* access to feed and water for the duration of the study.

Prior to initiation of the trial, steers were limit fed a diet consisting of 55% alfalfa hay, 40% WDGS, and 5% supplement for 5 days at a level of 1.8% BW to minimize variation in gut fill. At the beginning of the trial cattle were poured with Ivomec®, tagged, weighed, and vaccinated with Bovishield™ Gold 5 and Vision® 7. Weights were measured on two consecutive days (days 0 and 1) to determine initial BW. Feed ingredient samples were collected weekly throughout the trial, dried in a forced-air oven at 60°C for 48 hours, and analyzed for nutrient content. On day 26, following grain adaptation, and after being on a common finishing diet for six days, BW was measured and cattle were implanted

Table 1. Dietary composition (%) and DOF for grain adaptation diets and the finishing diet.

Days fed:	1-6	7-13	14-20	
Adaptation:	1	2	3	Finisher
Ingredient, %				
Alfalfa hay	30	20	10	0
Corn silage	14	14	14	14
Dry rolled corn	25	35	45	55
WDGS[1]	25	25	25	25
Supplement[2]	6	6	6	6
Analyzed Composition, %				
CP	16.39	15.55	14.71	13.87
NDF	36.73	31.71	26.69	21.67
Ca	0.93	0.79	0.65	0.51
P	0.39	0.39	0.39	0.40
K	1.41	1.24	1.07	0.80
S	0.25	0.23	0.22	0.20

[1]Wet distillers grains with solubles.
[2]The same supplement was used for all diets while 33 or 44g/ton Rumensin and 90 mg/head/day Tylan. (DM) was added using a micro machine.

Table 2. Feedlot performance and carcass characteristics of cattle fed 33 g/ton or 44 g/ton Rumensin during the adaptation period.

Item	Treatment		SEM	*P*-value
	33 g/ton	44 g/ton		
Performance				
Initial BW, lb	827	827	42	0.49
Final BW, lb[1]	1403	1409	19	0.59
DMI, lb/day				
26 days	20.0	19.9	0.4	0.39
Final	26.9	26.7	0.7	0.42
ADG, lb				
26 days	3.83	3.95	0.3	0.49
Final[1]	4.59	4.64	0.5	0.66
F:G[2]				
26 days	5.21	5.03	—	0.44
Final[1]	5.78	5.78	—	0.96
Final live BW, lb	1401	1403	23	0.81
Carcass characteristics				
HCW, lb	884	888	12	0.59
Dressed yield, %	63.1	63.3	0.3	0.45
LM area, in[2]	12.8	12.7	0.3	0.45
12th rib fat, in	0.57	0.58	0.02	0.55
Yield Grade[3]	3.68	3.76	0.04	0.21
Marbling[4]	589	589	9	0.99
Liver abscess, %	15.2	10.2	—	0.35

[1]Final BW was calculated from HCW using a common dressed yield of 63%.
[2]Statistics performed on carcass adjusted G:F, the inverse of feed efficiency.
[3]Calculated as 2.5+ (2.5 x 12th rib fat) + (0.2 x 2.5[KPH]) + (0.0038 x HCW) − (0.32 x LM area).
[4]400 = Slight, 500 = Small, 600 = Modest.

with Component TE-S. A 4% pencil shrink was used for analyzing 26-day performance.

After 113, 127, or 141 days on feed (depending on BW block), cattle were weighed and transported to a commercial abattoir (Cargill Meats Solutions, Fort Morgan, Colo.). A 4% pencil shrink was subtracted from final BW to obtain final live weight. Hot carcass weights (HCW) and liver abscess scores were obtained at the time of slaughter. Following a 48-hour chill, USDA marbling score, 12th rib fat thickness and LM area were recorded. Yield grade was calculated using HCW, 12th rib fat thickness, LM, and percent of kidney, pelvic, and heart fat (KPH) using the following formula: 2.5+ (2.5 x 12th rib fat) + (0.2 x 2.5[KPH]) + (0.0038 x HCW) − (0.32 x LM). Carcass adjusted performance was calculated using a common dressing percentage (63%) to determine carcass adjusted final BW, ADG and F:G.

Animal performance data and carcass characteristics were analyzed as a randomized block design using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C.) Pen was the experimental unit, fixed effect was treatment, and block was treated as a random effect. Prevalence of liver abscesses was analyzed using the GLIMMIX procedure of SAS.

Results

Feedlot performance data and carcass characteristics are summarized in Table 2. Rumensin level did not affect ($P \geq 0.39$) DMI, ADG, or F:G during the grain adaptation period. These findings are in contrast to the observations of a previous trial where improvements in feed efficiency were observed early in the feeding period as a result of feeding 44 g/ton Rumensin compared to 33 g/ton (*2010 Plains Nutrition Council Proceedings*, p. 112). Among day DMI variance was not different as a result of Rumensin level during the adaptation period ($P = 0.56$) or for the first six days cattle were fed a common finishing diet ($P = 0.75$; data not presented). Although individual animal intake can be masked in a pen setting, intake variation for a pen is one of the methods available to estimate incidence of subacute acidosis in a feedlot setting. Since performance and DMI variation were not different as a result of Rumensin level in this trial, incidence of acidosis was likely not affected by Rumensin level. Similarly, in an acidosis challenge trial feeding 40 g/ton Rumensin compared to 30 g/ton did not improve time below ruminal pH of 5.6 or pH variation which are measures of acidosis (*1999 Nebraska Beef Cattle Report,* p.41*)*.

No effects ($P \geq 0.42$) of Rumensin level during the grain adaptation period were observed over the entire feeding period for DMI, ADG, or F:G. Carcass characteristics were not affected by Rumensin level during the adaptation period. Hot carcass weights were not different ($P = 0.59$) among treatments and dressing percentage was not different ($P = 0.45$). No differences were observed in LM area, calculated YG, USDA marbling scores, or 12th rib fat thickness. Feeding 44 g/ton Rumensin during the adaptation period did not improve feedlot performance or carcass characteristics when compared to 33 g/ton Rumensin.

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Comparing Wet and Dry Distillers Grains Plus Solubles for Yearling Finishing Cattle

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Summary

Long yearling steers were used to compare wet distillers grains plus solubles (WDGS) and dried distillers grains plus solubles (DDGS) to a corn control (CON) when included at 35% of diet DM in finishing diets. Final BW was heavier (P = 0.03) for WDGS and DDGS as a result of increased (P < 0.01) ADG. Intakes were not different (P = 0.33) among treatments. Cattle fed WDGS were most efficient, DDGS intermediate, and CON the least efficient. The feeding values were 31.3 and 21.5% greater for WDGS and DDGS than corn, respectively.

Introduction

A University of Nebraska–Lincoln meta-analysis (*2011 Nebraska Beef Cattle Report,* pp. 40-41) determined the feeding value of WDGS compared to dry rolled corn (DRC) or high-moisture corn (HMC) blended with DRC (corn blend) was greater for yearlings fed in the summer than for calf-feds fed in the winter. The feeding values calculated for WDGS in this meta-analysis when fed to calf-feds was 124% the value of corn blend and was 131 to 146% the value of corn blend when fed to summer yearlings, depending on inclusion level. Additional research compared 35% WDGS or DDGS to corn blend in calf-feds and reported 130 and 111% the feeding value of corn blend for WDGS and DDGS, respectively (*2011 Nebraska Beef Cattle Report,* pp. 48-49). Therefore, the objective of this study was to compare the feeding value of WDGS and DDGS to corn blend in long yearling steers.

Procedure

Crossbred, long yearling steers (n = 171; 797 ± 66 lb) were utilized in a randomized block design beginning mid-August and ending mid-January. Steers were blocked by BW, stratified within block, and assigned randomly to pen (21 pens; 8 or 9 steers/pen). Pens were assigned randomly to one of three treatments (7 replications/treatment) that consisted of: 1) corn-based control (CON); 2) wet distillers grains plus solubles (WDGS); and 3) dried distillers grains plus solubles (DDGS). Wet distillers grains plus solubles (WDGS; 34.6% DM) or dried distillers grains plus solubles (DDGS; 88.2% DM) were purchased from the same plant and were included in the diets at 35% (DM basis). Distillers grains plus solubles (DG) replaced corn blend. Basal ingredients consisted of a HMC and DRC blend fed at a 1:1 ratio (DM basis), 7.5% grass hay, and 5% dry supplement (DM basis; Table 1). Diets were formulated to contain at minimum 13.0% CP, 0.6% Ca, 0.15% P, and 0.6% K. Urea was included in CON supplement and all supplements contained 30 g/ton (DM) monensin and 90 mg/head/day tylosin (Elanco Animal Health, Greenfield, Ind.).

Prior to initiation of the study, cattle were limit fed a common diet at 2.0% BW that contained 47.5% wet corn gluten feed, 47.5% alfalfa hay, and 5.0% supplement for five consecutive days to eliminate variation due to gut fill. Following the limit feeding period, steers were individually weighed on day 0 and day 1, and the average of the two weights was used to obtain an accurate initial BW. Steers were adapted to the finishing diet by replacing equal parts of grass hay and alfalfa hay with corn blend for steps 1, 2, and 3 (3, 4, and 7 days, respectively). Step 4 included 7.5% grass hay and 5.0% alfalfa hay for seven days. On day 22, alfalfa hay was removed and steers were fed their respective finishing diet. Steers were implanted on day 36 with Revalor®-S. Cattle were fed once daily, and feed refusals were collected and weighed when needed throughout the trial and dried in a forced-air oven at 60°C for 48 hours to calculate DMI. Steers were harvested at a commercial abattoir (Greater Omaha Pack, Omaha, Neb.) on day 148. On the day of slaughter HCW were collected, and following a 48-hour chill, USDA marbling score, 12th rib fat depth, and LM area were recorded. A common dressing percentage of 63% was used to calculate carcass adjusted performance to determine final BW, ADG, and F:G.

The difference in gain efficiency (inverse of F:G) between the different types of DG was divided by the gain efficiency of the DDGS treatment and the inclusion level of DG (35% DM) to

Table 1. Diet composition.

	CON [1]	WDGS [1]	DDGS[1]
HMC[2]	43.75	26.25	26.25
DRC[2]	43.75	26.25	26.25
WDGS[2]	—	35.0	—
DDGS[2]	—	—	35.0
Grass Hay	7.5	7.5	7.5
Supplement[3]	5.0	5.0	5.0

[1]CON — Control diet with no distillers grains plus solubles; WDGS — Wet distillers grains plus solubles included at 35% of diet DM; DDGS — Dried distillers grains plus solubles included at 35% diet DM.
[2]HMC — high moisture corn; DRC — Dry rolled corn; WDGS — wet distillers grains plus solubles; DDGS — dried distillers grains plus solubles.
[3]Supplements formulated to provide minimum dietary levels of 13.0% CP, 0.6% Ca, 0.15% P, 0.6% K. Contained 30 g/ton (DM) of monensin and 90 mg/head/day tylosin.

Table 2. Growth performance and carcass characteristics.

	Treatments[1]				
	CON	DDGS	WDGS	SEM	*P*-Value
Performance					
Initial BW, lb	810	810	809	1	0.44
Live Final	1476[a]	1525[b]	1531[b]	11	< 0.01
Final BW[2], lb	1424[a]	1488[b]	1497[b]	10	< 0.01
ADG[3], lb	4.15[a]	4.58[b]	4.65[b]	0.07	< 0.01
DMI, lb/d	28.5	29.2	28.8	0.4	0.33
F:G[4]	6.85[a]	6.34[b]	6.17[c]	—	< 0.01
Carcass Characteristics					
HCW, lb	897[a]	937[b]	943[b]	6	< 0.01
Dressing Percent	60.9[a]	61.6[b]	61.7[b]	0.2	0.03
Marbling Score[5]	608	611	618	12	0.81
12th rib fat, in.	0.55	0.58	0.60	0.02	0.24
LM, area in.[2]	13.0	13.1	13.2	0.1	0.09

[abc]Within a row means without common superscript differ ($P \leq 0.05$).
[1]CON — Control diet with no distillers grains; WDGS — Wet distillers grains plus solubles included at 35% of Diet DM; DDGS — Dry distillers grains with solubles included at 35% of diet.
[2]Calculated from hot carcass weight, adjusted to a common dressing percentage of 63.0%.
[3]Calculated using carcass adjusted final BW.
[4]Analyzed as gain:feed, reciprocal of feed conversion (F:G).
[5]Marbling score: 400 = Slight^{0}; 450 = Slight^{50}; 500 = Slight^{0}, etc.

determine the differences in feeding value between types of DG. The same calculations were used to calculate the improved feeding value of each DG compared to the CON treatment.

Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C.). The study was analyzed as a randomized block design. Block was considered to be fixed, and pen was the experimental unit. Differences were considered significant when $P \leq 0.05$.

Results

Steers fed DDGS or WDGS had greater ADG ($P < 0.01$) than CON fed cattle, but DDGS and WDGS were not different ($P = 0.47$; Table 2). Increased ADG resulted in heavier ($P < 0.01$) final BW for WDGS and DDGS compared to CON. There was no difference ($P = 0.33$) for DMI among treatments. Similar DMI and increased ADG resulted in diets containing DG having improved ($P < 0.01$) F:G values compared to CON, and cattle fed WDGS were more efficient than DDGS. Cattle fed DDGS or WDGS also had greater ($P < 0.01$) HCW than CON. There were no differences among treatments for marbling score, back fat thickness, or LM area ($P \geq 0.09$).

Feeding value calculations suggest diets containing WDGS and DDGS to be 131 and 122% the feeding value of corn blend, respectively. The feeding value for WDGS was 109% that of DDGS. The current feeding value for WDGS is nearly identical to the meta-analysis and calf-fed study which reported improved feeding values greater than 130% that of the corn blend in diets containing 30-40% WDGS. Contrasting to both of these previous reports, the improvement for DDGS compared to corn blend in this study is greater than the 111% and the 112% feeding value reported for the calf-fed study (*2011 Nebraska Beef Cattle Report,* pp. 48-49) and the meta-analysis (*2011 Nebraska Beef Cattle Report,* pp. 40-41), respectively. These differences in improved feeding values between studies could be due in part to the DG within each study being produced by different ethanol plants. These results reiterate that including DG in finishing diets will improve cattle performance compared to the corn blend. Also, the greater feeding value for WDGS compared to DDGS, suggests the feeding value of WDGS is reduced during the drying process.

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Effects of Modified Distillers Grains Plus Solubles and Condensed Distillers Solubles With and Without Oil Extraction on Finishing Performance

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Summary

A finishing study was conducted to evaluate the effects of feeding 27% inclusion of condensed distillers solubles (CDS) and 40% inclusion of modified distillers grains plus solubles (MDGS) with and without corn oil removal. De-oiled CDS or MDGS did not impact performance or carcass characteristics compared to normal fat. Cattle fed CDS or MDGS, regardless of fat content, had greater final BW, ADG, and HCW compared to controls. Feed conversion, regardless of fat content, was greatly improved for CDS or MDGS compared to controls. These data suggest that cattle fed de-oiled distillers or solubles have comparable performances to normal fat concentration using the centrifugation process removing oil from solubles.

Introduction

The byproducts produced by ethanol plants are distillers grains plus solubles and solubles (syrup). The corn oil in these byproducts has market value and is being removed from the thin stillage (solubles) portion using centrifugation. Limited data are available for feeding lower fat distillers in finishing diets, and there is no datum with feeding distillers using this new oil removal process. In 2012, approximately 50% of the plants were removing oil. Thus, the objective of this study was to determine the effect of feeding de-oiled corn distillers solubles and modified distillers grains on finishing performance and carcass characteristics.

Procedure

A 179 day finishing experiment was conducted using 225 crossbred, calf fed steers (initial BW = 659 ± 20 lb) in a complete block design, with a 2x2+1 factorial arrangement of treatments. Steers were limit fed for five days at 2% of BW prior to the initiation of the trial and weighed on two consecutive days (0 and 1) to determine initial BW. Steers were implanted with Revalor®-IS d 1 and reimplanted with Revalor®-S on day 83. Steers were blocked by BW, stratified by BW within each block, and assigned randomly to pen. Pens were then assigned randomly to one of five treatments with nine steers per pen and five pens per treatment.

The treatments (Table 1) consisted of a control diet with a 1:1 blend of dry rolled and high moisture corn and 7.5% sorghum silage, 27% de-oiled (6.0% fat) or 27% normal fat (21.1% fat) CDS, and 40% de-oiled (9.2% fat) or 40% normal fat (11.8% fat) MDGS (DM basis). Modified distillers grains plus solubles were procured at the initiation of the experiment from the same plant on two different weeks when the process was running to remove oil or not. Distillers solubles were sourced from the same plant and received approximately every three weeks throughout the experiment on alternating weeks, again with or without the oil process operating in the plants. Soypass™ was included in the control and CDS diets for 38 and 60 days, respectively, to meet or exceed MP requirements. All diets contained 5% supplement which was formulated to include 30g/ton of DM monensin and provide 90 mg/steer Tylan®. All animals were harvested on day 180 at a commercial abattoir (Greater Omaha Packing, Omaha, Neb.) and hot carcass weights (HCW) were recorded at that time. Carcass 12th rib fat, LM area, and USDA marbling score were recorded after a 48-hour carcass chill. Yield grade was calculated using the USDA YG equation [YG = 2.5 + 2.5(Fat thickness, in) – 0.32 (LM area, in^2) + 0.2 (KPH fat, %) + 0.0038 (HCW, lb)]. Final BW, ADG, and F:G were calculated using HCW adjusted to a common dressing percentage of 63%.

Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C.) as a randomized block design with pen as the

Table 1. Diet composition on a DM basis fed to finishing steers.

		27% CDS		40% MDGS	
Ingredient, % of DM	Control[2]	De-Oiled	Normal Fat	De-Oiled	Normal Fat
DRC[1]	43.75	30.25	30.25	23.75	23.75
HMC[1]	43.75	30.25	30.25	23.75	23.75
MDGS[1]: De-Oiled	—	—	—	40	—
MDGS[1]: Normal Fat	—	—	—	—	40
CDS[1]: De-Oiled	—	27	—	—	—
CDS[1]: Normal Fat	—	—	27	—	—
Sorghum Silage	7.5	7.5	7.5	7.5	7.5
Supplement [3]	5	5	5	5	5
Sorghum Silage	7.5	7.5	7.5	7.5	7.5
Analyzed Composition, %					
Fat	4.43	4.72	8.80	6.12	7.19

[1]DRC = dry rolled corn; HMC = high moisture corn; MDGS = Modified distillers grains plus solubles; CDS = condensed distillers solubles.
[2]Soypass was fed in control diet for 38 days and in the CDS diets for 60 days.
[3]Formulated to contain 345 mg/steer daily of Rumensin and 90 mg/steer daily of Tylan.

Table 2. Nutrient composition of MDGS and CDS[1].

	De-oiled CDS	Normal CDS	De-Oiled MDGS	Normal MDGS
Fat	6.0	21.1	9.20	11.8
CP	29.6	27.0	33.7	33.0
S	1.26	0.78	0.65	0.56
NDF	—	—	29.4	31.9
DM	27.0	27.5	46.0	46.5

[1]All values expressed on a DM basis.

experimental unit. Treatment comparisons were made using pair-wise comparisons when the F-test statistic was significant at an alpha level of $P = 0.05$. Pre-planned contrasts were used to test the effect of oil removal within CDS and MDGS.

Results

The fat concentration (Table 2) of the de-oiled CDS and normal CDS were 6.0% and 21.1%, respectively, and 9.2% and 11.8% fat for de-oiled MDGS and normal fat MDGS. Crude protein was increased for both de-oiled CDS and MDGS compared to normal fat CDS and MDGS. Sulfur concentration was increased slightly for both de-oiled CDS and MDGS compared to normal fat CDS and MDGS. Dietary fat was 4.72% for de-oiled CDS, 8.80% for the normal fat CDS, 6.12% for de-oiled MDGS and 7.19% for the normal fat MDGS compared to 4.43% fat for the control treatment.

There were no statistical differences ($P > 0.25$) in performance or carcass traits between de-oiled CDS and normal fat CDS (Table 3), for the main effect of fat content. Cattle fed the de-oiled CDS had numerically greater ADG and lower F:G than the normal CDS values. Compared to the control, cattle fed de-oiled CDS had greater final BW, ADG, and HCW ($P < 0.01$). Cattle fed normal fat CDS were intermediate to control and de-oiled CDS for final BW, ADG, and HCW ($P > 0.36$). Feeding de-oiled and normal fat CDS decreased DMI and improved F:G compared to the control ($P < 0.01$). Feeding values, relative to corn, calculated from G:F were 159 and 147% of corn for de-oiled CDS and normal fat CDS, respectively.

There was no significant difference ($P > 0.44$) due to fat content of MDGS for all traits. Steers fed de-oiled and normal fat MDGS had greater final BW, ADG and HCW than control steers ($P < 0.02$). Feed conversion was improved with feeding MDGS ($P < 0.01$) but there was no difference between de-oiled or normal fat MDGS ($P = 0.80$). The feeding values were 130% of corn for both de-oiled and normal fat MDGS at 40% inclusion. There were no significant differences between treatments for LM area, 12th rib fat, calculated YG, and marbling score; ($P > 0.13$).

The fat content of 27% inclusion of CDS or 40% inclusion of MDGS, as the sole byproduct in the diet, had no impact on performance or carcass characteristics when the oil was removed from the solubles portion using the centrifugation process. These data suggest that cattle fed de-oiled CDS or MDGS perform similar to cattle fed normal fat CDS or MDGS.

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Table 3. Effect of feeding de-oiled and normal fat CDS and MDGS on finishing performance.

		27% CDS		40% MDGS			*P*-value		
	Control	De-oiled	Normal	De-oiled	Normal	SEM	F-Test	CDS[1]	MDGS[2]
Performance									
Initial BW, lb	662	661	663	662	661	1	0.39	0.07	0.68
Final BW, lb	1248[a]	1293[b,c]	1277[a,b]	1308[b,c]	1318[c]	14	0.01	0.43	0.61
DMI, lb/day	20.8[a]	19.4[b]	19.4[b]	20.5[a]	20.8[a]	0.4	0.01	0.97	0.58
ADG, lb	3.28[a]	3.53[b,c]	3.43[a,b]	3.61[b,c]	3.67[c]	0.08	0.02	0.36	0.60
Feed:Gain[3]	6.36[a]	5.49[b]	5.66[b]	5.69[b]	5.67[b]		<0.01	0.29	0.80
Carcass Characteristics									
HCW, lb	786[a]	814[b,c]	805[a,b]	824[b,c]	830[c]	9	0.01	0.43	0.61
LM area, in	12.56	13.19	12.81	12.80	12.65	0.23	0.38	0.25	0.66
12th rib fat, in	0.50	0.50	0.47	0.53	0.56	0.03	0.28	0.47	0.47
Calculated YG	3.21	3.11	3.15	3.37	3.49	0.11	0.13	0.81	0.44
Marbling score[4]	570	579	575	594	599	14	0.50	0.85	0.77

[1]Effect between de-oiled and normal CDS.
[2]Effect between de-oiled and normal MDGS.
[3]Analyzed as G:F, the reciprocal of F:G.
[4]Marbling score: 500 = Small00.
[abc]Means within a row with different superscripts differ ($P < 0.05$)

Effects of Feeding Microbial Feed Additives on Growth Performance and Carcass Traits of Steers Fed Steam-Flaked Corn-Based Diets with Wet Distillers Grains Plus Solubles

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Summary

An experiment was conducted to determine the effects of feeding two commercially available direct-fed microbials (DFM) on finishing steer performance fed steam-flaked corn based diets. Dietary treatments included a control diet without DFM, and two commercially available products (10-G and Bovamine). No significant differences were observed among treatments for animal performance or carcass characteristics. However, numeric advantages were observed for ADG and feed efficiency when cattle were fed a DFM.

Introduction

Microbial feed additive products are available for use by the feedlot industry. They are commonly referred to as direct-fed microbials (DFM). These products may include viable cultures of bacteria and/or fungi, and feeding them may improve F:G and ADG in beef cattle (*Journal of Animal Science,* 81:E120-E132). There are two modes of action often reported for DFM's. One mode of action is the competitive exclusion of pathogenic organisms in the lower gut, the second may be mitigation of ruminal acidosis by altering ruminal fermentation endproducts (reducing lactic acid). Several dietary and management factors may have an influence on the effect of DFM's: corn processing method, dietary energy content, byproduct inclusion, use of ionophores. Additionally, cattle type (calf-fed vs. yearlings) may increase or decrease the response of the DFM. Many individual DFM products have been evaluated but direct comparisons of these products are limited. Therefore, we conducted an experiment to evaluate the effect of two different commercially available DFM products, and a control diet without DFM on performance and carcass characteristics of finishing cattle.

Procedure

Yearling crossbred steers (n = 174; BW = 890 ± 63 lb) were blocked into two BW blocks, stratified by BW within block, and then assigned randomly within strata to a total of 18 pens (six replications/treatment). Steers were limit fed a diet that consisted of 50% corn silage, 25% WDGS, and 25% alfalfa hay (DM basis) at 2% of BW for five days to reduce variation in gut fill. Steers were individually weighed for two consecutive days (days 0 and 1) after the limit feeding period and the average of the two weights was used as initial BW. Steers in the heavy BW block were implanted with Component TE-S on day 0, steers in the light BW block were implanted with Component TE-IS on day 0 and reimplanted with Component™ TE-S on day 49 (Elanco Animal Health; Greenfield, Ind.). The three dietary treatments included 1) control (CON), 2) 10-G, which includes five strains of lactic acid bacteria (*Enterococcus faecium, Lactobacillus acidophilus, Lactobacillus brevis, Lactobacillus plantarum* and *Pediococcus acidilactici*; Life Products, Inc., Norfolk, Neb.), and 3) Bovamine® (*Lactobacillus acidophilus* and *Propionibacterium freudenreichii*; Nutritional Physiology Co., Overland Park, Kan.). To apply the dietary treatments, all pens were fed 0.79 lb DM of fine ground corn, or fine ground corn containing the DFM. The fine-ground corn carrier was top-dressed in the bunk immediately after feeding. The 10-G was fed to achieve a target of 650 million colony forming units (cfu)/head/day and Bovamine was fed at 1.3 billion cfu/head/day. The amount of DFM product fed in this study represents 130% of label directions to ensure adequate bacterial counts were offered. Original packets of DFM were opened and weighed into vials for daily feeding. Original product and vials containing product were stored frozen at -5°C until fed. During mixing and feeding the DFM, separate color-coded mixing containers and gloves were used to prevent cross-contamination of treatments.

Cattle were adapted to the finishing diet in 20 days with corn replacing corn silage and alfalfa hay. The finishing diet consisted of (DM basis) 62% steam-flaked corn (29 lb/bu), 25% wet distillers grains plus solubles, 7% alfalfa hay, and 6% liquid supplement. Supplement was formulated to provide 30 g/ton Rumensin and a minimum of 90 mg/head/day Tylan® (Elanco Animal Health; Greenfield, Ind). Ingredient samples were collected weekly and composited for nutrient analysis. Samples of each DFM were enumerated at a commercial laboratory before the experiment began, and again on day 35 and day 89.

Cattle were harvested at a commercial abattoir (Cargill Meat Solutions, Fort Morgan, Colo.) on day 97 (heavy BW block) and 114 (light BW block). Hot carcass weight and liver abscess scores were obtained on the day of slaughter. Following a 48-hour chill, USDA marbling score, 12th rib fat depth, and LM area were recorded.

Table 1. Bacterial counts of direct fed microbials.

	Direct Fed Microbial[1]	
	10-G	BOV
Pre-trial		
Lactic acid bacteria[2]	3.6×10^9 cfu/g	5.8×10^7cfu/g
Total propionibacteria[3]	—	$1.6 \text{ E} \times 10^{10}$cfu/g
day 35		
Lactic acid bacteria	3.7×10^9 cfu/g	8.5×10^7cfu/g
Total propionibacteria	—	1.6×10^{10}cfu/g
day 89		
Lactic acid bacteria	3.2×10^9 cfu/g	5.9×10^7 cfu/g
Total propionibacteria	—	1.7×10^{10} cfu/g

[1]10-G = 5 strains of lactic acid bacteria (10-G®), BOV = *L. acidophilus* plus *propionibaterium freudenreichii* (Bovamine).
[2]Lactic acid bacteria counts using MRS agar.
[3]Propionibacteria counts using sodium lactate agar.

Table 2. Performance and carcass characteristics of cattle fed direct fed microbials.

	Dietary Treatments[1]				
Item	CON	10-G	BOV	SEM	*P*-value
Performance					
Initial BW, lb	892	890	890	2	0.77
Final BW, lb[2]	1422	1427	1424	8	0.80
ADG, lb[2]	4.87	4.94	4.91	0.07	0.60
DMI, lb/day	28.4	28.4	28.3	0.2	0.72
F:G[2]	5.83	5.75	5.76	0.09	0.56
Carcass					
HCW, lb	896	899	898	5	0.80
12th Rib fat depth, in	0.57	0.60	0.57	0.02	0.27
Marbling[3]	541	524	523	10	0.17
Calculated yield grade	3.42	3.49	3.42	0.04	0.25
Liver abscess, %	10.8	14.5	19.3	7.0	0.49
LM area, in[2]	12.9	12.8	13.0	0.3	0.65

[1]Dietary treatments: 10-G = 5 strains of lactic acid bacteria (10-G®), BOV = *L. acidophilus* plus *propionibaterium freudenreichii* (Bovamine), CON = control.
[2]Calculated using hot carcass weight and 63% dressing percent.
[3]Marbling score: 500 = Small00, 600 = Modest00.

Yield grade was calculated using HCW, 12th rib fat depth, LM area, and KPH (2.5 + (2.5 x 12th rib fat) + (0.2 x KPH) + (0.0038 x HCW) – (0.32 x LM area)). Carcass weight was adjusted to a common dressing percentage (63%) to calculate final BW, and then daily gain and feed efficiency were determined. Data were analyzed as a randomized block design using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C.). Pen was the experimental unit with BW block as a random effect.

Results

The nutrient composition of the finishing diet used in this experiment was 14.5% CP, 5.4% ether extract, 0.81% K, 0.58% Ca, 0.38% P, and 0.20% S. Bacterial counts for the DFM products analyzed on day 35 and 89 were similar to the original counts before trial initiation (Table 1). Therefore, the feeding rate of the DFM would have achieved targeted levels throughout the duration of the experiment. There were no significant differences ($P > 0.55$) for DMI, final BW, ADG, and F:G among treatments (Table 2). However, there were numeric advantages for ADG and feed efficiency when a DFM was fed, which is similar to previous observations when more replicates are used. Compared to steers fed the control diet, feeding 10-G and Bovamine resulted in a 1.8% and 1.2% improvement in feed efficiency (respectively; calculated based on G:F). Hot carcass weight, marbling score, 12th rib fat depth, incidence of liver abscesses, yield grade, and LM area were not different ($P \geq 0.16$) among treatments.

In summary, there were no significant differences for performance among treatments. However, the numerical differences observed in the current experiment support previous research that show small improvements in animal performance when a DFM is included in finishing diets.

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The Effect of Lameness on Average Daily Gain in Feedlot Steers

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Summary

The objective of this study was to test the effects of lameness on average daily gain (ADG) of feedlot steers. We evaluated two feedlot health data sets: 1) 14,798 steers from a 14-year period (1993 to 2006) at the Meat Animal Research Center (USDA MARC) near Clay Center, Neb.; and 2) 16,766 steers from an 8-year period (2002 to 2009) at the University of Nebraska Agricultural Research and Development Center (ARDC) near Mead, Neb. The ADG for USDA MARC steers with lameness late in the feeding period (≥ 60 days) was 0.04 lb/day less than steers without lameness. The ADG for ARDC steers with lameness later in the experimental trial period (≥ 60 days) was 0.2 lb/day less than steers without lameness. Lameness in steers had a significant and meaningful negative effect on ADG later in the feeding period.

Introduction

Lameness is important to feedlot producers because there is a cost associated with foot and leg lameness. A lame animal has been estimated to be worth 53% of the original price of animals without lameness (*Feedlot Lameness* (G1159), 1993). The decrease in value includes losses from labor and medication for the animal and reduced performance. Lame cattle may be reluctant to eat or approach the feed bunk, resulting in reduced weight gain. Previous work has documented lame cattle have 0.04 lb less ADG than cattle without lameness (*Professional Animal Scientist*, 2006, 22:450-453). Lameness is also detrimental to the health and well-being of the animal because the injuries can be painful.

Some of the more common causes of lameness in feedlot cattle are joint infection, bruising and abrasions of the sole, toe abscesses, laminitis, injuries, and footrot. Footrot is one of the most commonly diagnosed diseases in the feedlot but is often misdiagnosed. Footrot typically accounts for 10% of lameness (1993, NebGuide). Because clinical signs of foot and leg lameness appear similar, it is common for the cause of cattle lameness to be misclassified. The objective of the study was to test the effect of undifferentiated lameness on ADG of feedlot steers.

Procedure

USDA MARC Data Set

We evaluated health data of 14,852 steers collected over a 14-year period (1993-2006) at USDA MARC. All the calves were born in USDA MARC pastures before entering the feedlot as calf-feds and all the animals were vaccinated based on USDA MARC protocol. Health data collected over the 14-year period for each individual animal from birth to slaughter included birth date, weaning date, days on feed (DOF), end date, weaning BW, final BW, diagnosis, treatment, and treatment date. Health records were categorized by disease system, and only the first treatment for a given disease was used in the analysis. To prevent misclassification bias, all the lameness diagnoses, for example, foot rot, laminitis, or toe abscess, were classified simply as lameness.

Variables explaining ADG were tested in a multivariable general linear mixed model with year as a random effect using PROC GLIMMIX in SAS (SAS Inst. Inc., Cary, N.C.). Significance was at alpha less than or equal to 0.05.

Lameness in the feedlot period was categorized into three periods: disease occurring less than 60 DOF (< 60 days), disease occurring more than or equal to 60 DOF (≥ 60 days) or having no disease. Sixty days was chosen to include the beginning of the growing period when the animals are introduced into the feedlot and then when the animals have been in the feedlot for greater than 60 days. The DOF variable was also categorized into three periods: less than 200 DOF, 201-300 DOF, and greater than 301 DOF. The main outcome measure of ADG was calculated by taking the final BW and subtracting the weaning BW then dividing by the number of days of feed.

ARDC Data Set

Steers are received at ARDC in the fall. There were a total of 16,766 steers in different experiments conducted over an eight-year period (2002-2009).

Health records were collected for each individual steer when they started on finishing trials as calf-feds (> 160 DOF), summer yearlings (130-160 DOF), and fall yearlings (< 130 DOF). Health data included arrival date, experiment start date, market date, DOF in the experiment, arrival BW, start BW for the experiment, final BW, diagnosis, treatment, treatment date, pen, experiment, and whether or not the steer was a calf-fed or back-grounded as a spring or fall yearling. Health records were categorized by disease system and only the first treatment date was used in the analysis.

Variables explaining ADG were tested in a multivariable general linear mixed model with pen nested within experiment with a random intercept as a random effect using PROC GLIMMIX in SAS. Significance was set at alpha less than or equal to 0.05. Diseases were categorized into three periods: disease occurring less than 60 days on experimental trial (< 60), disease occurring more than or equal to 60 days on experimental trial (≥ 60) or having no disease. ADG for this group of animals was calculated by using the HCW divided by the dressing percent then minus the start BW for experimental trial divided by the days on experimental trial.

Results

USDA MARC Data Set

Steers born from February to May were weaned between August and October. The average age at weaning was 185 days (88 to 280 days). Steers averaged 273.4 DOF (35 to 419 days).

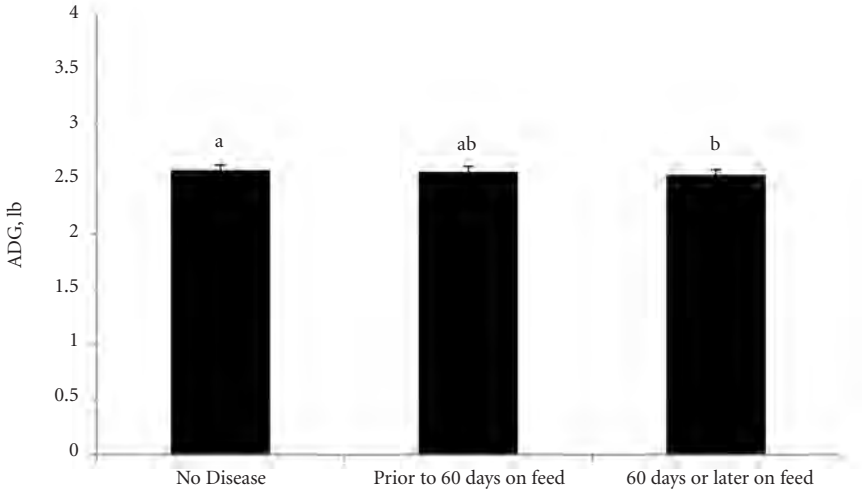

Figure 1. The estimates of ADG for lameness in the Meat Animal Research Center. Steers had a significant difference between lengths of days on feed. Error bars represent the standard error on the mean. Variables with different superscripts are statistically different ($P \leq 0.05$).

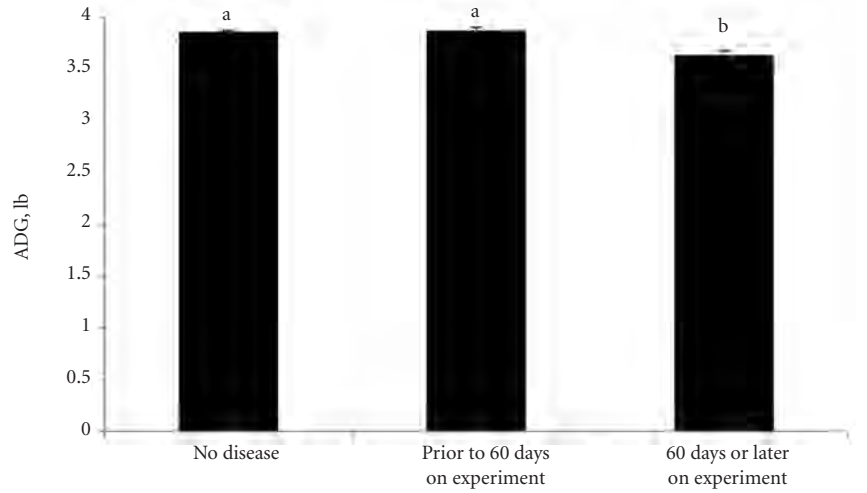

Figure 2. The estimates of ADG for lameness in the University of Nebraska's Agricultural Research and Development Center. Steers had a significant difference between lengths of days on feed. Error bars represent the standard error on the mean. Variables with different superscripts are statistically different ($P \leq 0.05$).

The average weaning and final BWs were 486.7 lb and 1,250.9 lb, respectively and ADG was 2.9 lb per day. The incidence density for lameness over the 14-year period was 25.5 cases per 100,000 animal days. The incidence rate for lameness over the 14-year period was 6.7 per 100 animals.

Variables significantly explaining ADG were lameness, DOF, the number of days between last weight and leaving the feedlot, and weaning weight. Other morbidity events also affected ADG but these events did not have a large impact on the estimates of the effect of lameness.

After adjusting for confounders, the ADG for steers with lameness prior to 60 days and 60 days or later was 0.02 lb and 0.04 lb/day less than steers without lameness, respectively (Figure 1). Steers becoming lame later in the feeding period performed worse than steers that did not become lame.

ARDC Data Set

Steers averaged 143 days on experimental trial (80 to 229 days). The average receiving BW, experiment start BW and final BW were 544.1 lb, 772.0 lb, and 1,317.9 lb, respectively and ADG was 3.9 lb/day. The incidence density for lameness over the eight-year period was 20.4 cases per 100,000 animal days. The incidence rate for lameness over the eight-year period was 2.8 per 100 animals.

Variables significantly explaining ADG were lameness, days on experimental trial, the experiment start weight, and year. After adjusting for the other variables in the model, the ADG for steers with lameness 60 days or later was 0.22 lb/d less than steers without lameness (Figure 2). There was not a significant difference between having no disease and becoming lame in the first 60 days.

There are differences in the data between the two research facilities. The ARDC data set used data collected while steers were on feedlot experiments, so health and performance over the entire growing period was not evaluated. The USDA MARC data used information for calf-feds so post-weaning growth is included in the feedlot phase. No information on experiment or pens was available in USDA MARC data. The steers in the UNL ARDC data also were on study for fewer days so there may not have been time for the steers to recover from lameness compared to the larger range of DOF for the USDA MARC data set. This could result in a larger difference between the ADG for the lame steers. Both sets included pens so individual ADG was known for each animal that became lame, but DMI is unknown for individuals due to pen feeding. Therefore, feed efficiency (G:F) cannot be evaluated to determine whether lameness decreases ADG due to lower DMI or due to poorer feed efficiency.

Lameness had a significant negative impact on ADG in both feedlots. Lameness had a greater effect on ADG if it occurred later in the feeding period and this was probably because steers did not have as much time to recover.

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Effect of Feeding Greater Amounts of Calcium Oxide Treated Corn Stover and Micro-Aid® on Performance and Nutrient Mass Balance

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Summary

Feedlot performance and mass balance were evaluated on steers fed either 5% untreated corn stover (CON), 20% untreated corn stover (NONTRT), or 20% calcium oxide (CaO) treated corn stover (TRT) when fed with or without saponins (Micro-Aid) in a 3x2 factorial. In both WINTER and SUMMER experiments, ADG, F:G and HCW were improved (P < 0.01) in CON and TRT fed steers compared to NONTRT fed steers. Micro-Aid fed steers had slightly greater ADG and DMI in the SUMMER. Manure % nitrogen (N) was greatest when NONTRT and TRT were fed compared to steers on CON diet. However, neither diet nor Micro-Aid influenced manure N amounts or N losses across both seasons.

Introduction

Feeding more roughage or feeding less digestible diets has been shown to increase manure N and reduce N losses in the winter, but not always in the summer (*2003 Nebraska Beef Cattle Report*, p. 54*; 2005 Nebraska Beef Cattle Report,* p. 54). Two recent studies (*2011 Nebraska Beef Cattle Report,* p. 35; *2012 Nebraska Beef Cattle Report,* p. 106) evaluated calcium oxide (CaO) treated forages compared to untreated forages. In these two studies, it was determined that diets containing 20% CaO treated forages had improved digestibility and performance.

Recent trials (*2012 Nebraska Beef Cattle Report,* p. 98) evaluating performance and mass balance of steers fed Micro-Aid found no difference in performance and carcass characteristics between treatments. Cattle in the winter experiment fed Micro-Aid had more DM, OM, and nutrients removed in manure, and decreased N losses. However, there were no differences in manure N or losses in the summer experiment due to feeding Micro-Aid.

The objective of these studies was to evaluate the impact of increasing CaO treated and untreated corn stover and its influence on N mass balance and manure amounts. Given variable results across seasons due to Micro-Aid, more research related to nutrient mass balance was warranted.

Procedure

Cattle Performance

Two experiments were conducted using 192 steers in each study. Calves (694 ± 23 lb BW) were fed for 183 days from November to May (WINTER) and yearlings (866 ± 34 lb BW) were fed for 140 days from May to October (SUMMER) to evaluate the effect of feeding greater amounts of corn stover in combination with Micro-Aid. Micro-Aid (DPI Global, Porterville, Calif.) is manufactured from a phytogenic extract that contains saponins, which have natural detergent and surfactant properties. Steers were individually weighed two consecutive days (day 0 and day 1) to obtain an initial BW. Cattle were stratified by BW within two weight blocks (light and heavy) and assigned randomly to 24 pens (12 pens per block, 8 steers/pen). Six treatments were applied as a 3x2 factorial in a generalized randomized block design with factors being diet and Micro-Aid. The WINTER and SUMMER dietary treatments consisted of 1) control (CON) with 5% nontreated corn stover, 2) nontreated (NONTRT) with 20% nontreated corn stover and 3) treated (TRT) with 20% corn stover treated with 5% CaO. All diets in WINTER and SUMMER contained 40% MDGS and 4% supplement. Additionally, the WINTER diets contained a 50:50 blend of dry rolled corn (DRC) and high moisture corn (NONTRT and TRT diets replaced the corn blend with corn stover) while SUMMER diets only contained DRC as a corn source. Steers in both trials were fed grain adaptation diets for 21 days with corn replacing alfalfa while MDGS, corn stover and supplement were held constant. Supplements for all diets were formulated to provide 0 or 1 g/head/day of Micro-Aid, 30 g/ton of DM of Rumensin, and 125 mg/steer daily of thiamine. Nutrient compositions of the final diets (DM basis) are presented in Table 1.

Table 1. Nutrient composition of diets[1] fed in the WINTER and SUMMER (DM basis).

	CON[2]	NONTRT[3]	TRT[4]
WINTER			
CP %	15.6	14.6	15.0
Ca %	0.84	0.87	0.83
P %	0.52	0.48	0.49
K %	0.79	0.85	0.86
S %	0.35	0.34	0.34
SUMMER			
CP %	16.1	15.4	15.8
Ca %	0.93	0.97	0.90
P %	0.56	0.54	0.55
K %	0.83	0.90	0.90
S %	0.39	0.38	0.38

[1]Diets formulated to provide 0 or 1 g/steer Micro Aid and 125 mg/steer thiamine daily, and 30 g/ton of DM of Rumensin.
[2]CON = Control diet.
[3]NONTRT = Nontreated stover (20% DM inclusion) diet.
[4]TRT = Treated stover (20% DM inclusion) diet.

Table 2. Finishing performance and carcass characteristics of steers fed during the WINTER trial.

Diet	CON	NONTRT	TRT	SEM	*P*-value
Performance					
Initial BW, lb	694	695	695	1	0.41
Live Final BW, lb[1]	1361[a]	1311[b]	1346[a]	9	<0.01
DMI, lb/day	22.4	22.9	22.4	0.26	0.42
ADG, lb[2]	3.67[a]	3.24[b]	3.61[a]	0.06	<0.01
F:G[3]	6.36[a]	7.05[b]	6.22[a]		<0.01
Carcass Characteristics					
HCW, lb	860[a]	812[b]	854[a]	7	<0.01
Dressing %	63.3[a]	62.0[b]	63.6[a]	0.002	<0.01
LM area, in^2	13.55	13.14	13.55	0.23	0.36
12th Rib Fat, in	0.51	0.41	0.48	0.03	0.07
Marbling[4]	582[a]	532[b]	551[a]	12	<0.01
Calculated USDA YG[5]	2.72	2.41	2.62	0.12	0.25

[a,b]Means within a row with unlike superscripts differ ($P < 0.05$).
[1]Live Final BW calculated: Avg. BW of pen shrunk 4%.
[2]ADG based on carcass-adjusted final BW = HCW/0.63.
[3]Analyzed as G:F, the reciprocal of F:G.
[4]Marbling: 500 = small^0, 600 = modest^0, etc.
[5]Calculated as 2.50 +(2.5*fat depth, in) – (0.32*LM area, in^2) + (0.2*2.5 KPH) + (0.0038*HCW, lb).

Table 3. Finishing performance and carcass characteristics of steers fed with or without Micro Aid during the WINTER trial.

Micro Aid level	0 g/head/day	1 g/head/day	SEM	*P*-value
Performance				
Initial BW, lb	694	695	1	0.40
Live Final BW, lb[1]	1331	1347	8	0.19
DMI, lb/day	22.5	22.7	0.30	0.47
ADG, lb[2]	3.47	3.54	0.07	0.39
F:G[3]	6.65	6.43		0.60
Carcass Characteristics				
HCW, lb	838	846	8	0.37
Dressing %	63.0	62.9	0.002	0.80
LM area, in^2	13.36	13.47	0.27	0.69
12th Rib Fat, in	0.47	0.46	0.03	0.69
Marbling[4]	559	551	10	0.60
Calculated USDA YG[5]	2.61	2.56	0.10	0.77

[1]Live Final BW calculated: Avg. BW of pen shrunk 4%.
[2]ADG based on carcass-adjusted final BW = HCW/0.63.
[3]Analyzed as G:F, the reciprocal of F:G.
[4]Marbling: 500 = small^0, 600 = modest^0, etc.
[5]Calculated as 2.50 +(2.5*fat depth, in) – (0.32*LM area, in^2) + (0.2*2.5 KPH) + (0.0038*HCW, lb).

Table 4. Finishing performance and carcass characteristics of steers fed during the SUMMER trial.

Diet	CON	NONTRT	TRT	SEM	*P*-value
Performance					
Initial BW, lb	866	868	866	1	0.88
Live FBW, lb[1]	1457	1441	1447	9	0.09
DMI, lb/day	26.8[a]	28.8[b]	27.6[a]	0.2	<0.01
ADG, lb[2]	4.18[a]	3.77[b]	4.04[a]	0.05	<0.01
F:G[3]	6.42[a]	7.65[b]	6.85[c]		<0.01
Carcass Characteristics					
HCW, lb	914[a]	878[b]	901[a]	5	<0.01
Dressing %	62.8[a]	60.9[b]	61.3[c]	0.001	<0.01
LM area, in^2	14.13	13.79	14.05	0.17	0.37
12th Rib Fat, in	0.59	0.53	0.57	0.2	0.16
Marbling[4]	574	537	556	11	0.09
Calculated USDA YG[5]	2.93	2.75	2.86	0.08	0.34

[a,b,c]Means within a row with unlike superscripts differ ($P < 0.05$).
[1]Live Final BW calculated: Avg. BW of pen shrunk 4%.
[2]ADG based on carcass-adjusted final BW = HCW/0.63.
[3]Analyzed as G:F, the reciprocal of F:G.
[4]Marbling: 500 = small^0, 600 = modest^0, etc.
[5]Calculated as 2.50 +(2.5*fat depth, in) – (0.32*LM area, in^2) + (0.2*2.5 KPH) + (0.0038*HCW, lb).

Chemical treatment consisted of water, CaO (Granular - Standard Quicklime, Mississippi Lime Co, Kansas City, Mo.), and ground residue (3-inch. screen) weighed and mixed in Roto-Mix feed trucks. The mixture was calculated to be 50% DM with CaO added at 5% of the forage (DM basis). Feed trucks dispensed treated residue into a silage bag at least 7 days prior to feeding and was stored anaerobically in silo bags. Actual DM of the treated stover was 47% DM in the WINTER experiment and 53% DM in the SUMMER experiment.

Cattle on the WINTER trial were implanted on d 1 with Revalor-IS and reimplanted with Revalor-S on d 86. Yearling steers on the SUMMER trial were implanted with Revalor-S on d 36. Steers were harvested at a commercial abattoir (Greater Omaha, Omaha, Neb.) on d 184 and d 141 for the WINTER trial and SUMMER trial respectively. Hot carcass weight was recorded on the day of slaughter. Fat thickness, marbling scores and LM area were measured after a 48-hour chill. Final BW, ADG and G:F were calculated based on hot carcass weights adjusted to a common dressing percent of 63%. Live BW was collected for dressing percent calculation following a 4% shrink.

Nutrient Balance

Nutrient mass balance experiments were conducted using 24 open feedlot pens with retention ponds to collect runoff from 12 pens (statistics for runoff used data from only these 12 pens) balanced across treatments. When rainfall occurred, runoff collected in retention ponds, was drained and quantified using an air bubble flow meter (ISCO, Lincoln, Neb.). After cattle were removed from the pens, manure was piled on a cement apron and sampled (n = 30/pen) for nutrient analysis while being loaded. Manure was weighed after removal. Manure was either freeze-dried for nutrient analysis (n = 20; composited 2/pen) or oven dried (60° C forced air oven) for DM removal calculation (n = 10).

Feed ingredients were sampled monthly and feed refusals were used

(Continued on next page)

to determine nutrient intake using a weighted composite on a pen basis. Retained steer N and P were calculated using the energy, protein and P equations (Beef NRC, 1996). Nutrient excretion was determined from subtracting nutrient retention from intake (ASABE, 2005). Total N lost (lb/steer) was calculated by subtracting manure and runoff N from excreted N. Percentage of N lost was calculated as N lost divided by N excretion.

Statistical Analysis

Dietary treatments were fed in the same pens for both trials. All data were analyzed by experiment (season) using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C.) with pen as the experimental unit. Interactions were tested between diet and Micro-Aid inclusion with simple (significant interaction) or main (no interaction) effects discussed. Treatments were included in the model as fixed effects and block was included as a random effect. *P*-values of 0.10 were considered significant.

Results

Feedlot Performance

In the WINTER, no interactions were observed between diet (stover) and Micro-Aid ($P \geq 0.42$). Among steers fed in the WINTER experiment, there were no differences ($P = 0.42$) among diet treatments for DMI. Steers fed CON and TRT had similar ADG and F:G ($P > 0.3$) yet both treatments had greater final BW and ADG, and improved F:G ($P < 0.01$) compared to NONTRT steers (Table 2). Steers fed CON and TRT diets had similar ($P \geq 0.11$) HCW, dressing percent, and marbling, which were greater than NONTRT steers ($P < 0.01$). There were no differences ($P \geq 0.07$) among dietary treatments for LM area, 12th rib fat, or calculated USDA yield grade (YG). Although ADG, F:G and LM area where numerically greater for steers fed Micro-Aid, no statistical differences ($P > 0.19$) were observed for feedlot performance or carcass characteristics in this experiment (Table 3).

Table 5. Finishing performance and carcass characteristics of steers fed with or without Micro Aid during the SUMMER trial.

Diet	0 g/head/day	1 g/head/day	SEM	*P*-value
Performance				
Initial BW, lb	867	865	1	0.11
Live Final BW, lb[1]	1447	1465	7	0.09
DMI, lb/day	27.3	28.1	0.2	<0.01
ADG, lb[2]	3.91	4.08	0.04	0.01
F:G[3]	7.02	6.93		0.33
Carcass Characteristics				
HCW, lb	891	905	4	0.02
Dressing %	61.6	61.8	0.001	0.18
LM area, in^2	13.87	14.11	0.14	0.25
12th Rib Fat, in	0.56	0.56	0.02	0.92
Marbling[4]	559	552	9	0.61
Calculated USDA YG[5]	2.85	2.84	0.07	0.89

[1]Live Final BW calculated: Avg. BW of pen shrunk 4%.
[2]ADG based on carcass-adjusted final BW = HCW/0.63.
[3]Analyzed as G:F, the reciprocal of F:G.
[4]Marbling: 500 = small^0, 600 = modest^0, etc.
[5]Calculated as 2.50 +(2.5*fat depth, in) – (0.32*LM area, in^2) + (0.2*2.5 KPH) + (0.0038*HCW, lb).

Table 6. Effect of diet on nitrogen mass balance during the WINTER[1] trial.

Variable	CON	NONTRT	TRT	SEM	*P*-value
N intake	101.1[a]	94.5[b]	97.6[b]	1.2	<0.01
N retention[2]	14.3[a]	12.7[b]	14.1[a]	0.2	<0.01
N excretion[3]	86.8[a]	81.8[b]	83.6[b]	1.0	<0.01
Manure N, %[4]	1.18	1.32	1.31	0.06	0.18
Manure N	42.3	44.7	43.4	2.3	0.76
N runoff	5.20[a]	2.20[b]	5.75[a]	0.26	<0.01
N lost	41.9	36.0	37.3	2.3	0.18
N Loss %[5]	48.3	44.0	44.4	2.7	0.47
Manure DM, %	62.26[a]	55.67[b]	57.62[b]	1.15	<0.01
DM removed	3597	3437	3314	181	0.55
OM removed	710	838	787	42	0.13

[a,b,c]Means within a row with unlike superscripts differ ($P < 0.05$).
[1]Values expressed as lb/steer over entire feeding period of calf-feds (183 DOF) unless specified.
[2]Calculated using NRC net protein and net energy equations.
[3]Calculated as N intake – N retention.
[4]N content of manure expressed as a percent.
[5]Calculated as N lost divided by N excretion.

Table 7. Effect of Micro-Aid on nitrogen mass balance during the WINTER[1] trial.

Variable	0 g/head/day	1 g/head/day	SEM	*P*-value
N intake	96.9	98.5	0.9	0.24
N retention[2]	13.6	13.8	0.2	0.54
N excretion[3]	83.3	84.8	0.8	0.22
Manure N, %[4]	1.31	1.23	0.05	0.22
Manure N	43.6	43.3	1.9	0.94
N runoff	4.20	4.57	0.21	0.26
N lost	37.6	39.1	1.8	0.57
N Loss %[5]	45.1	46.1	2.2	0.75
Manure DM, %	58.78	58.26	0.94	0.70
DM removed	3333	3565	148	0.28
OM removed	774	783	34	0.85

[1]Values expressed as lb/steer over entire feeding period of calf-feds (183 DOF) unless specified.
[2]Calculated using NRC net protein and net energy equations.
[3]Calculated as N intake – N retention.
[4]N content of manure expressed as a percent.
[5]Calculated as N lost divided by N excretion.

Table 8. Effect of diet on nitrogen mass balance during the SUMMER[1] trial.

Variable	CON	NONTRT	TRT	SEM	*P*-value
N intake	94.2	97.0	94.0	1.1	0.12
N retention[2]	11.9[a]	10.8[b]	11.5[a]	0.2	<0.01
N excretion[3]	82.3[a]	86.2[b]	82.5[a]	1.0	0.03
Manure N, %[4]	1.02[a]	1.41[b]	1.40[b]	0.07	<0.01
Manure N	16.1	17.4	15.9	1.2	0.63
N runoff	1.9[a]	1.0[b]	1.8[a]	0.12	<0.01
N lost	65.3	68.3	65.7	1.5	0.35
N Loss %[5]	79.3	79.2	79.5	1.5	0.99
Manure DM, %	71.58[a]	63.43[b]	66.18[b]	1.12	<0.01
DM removed	1670	1261	1176	186	0.16
OM removed	314	376	321	23	0.14

[a,b]Means within a row with unlike superscripts differ ($P < 0.05$).
[1]Values expressed as lb/steer over entire feeding period of yearlings (140 DOF) unless specified.
[2]Calculated using NRC net protein and net energy equations.
[3]Calculated as N intake – N retention.
[4]N content of manure expressed as a percent.
[5]Calculated as N lost divided by N excretion.

Table 9. Effect of Micro-Aid on nitrogen mass balance during the SUMMER[1] trial.

Variable	0 g/head/day	1 g/head/day	SEM	*P*-value
N intake	93.2	96.9	0.9	<0.01
N retention[2]	11.1	11.6	0.1	0.01
N excretion[3]	82.0	85.3	0.8	0.01
Manure N, %[4]	1.21	1.35	0.06	0.10
Manure N	16.9	16.0	1.0	0.56
N runoff	1.48	1.69	0.09	0.17
N lost	64.4	68.4	1.2	0.04
N Loss %[5]	78.5	80.2	1.2	0.33
Manure DM, %	66.74	67.38	0.92	0.63
DM removed	1500	1238	151.8	0.24
OM removed	347	327	18.5	0.45

[1]Values expressed as lb/steer over entire feeding period of yearlings (140 DOF) unless specified.
[2]Calculated using NRC net protein and net energy equations.
[3]Calculated as N intake – N retention.
[4]N content of manure expressed as a percent.
[5]Calculated as N lost divided by N excretion.

In the SUMMER, no interactions were observed between diet and Micro-Aid ($P \geq 0.13$) except for DMI (data not shown; P = 0.03). Steers fed CON without Micro-Aid had the lowest DMI but feeding Micro-Aid in the CON diet increased DMI which led to the interaction. Steers fed NONTRT diets had the greatest DMI and steers fed TRT diets were intermediate in DMI regardless of whether Micro-Aid was included. Cattle fed in the SUMMER experiment on CON and TRT diets had greater ADG ($P < 0.01$) than NONTRT steers (Table 4). Feed conversion was different among all three treatments ($P < 0.01$), with the lowest F:G for CON, followed by TRT, and the greatest F:G for NONTRT. Steers on the CON and TRT diets had greater HCW compared to NONTRT steers ($P < 0.01$). Steers fed Micro-Aid diets had greater ($P < 0.01$) DMI compared to the steers fed diets without Micro-Aid. Additionally, Micro-Aid fed steers had greater final BW ($P = 0.02$), ADG ($P = 0.01$) and HCW ($P = 0.02$). However, F:G was similar ($P = 0.34$) between steers fed Micro-Aid and those which were not (Table 5). Dressing percentages were different among all three treatments ($P < 0.01$) with cattle fed NONTRT having the lowest dressing percentage illustrating why HCW should be used for performance calculations, particularly at greater levels of roughage inclusion. There were no differences among treatments for LM area, 12th rib fat, marbling and calculated yield grade.

Nutrient Balance

Steers in the WINTER experiment fed NONTRT and TRT diets had lower N intake ($P < 0.01$) than steers fed the CON diet (Table 6). Steer fed NONTRT and TRT diets had similar ($P = 0.22$) N excretion that was lower than ($P < 0.01$) steers fed the CON diet. Nitrogen retention was similar ($P = 0.63$) between steers fed CON and TRT diets, but greater compared to NONTRT steers ($P < 0.01$). Runoff N was lowest for NONTRT diets ($P < 0.01$), and there was a diet by Micro-Aid interaction ($P < 0.01$). The addition of Micro-Aid tended to lower runoff N ($P = 0.06$) in CON diets and increase runoff N in TRT diets ($P < 0.01$) which is difficult to explain. Likewise, runoff is a relatively small portion of total N mass balance. Manure % N was numerically lower for steers on the CON diet compared to NONTRT and TRT steers ($P = 0.18$) and N loss (as a percent) was numerically greater for steers on the CON diet compared to the NONTRT and TRT steers ($P = 0.18$). Micro-Aid fed steers did not differ ($P \geq 0.22$) from non Micro-Aid fed steers in manure N or N loss (Table 7). Overall, dietary treatments had little impact on amount of manure N or amount lost.

In the SUMMER experiment, steers on the NONTRT diet had greater N excretion ($P = 0.03$) compared to CON and TRT, which were similar ($P = 0.90$; Table 8). Manure N concentration, as a percent, was similar ($P = 0.94$) between steers fed NONTRT and TRT diets and greater compared to steers on the CON diet ($P < 0.01$). Diet treatment did not affect amount or percent N loss ($P > 0.35$). In the SUMMER experiment, steers fed Micro-Aid (Table 9) had greater N intake, retention, and excretion ($P \leq 0.01$). There was a tendency for Micro-Aid fed steers to have a greater % N in manure ($P = 0.10$), but feeding Micro-Aid did not influence amount of N removed in manure ($P = 0.56$). Amount of N loss was slightly greater for steers fed Micro-Aid ($P = 0.04$), but not as a percentage of N excretion ($P = 0.33$) suggesting this was due to greater excretion. Similar to WINTER, diet did not dramatically impact manure N or N losses.

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Feeding Elevated Levels of Corn Silage in Finishing Diets Containing MDGS

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Summary

A finishing experiment evaluated substitution of corn with corn silage in diets with modified distillers grains with solubles (MDGS). Steers were fed 15, 30, 45, or 55% corn silage in diets with 40% MDGS. Two additional treatments were tested with 30% corn silage and 65% MDGS and 45% corn silage and 0% MDGS. As corn silage inclusion increased, there was a slight linear increase in F:G with a linear decrease in DMI and ADG. However, ADG and F:G were improved when corn silage was fed with MDGS.

Introduction

The use of corn silage in beef finishing diets has been economical in times of high-priced corn. Feeding corn silage allows cattle feeders to take advantage of the entire corn plant at a time of maximum quality and tonnage as well as secure substantial quantities of roughage/grain inventory. In past research (*2000 Nebraska Beef Cattle Report*, pp. 68-71), when corn silage partially replaced corn in finishing diets, ADG and feed efficiency were reduced as corn silage inclusion increased. However this research was completed prior to the expansion of the ethanol industry and the use of distillers grains in finishing diets. To our knowledge, there has been no research evaluating elevated levels of corn silage in finishing diets containing distillers grains. Therefore the objectives of this experiment was to determine the performance effects and carcass characteristics (along with economic outcomes as reported in *2013 Nebraska Beef Cattle Report*, pp. 76-77) of feeding elevated levels of corn silage and MDGS as a partial replacement of corn in finishing diets.

Procedure

Crossbred steer calves (n = 324; BW = 715 ± 38 lb) were sorted into two weight blocks and assigned randomly to one of 36 pens (9 head/pen). Treatments (Table 1) consisted of 15, 30, 45, and 55% corn silage with 40% MDGS (15:40, 30:40, 45:40, and 55:40, respectively) as well as one treatment with 30% corn silage and 65% MDGS (30:65) and another with 45% corn silage and 0% MDGS (45:0). Elevated levels of corn silage and MDGS replaced a 1:1 blend of dry rolled corn: high moisture corn. All steers were fed a supplement formulated for 30 g/ton of DM Rumensin® and a targeted intake of 90 mg/steer daily of Tylan®. Steers consuming 45:0 treatment diets were supplemented with Soypass for the first 84 days to meet metabolizable protein requirements. Pens were fed once daily at approximately 0930 hours. Steers were implanted with Revalor®-IS on day 1 and re-implanted with Revalor®-S on day 83. All steers were on feed for 173 days. Prior to being transported to a commercial abattoir (Greater Omaha Packing Co., Inc., Omaha, Neb.), pens of steers were weighed on a platform scale. A 4% pencil shrink was applied to this weight for final live BW and calculation of dressing percentage. Hot carcass weight was obtained the day of harvest. Carcass adjusted final BW, used in calculation of ADG and G:F, was calculated from HCW and a common dressing percentage (63%). Marbling score, 12th rib fat thickness, and LM area were recorded after a 48 hour carcass chill.

Performance and carcass data were analyzed using the mixed procedure of SAS (SAS Inst. Inc., Cary, N.C.). Pen was the experimental unit, and BW block was included as a fixed effect. Orthogonal contrasts were used to test the effects of corn silage inclusion levels within diets containing 40% MDGS. Pairwise preplanned contrasts were used to test 45% corn silage with and without MDGS and 30% corn silage with 40 or 60% MDGS.

Results

Performance

As corn silage inclusion increased, final BW, ADG, and DMI linearly

Table 1. Diet composition (DM basis).

	Treatment[1]					
	15:40	30:40	45:40	55:40	30:65	45:0
DRC[2]	20.0	12.5	5.0	0.0	0.0	25.0
HMC[3]	20.0	12.5	5.0	0.0	0.0	25.0
Corn Silage	15.0	30.0	45.0	55.0	30.0	45.0
MDGS[4]	40.0	40.0	40.0	40.0	65.0	0.0
Supplement[5]	5.0	5.0	5.0	5.0	5.0	5.0

[1]15:40= 15% Corn Silage, 40% MDGS; 30:40= 30% Corn Silage, 40% MDGS; 45:40= 45% Corn Silage, 40% MDGS; 55:40= 55% Corn Silage, 40% MDGS; 30:65= 30% Corn Silage, 65% MDGS; 45:0= 45% Corn Silage, 0% MDGS.[2]DRC= Dry rolled corn.
[3]HMC= High moisture corn.
[4]MDGS= Modified distillers grains with solubles.
[5]Formulated to provide 338 mg/head/day Rumensin and 90 mg/head/day Tylan. The 45:0 treatment supplement contained urea formulated for 1.49% dietary inclusion (DM basis). Soypass was also fed to the 45:0 treatment for 84 days to meet metabolizable protein requirements.

Table 2. Effect of corn silage and MDGS inclusion on cattle performance and carcass characteristics.

	Treatment[1]							*P*-value[2]			
	15:40	30:40	45:40	55:40	30:65	45:0	SEM	Lin.	Quad.	30	45
Initial BW, lb	727	725	724	725	726	726	1.0	0.09	0.29	0.69	0.06
Final BW[3], lb	1426	1403	1375	1335	1353	1340	10.3	<0.01	0.21	<0.01	0.02
DMI, lb/day	23.2	22.8	22.7	21.9	21.7	22.2	0.3	0.01	0.45	0.01	0.30
ADG, lb[3]	4.04	3.92	3.76	3.53	3.62	3.55	0.06	<0.01	0.19	<0.01	0.02
Feed:Gain	5.73	5.81	6.03	6.21	5.98	6.28		<0.01	0.33	0.12	0.04
HCW, lb	899	884	866	841	852	844	6.5	<0.01	0.21	<0.01	0.02
Dressing %, %	63.3	62.6	61.9	61.1	62.1	61.1	0.3	<0.01	0.54	0.19	0.07
LM area, in^2	14.53	14.55	14.32	14.05	14.23	14.08	0.237	0.13	0.46	0.34	0.49
12^{th}-rib fat, in	0.55	0.53	0.52	0.43	0.50	0.49	0.022	<0.01	0.09	0.29	0.29
Calculated YG	3.14	3.04	3.04	2.79	2.93	2.92	0.110	0.05	0.47	0.50	0.45
Marbling Score[4]	556	557	543	532	547	539	12.0	0.13	0.52	0.55	0.85

[1]15:40= 15% Corn Silage, 40% MDGS; 30:40= 30% Corn Silage, 40% MDGS; 45:40= 45% Corn Silage, 40% MDGS; 55:40= 55% Corn Silage, 40% MDGS; 30:65= 30% Corn Silage, 65% MDGS; 45:0= 45% Corn Silage, 0% MDGS.
[2]Lin. = *P*-value for the linear response to corn silage inclusion, Quad.= *P*-value for the quadratic response to corn silage inclusion, 30 = t-test comparison of treatments 30:40 and 30:65, 45 = t-test comparison of treatments 45:40 and 45:0.
[3]Calculated from hot carcass weight, adjusted to a common 63% dressing percentage.
[4]Marbling Score: 400=$Slight^{00}$, 500=$Small^{00}$.

decreased ($P < 0.05$; Table 2). Feed:gain increased linearly ($P < 0.01$) with increasing corn silage in the diet, with the steers on the 15:40 treatment being 1.5%, 5.0%, and 7.7% more efficient than steers on treatments 30:40, 45:40, and 55:40, respectively. Although there were improvements in F:G for decreasing levels of corn silage in this experiment, the magnitude of these improvements are less than those seen in previous experiments utilizing elevated levels of corn silage in diets containing no distillers grains (*2000 Nebraska Beef Cattle Report*, pp. 68-71). Cattle fed 45% corn silage with 40% MDGS instead of 0% MDGS had increased final BW and ADG ($P < 0.05$), no difference in DMI ($P = 0.30$), and improved F:G ($P = 0.04$). For steers fed 30% dietary corn silage, the addition of 65% MDGS (compared to 40% MDGS) resulted in decreases in final BW, DMI, and ADG ($P < 0.01$), as well as 3% less favorable F:G ($P < 0.01$).

Carcass characteristics

Dressing percentage, HCW, 12^{th} rib fat, and calculated YG decreased linearly ($P < 0.01$; Table 2) with increasing corn silage inclusion. There were no differences in marbling score or LM area ($P > 0.05$) due to corn silage inclusion with 40% MDGS. Comparing steers fed 30% corn silage with 40% MDGS instead of 65% MDGS, HCW was 32 lb greater ($P < 0.01$), with no differences ($P > 0.05$) in other carcass characteristics. There also was an improvement in HCW (22 lb; $P = 0.02$) for steers fed 40% MDGS instead of 0% MDGS in diets containing 45% corn silage. There were no other differences ($P > 0.07$) in carcass characteristics for steers consuming diets containing 45% corn silage.

In general, corn silage in combination with MDGS can be utilized to partially replace corn in finishing diets. Cattle performance is reduced with increased level of corn silage in finishing diets containing MDGS. However, feeding corn silage with MDGS is better than without MDGS for ADG and F:G.

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Economics of Feeding Elevated Levels of Corn Silage in Finishing Diets Containing MDGS

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Summary

Economic assumptions were applied for substitution of corn with corn silage in diets with modified distillers grains plus solubles (MDGS) for determination of cost of gain and profit per head when corn was priced at $3.50, $5.00, or $6.50 per bushel and corn silage was priced at 8, 8.5, or 9 times the bushel price of corn on an as-is basis. Cost of gain linearly decreased and profit per head linearly increased as corn silage inclusion increased when corn silage was priced at 8 and 8.5 times the price of corn, regardless of corn price.

Introduction

Distillers grains have been shown to be an economical partial replacement of corn in finishing diets, especially when corn price is high. Corn silage was researched many years ago and was found to be economical when corn prices increase, however, ADG and F:G become less favorable with elevated levels of corn silage. Nonfeed costs (yardage and interest) may increase with elevated levels of corn silage in finishing diets due to lower ADG and additional DOF. However, economically priced corn silage and distillers grains relative to corn can more than offset these higher nonfeed costs with reductions in diet DM costs and total feed costs.

Due to the performance results of *2013 Nebraska Beef Cattle Report*, pp. 74-75, it was hypothesized that there may be economic incentives to feeding elevated levels of corn silage in finishing diets containing distillers grains. Therefore, the objective of this experiment was to determine the economic outcomes of *2013 Nebraska Beef Cattle Report*, pp. 74-75 using corn priced at $3.50, $5.00, and $6.50/bushel as well as corn silage priced at 8, 8.5, and 9 times the bushel price of corn (as-is basis).

Procedure

Economic data were based off performance results of *2013 Nebraska Beef Cattle Report*, pp. 74-75. Due to the effect of variable carcass weight across treatments, DOF were adjusted on a pen basis so that all pens were fed to a constant average carcass weight of 866 lb (DOFc). Initial purchase cost was calculated using average initial weight of a pen multiplied by an initial price/lb determined to achieve a breakeven or net return of $0/head for the 15% corn silage control treatment. Cattle interest charges were calculated as 7.5% interest * (purchase price-$200/steer down) * (DOFc/365). Corn (1:1 blend of dry rolled corn and high moisture corn) was priced at $3.50, $5.00, or $6.50 per bushel with an additional $2.17/ton (DM) for the cost of corn processing. Corn silage was priced at 8, 8.5, or 9 times the bushel price of corn on an as-is basis (i.e., $3.50 per bushel corn would calculate to $28/unshrunk ton of corn silage at 35% DM and 8 times the bushel price of corn). Modified distillers grains with solubles feed costs were calculated as 90% the price of corn on a DM basis. Supplement was assumed to be equal to the price of corn on a DM basis. A pencil shrink was applied to all ingredients; 1% was used for corn and supplement, 5% for MDGS, and 10% for corn silage. Feed costs were determined by using diet DM costs * DMI * DOFc. A feed interest charge of 7.5% for one half of total feed charges was used. Processing and medicine charges were assumed at $20/steer. Yardage was calculated as $0.45/head/day utilizing DOFc. Cost of gain calculations included yardage,

Table 1. Effect of corn silage and MDGS inclusion on cost of gain ($/cwt).

	Treatment[1]							*P*-value[2]			
Item	15:40	30:40	45:40	55:40	30:65	45:0	SEM	Lin.	Quad.	30	45
$3.50/bu corn											
8[3]	52.13	50.07	48.90	49.09	51.03	52.97	0.65	<0.01	0.16	0.30	<0.01
8.5[3]	52.35	50.51	49.59	49.90	51.49	53.69	0.65	<0.01	0.16	0.29	<0.01
9[3]	52.57	50.95	50.28	50.71	51.94	54.41	0.65	0.02	0.16	0.28	<0.01
$5.00/bu corn											
8[3]	68.39	65.30	63.42	63.40	66.26	68.92	0.88	<0.01	0.17	0.44	<0.01
8.5[3]	68.70	65.93	64.41	64.56	66.91	69.94	0.87	<0.01	0.17	0.42	<0.01
9[3]	69.01	66.56	65.39	65.72	67.57	70.97	0.87	<0.01	0.17	0.41	<0.01
$6.50/bu corn											
8[3]	84.65	80.53	77.95	77.71	81.49	84.86	1.11	<0.01	0.17	0.54	<0.01
8.5[3]	85.05	81.35	79.23	79.22	82.34	86.19	1.10	<0.01	0.18	0.52	<0.01
9[3]	85.46	82.17	80.51	80.72	83.19	87.53	1.09	<0.01	0.18	0.51	<0.01

[1]15:40 = 15% Corn Silage, 40% MDGS; 30:40= 30% Corn Silage, 40% MDGS; 45:40= 45% Corn Silage, 40% MDGS; 55:40= 55% Corn Silage, 40% MDGS; 30:65= 30% Corn Silage, 65% MDGS; 45:0= 45% Corn Silage, 0% MDGS.
[2]Lin. = *P*-value for the linear response to corn silage inclusion, Quad.= *P*-value for the quadratic response to corn silage inclusion, 30 = t-test comparison of treatments 30:40 and 30:65, 45 = t-test comparison of treatments 45:40 and 45:0.
[3]Corn silage priced at 8, 8.5, or 9 times the bushel price of corn on an as-is basis.

Table 2. Effect of corn silage and MDGS inclusion on profit per head ($).

	Treatment[1]							*P*-value[2]			
Item	15:40	30:40	45:40	55:40	30:65	45:0	SEM	Lin.	Quad.	30	45
$3.50/bu corn											
8[3]	—	14.01	22.33	19.61	3.63	(10.52)	5.44	<0.01	0.21	0.18	<0.01
8.5[3]	—	12.53	19.20	15.31	2.06	(13.81)	5.48	0.03	0.20	0.18	<0.01
9[3]	—	11.04	16.06	11.01	0.50	(17.11)	5.52	0.10	0.20	0.18	<0.01
$5.00/bu corn											
8[3]	—	20.39	32.94	33.81	10.45	(8.17)	6.47	<0.01	0.25	0.28	<0.01
8.5[3]	—	18.27	28.46	27.67	8.21	(12.88)	6.53	<0.01	0.24	0.28	<0.01
9[3]	—	16.15	23.99	21.52	5.97	(17.59)	6.59	0.01	0.24	0.28	<0.01
$6.50/bu corn											
8[3]											
8.5[3]	—	26.77	43.54	48.01	17.27	(5.82)	7.55	<0.01	0.28	0.38	<0.01
9[3]	—	24.01	37.73	40.02	14.35	(11.94)	7.62	<0.01	0.28	0.37	<0.01
	—	21.25	31.91	32.03	11.44	(18.06)	7.70	<0.01	0.27	0.37	<0.01

[1]15:40 = 15% Corn Silage, 40% MDGS; 30:40= 30% Corn Silage, 40% MDGS; 45:40= 45% Corn Silage, 40% MDGS; 55:40= 55% Corn Silage, 40% MDGS; 30:65= 30% Corn Silage, 65% MDGS; 45:0= 45% Corn Silage, 0% MDGS.
[2]Lin. = *P*-value for the linear response to corn silage inclusion, Quad.= *P*-value for the quadratic response to corn silage inclusion, 30 = t-test comparison of treatments 30:40 and 30:65, 45 = t-test comparison of treatments 45:40 and 45:0.
[3]Corn silage priced at 8, 8.5, or 9 times the bushel price of corn on an as-is basis.

processing and medicine, and total feed costs (feed and feed interest charges). A sale price of $1.926/lb * 866 lb or $1667.92/head was used for all cattle. To calculate profit per head, initial purchase cost (including cattle interest charges), total feed costs, processing and medicine, yardage, and a 1% calculated death loss was subtracted from sales price.

Economic data were calculated on a pen basis for statistical analysis utilizing the mixed procedure of SAS (SAS Inst. Inc., Cary, N.C.). Pen was the experimental unit, and block was included as a fixed effect. Orthogonal contrasts were used to test the effects of corn silage inclusion level within diets containing 40% MDGS. Pairwise preplanned contrasts were used to test 45% corn silage with and without MDGS and 30% corn silage with 40 or 65% MDGS.

Results

Corn silage pricing was based around the premise that the ratio of corn silage to corn price is affected by corn price, cost of grain harvest, and cost of corn silage harvest. Using current average custom rates for Nebraska the ratio is 8.6 at $3.50 per bushel corn, 8.4 at $5.50 per bushel corn, and 8.2 at $6.50 per bushel corn. When pricing corn at 8.5 times the bushel price of corn in this experiment, the optimum corn silage inclusion level for maximum profit per head was 45% at $3.50 per bushel corn and 55% at $6.50 per bushel corn with 45 and 55% inclusion being nearly equal at $5.00 per bushel corn (Table 1).

Cost of gain (COG) was linearly decreased ($P < 0.05$; Table 1) as corn silage inclusion was increased regardless of price combination evaluated. When comparing the highest (55%) and lowest (15%) inclusion levels of corn silage, there was a $3.04, $4.99, and $6.93/cwt improvement in COG when corn silage was priced at 8 times the bushel price of corn and when corn was priced at $3.50, $5.00, and $6.50 per bushel, respectively.

Profit per head was linearly increased ($P < 0.05$; Table 2) as corn silage inclusion was increased for all price combinations when corn was priced at $5.00 or $6.50 per bushel. When corn was priced at $3.50 per bushel, there was a linear increase in profit per head ($P < 0.05$) when corn silage was priced at 8 and 8.5 times the bushel price of corn. Compared to the cattle consuming the 15% corn silage treatment diets, there was an improvement in profit per head of $19.61, $33.81, and $48.01 with the inclusion of 40% more corn silage in the diet (55:40 treatment) when corn silage was priced at 8 times the price of corn and when corn was priced at $3.50, $5.00, and $6.50 per bushel, respectively. When comparing the same treatments and looking at corn silage priced at 8.5 times the price of corn, the profit per head at the corn prices evaluated was $15.31, $27.67, and $40.02.

The apparent synergistic effect of combining elevated levels of corn silage with distillers grains becomes particularly noticeable when looking at the economic outcomes of the two t-test comparisons (Table 2). When comparing cattle consuming 45% corn silage diets, the inclusion of MDGS (40% of the diet DM compared to 0%) resulted in improvements in cost of gain (range of $4.00 to $7.12/cwt) and profit per head (range of $32.63 to $50.68; $P < 0.01$) for all evaluated price combinations. For cattle fed diets containing 30% corn silage and either 40% or 65% MDGS, there was no difference in cost of gain or profit per head ($P > 0.05$) at any corn and corn silage price combination.

These data suggest that there is an economic incentive to feeding elevated levels of corn silage with distillers grains when market conditions dictate. The substitution of corn for elevated levels of corn silage and distillers grains in finishing diets becomes more economically appealing when cattle feeders are faced with higher corn price levels.

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Rapidly Transitioning Cattle to a Finishing Diet with RAMP®

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Summary

Cattle were transitioned from RAMP to a finishing diet over 27 or 28 days by decreasing RAMP (100 to 0%) and increasing finisher (0 to 100%) gradually over 4 steps or rapidly in fewer days and with fewer steps. Following adaptation, cattle were fed a common diet until slaughter. Grain adaptation treatment did not affect performance or carcass characteristics. Cattle can transition from RAMP to a finishing ration containing 47.5% Sweet Bran® in fewer days with fewer step diets without negatively affecting performance compared to more gradual transition from RAMP to a finishing diet.

Introduction

Using RAMP to transition cattle to a finishing ration has been shown to increase ADG and improve feed efficiency over the entire finishing period when compared to traditional grain adaptation with alfalfa hay (*2012 Nebraska Beef Cattle* Report, p.85). We hypothesized that improved performance during the finishing period might be attributed to a reduction in subclinical acidosis throughout the trial. A metabolism study found grain adaptation with RAMP compared with a traditional program does not appear to alter ruminal pH or pH variation during the adaptation period or during the first seven days on a finishing ration. Although adaptation with RAMP does not change ruminal pH, a reduction in subclinical acidosis during finishing may explain improvements in performance that cannot be explained by differences in energy intake during adaptation. The objective of this study was to determine if cattle can be transitioned from RAMP to a finishing ration more rapidly in fewer days and with fewer step diets compared with a traditional adaptation program.

Table 1. Dietary composition (%) on a DM basis and days fed for the control adaptation programs which involved blending RAMP with a finishing diet containing 25% Sweet Bran (CON25) or a 47.5% Sweet Bran finishing diet (CON47.5).

Days fed	1-4	5-10	11-16	17-22	23-28
Adaptation	100:0	75:25	50:50	25:75	0:100
CON25					
RAMP	100	75	50	25	—
Alfalfa hay	—	1.9	3.8	5.6	7.5
High moisture corn	—	15.6	31.2	46.8	62.5
Sweet Bran	—	6.3	12.5	18.8	25
Supplement[1]	—	1.2	2.5	3.8	5
CON47.5					
RAMP	100	75	50	25	—
Alfalfa hay	—	1.9	3.8	5.6	7.5
High moisture corn	—	10	20	30	40
Sweet Bran	—	11.9	23.7	35.6	47.5
Supplement[1]	—	1.2	2.5	3.8	5

[1]Supplement formulated to provide 25 g/ton Rumensin and 12 mg/lb thiamine on a DM.

Procedure

Yearling crossbred steers (n = 390; BW = 752 ± 31 lb) were limit-fed a 1:1 ratio of Sweet Bran and alfalfa hay fed at 2% of BW (DM) to minimize variation in gut fill. Weights were measured over two consecutive days (days 0 and 1) to determine initial BW. Using BW measurements obtained on day 0, steers were separated into three weight blocks, stratified by BW, and assigned randomly within strata to one of 40 feedlot pens, with 9 or 10 steers per pen.

Treatments consisted of grain adaptation programs (27 or 28 days) involving blends of RAMP and a finishing diet. A control adaptation program involved decreasing RAMP and increasing a 25% Sweet Bran finishing diet (25% Sweet Bran, 62.5 % high moisture corn (HMC), 7.5% alfalfa hay (AH), and 5% dry supplement) in 5 steps (100:0, 75:25, 50:50, 25:75, and 0:100 RAMP to finishing diet) fed for 4, 6, 6, 6, and 6 days, respectively (CON25; Table 1). Four remaining adaptation programs involved decreasing RAMP and increasing inclusion of a 47.5% *Sweet Bran* finishing diet (47.5% *Sweet Bran,* 40% HMC, 7.5% AH, and 5% dry supplement). Two programs consisted of 5 steps (100:0, 75:25, 50:50, 25:75, and 0:100 RAMP to finishing diet) fed for either 4, 6, 6, 6, and 6 days (CON47.5; Table 1) or 10, 1, 1, 1 and 14 days (3-1d; Table 2). The final two programs consisted of either 4 steps (100:0, 67:33, 33:67 and 0:100 RAMP to finishing diet) fed for 10, 2, 2, and 14 days (2-2d; Table 2) or 3-steps (100:0, 50:50, and 0:100 RAMP to finishing diet) fed for 10, 4, and 14 days (1-4 days; Figure 1). RAMP, all step rations, and the first finishing ration contained 25 g/ton of DM Rumensin and 12 mg/lb thiamine (DM).

Table 2. Percentage (DM) of 47.5% Sweet Bran finishing ration (finisher 1) blended with RAMP for respective days during grain adaptation for treatments 2-2 day step, 1-4 day step, and 3-1 day step. Following finisher 1, cattle were fed a common diet (finisher 2) until slaughter.

Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29-146
2-2 days	RAMP										32		67		Finisher 1														Finisher 2
1-4 days	RAMP										50				Finisher 1														Finisher 2
3-1 days	RAMP										25	50	75		Finisher 1														Finisher 2

Table 3. Feedlot performance and carcass characteristics of cattle adapted to grain using rapid or traditional grain adaptation with RAMP.

Item	Treatment					SEM	*P*-value
	CON25	CON47.5	2-2 day	1-4 day	3-1 day		
Performance							
Initial BW, lb	749	750	750	749	751	31.0	0.56
Final BW, lb[1]	1439	1440	1443	1449	1430	16.2	0.84
DMI, lb/day							
36 days	25.5	25.3	24.8	25.3	25.2	0.41	0.62
Final	26.5	26.0	26.3	26.6	26.0	0.36	0.39
ADG, lb							
36 days	4.23	4.44	4.29	4.56	4.35	0.32	0.85
Final	4.73	4.72	4.75	4.79	4.65	0.11	0.77
F:G[2]							
36 days	6.02	5.69	5.77	5.78	5.54	—	0.81
Final	5.58	5.49	5.51	5.53	5.58	—	0.81
Carcass traits							
LM area, in[2]	14.6	15.0	14.8	14.9	15.0	0.20	0.32
12 rib fat, in	0.52	0.50	0.59	0.53	0.58	0.04	0.11
Marbling[4]	542	518	538	550	537	12.0	0.11
Liver abscess,%	9.0	9.0	5.1	7.7	7.7	—	0.90

[1]Final BW was calculated from HCW using a common dressing percentage of 63%.
[2]Statistics performed on G:F, inverse of G:F presented
[3]400 = Slight, 500 = Small, 600 = Modest

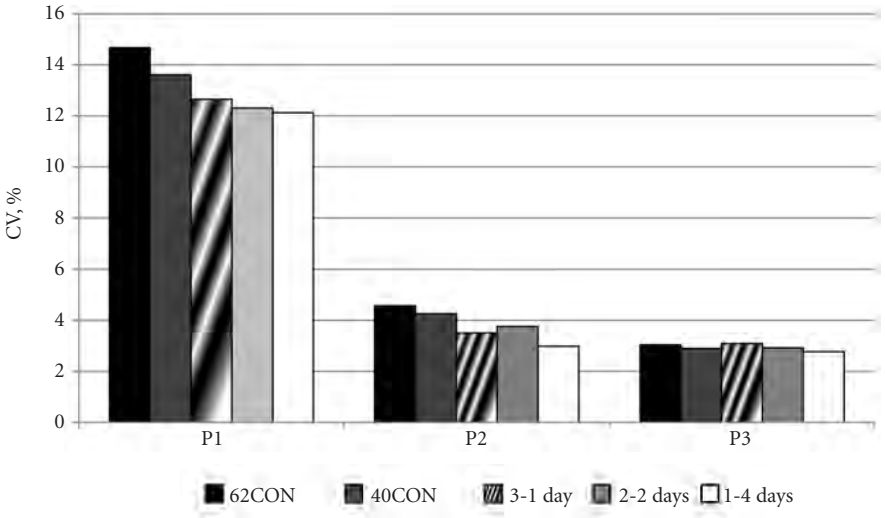

Figure 1. DMI variation (shown as CV) over three time periods (P1: all days before feeding a common finishing diet; days 1-27 or 1-28, P2: first six days of finishing diet 1, and P3: first six days on the common finishing diet). Treatments shown left to right in chart: CON25, CON40, 3-1days, 2-2 days, and 1-4 days.

Following adaptation, a common finishing diet (25% Sweet Bran, 22.5% modified distillers grains with solubles, 40% HMC, 7.5% AH, and 5% dry supplement which was formulated to provide 30 g/ton Rumensin and 90 mg/steer daily Tylan on a DM basis was fed for the remainder of the feeding period. After cattle were on a common finishing diet for 8 days (day 36), BW were collected to evaluate performance over the adaptation period, and steers were implanted with Revalor®-S.

On day 146, cattle were transported to a commercial abattoir (Greater Omaha Packing, Omaha, Neb.) to be harvested. Hot carcass weight (HCW) and liver abscess scores were obtained on the day of slaughter. Following a 48-hour chill, USDA marbling score, 12th rib fat thickness, and LM area were recorded. Carcass adjusted performance was calculated using a common dressing percentage (63%) to determine final BW, ADG and F:G.

Performance and carcass characteristics were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C.) Pen was the experimental unit, treatment was a fixed effect, and weight block was treated as a random effect. Treatment comparisons were made using pair-wise comparisons when the F-test statistic was significant at an alpha level of $P = 0.10$. Among day DMI variance and DMI for each pen were analyzed for three time periods (all days before feeding a common finishing diet; days 1-27 or 1-28, the first six days of finishing diet 1, and the first six days on the common finishing diet) using the MIXED procedure of SAS. Mean variance and DMI for each pen were then used to calculate CV for DMI for each period. Prevalence of liver abscesses was analyzed using the GLIMMIX procedure of SAS.

Results

Adaptation program did not affect DMI during the adaptation period ($P = 0.63$; Table 3) or over the entire feeding period ($P = 0.39$). Daily gain and F:G were similar among treatments on d 36 ($P > 0.81$) and over the entire finishing period ($P > 0.77$). Carcass traits were not affected by adaptation method. Variation (CV) in DMI for time periods during and after grain adaptation are summarized in Figure 1. Among day DMI variance over the adaptation period (days 1-28 or 1-27; P2) was greater for CON25 than all other adaptation treatments ($P < 0.05$). Intake variance was greater for CON47.5 when compared to 1-4 days and 2-2 days and tended ($P = 0.09$) to be greater when compared to 3-1 days during P2.

Although individual intake variation is masked in a pen setting, among day intake variation is a measure of subacute acidosis available in a feedlot setting. Shorter, more abrupt transitions between RAMP and finishing ration actually reduced intake variation and therefore may reduce subacute acidosis. Cattle fed RAMP for 10d can transition to a finishing ration containing 47.5% Sweet Bran in fewer days and with fewer step diets without negatively affecting performance.

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Transitioning Cattle from RAMP® to a Finishing Diet With or Without an Adaptation Period

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Summary

Cattle were transitioned from RAMP to a finishing diet gradually over 28 days by decreasing RAMP (100 to 0%) and increasing finisher (0 to 100%) gradually over 4 steps, rapidly in 2 steps or abruptly without an adaptation step. Following adaptation, cattle were fed a common finishing diet for the remainder of the feeding period. Transitioning cattle from RAMP to a finishing diet in 2 steps or without an intermediate step did not affect performance or carcass characteristics compared to a more traditional 4-step program. Cattle transitioned directly from RAMP to a finishing ration had greater among day intake variation and lower DMI after the abrupt transition but had less DMI variation following a transition to final finishing diet. Cattle fed RAMP for 10 days can be transitioned to a finishing ration containing 47.5% Sweet Bran® abruptly without negatively affecting performance.

Introduction

RAMP is a complete starter ration which contains a high level of Sweet Bran and a minimal amount of forage. Adapting cattle to high grain diets with RAMP increased ADG and improved feed efficiency over the entire finishing period when compared to traditional grain adaptation. (*2012 Nebraska Beef Cattle Report*, p.85). Previous work has shown that cattle fed RAMP for 10 days can be transitioned rapidly to a 47.5% Sweet Bran finishing ration in as little as three days using 3 steps or in four days using 1 step diet without negatively affecting performance (*2013 Nebraska Beef Cattle Report,* pp. 78-79). In a metabolism study, fistulated steers were transitioned from RAMP to a finishing diet gradually over an 18-day period or abruptly in one day without an adaptation period. Steers abruptly switched to a finishing ration had lower ruminal pH but DMI was not affected by adaptation treatment. The objective of this study was to evaluate the effects of transitioning cattle directly from RAMP to a finishing ration on feedlot performance and carcass characteristics compared to more gradual grain adaptation procedures using blends of RAMP and finishing diet as step diets.

Procedure

Crossbred steer calves (n = 300; BW = 752 ± 31 lb) were received and offered *ad libitum* RAMP for 24 days then limit fed RAMP at 2% of BW (DM basis) for five days to minimize variation in gut fill. Following, limit feeding, body weights were collected over two consecutive days (days 0 and 1) to determine initial BW. Using BW measurements obtained on day 0, steers were separated into three weight blocks, stratified by BW within block, and assigned randomly within strata to feedlot pens, with 10 steers per pen.

Three treatments were imposed during the grain adaptation period (24 or 28 days; Table 1) as follows: 1) control steers (4-STEP) were gradually adapted using a 4-step system which decreased RAMP inclusion (from 100 to 0%) while increasing inclusion of finishing ration (0 to 100%) equally over 4 periods (4, 6, 6, and 6 days) by mixing RAMP with finishing ration 1 (F1; 47.5% Sweet Bran, 40% high-moisture corn (HMC), 7.5% alfalfa hay and 5% supplement, DM basis) and fed as a single diet 2) feeding RAMP for 10 days (2-STEP), followed by a 50:50 blend of RAMP to F1 for four days and F1 for 14 days; and 3) feeding RAMP for 10 days and switching directly to F1 on day 11 (0-STEP).

Finishing diet 1 was fed 6 days for 4-STEP and 14 days for 0-STEP and 2-STEP. Following F1, a second finishing diet (F2), which contained 25% Sweet Bran, 22.5% modified distillers grains with solubles, 42.5% HMC, 5% wheat straw and 5% supplement, was fed to all steers for the remainder of the feeding period (DM basis). RAMP and F1 contained 25 g/ton Rumensin® and 12 mg/lb thiamine and F2 contained 30 g/ton Rumensin and was formulated to provide 90 mg per animal daily of Tylan (DM). On day 39, pen weights were collected to evaluate performance over the adaptation period.

All steers were implanted with Revalor®-IS on day 1 and re-implanted with Revalor®-S on day 92. On day 187, cattle were transported to a commercial abattoir (Greater Omaha Packing, Omaha, Neb.) to be harvested. Hot carcass weight (HCW) and liver abscess scores were obtained on the day of slaughter. Following a 48-hour chill, USDA marbling score, 12th rib fat thickness, and LM area were recorded. Yield grade was calculated using HCW, 12th rib fat thickness, LM, and an assumed percentage (2.5%) of kidney, pelvic,

Table 1. Days RAMP, blends of a 47.5% Sweet Bran finishing ration (Finisher 1) and RAMP (Finisher 1:RAMP), finisher 1, and finisher 2 were fed over the feeding period for each treatment.

Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29-187
4-STEP	RAMP				25:75						50:50						75:25						Finisher 1						Finisher 2
2-STEP	RAMP										50:50				Finisher 1														Finisher 2
0-STEP	RAMP										Finisher 1																		Finisher 2

Table 2. Feedlot performance and carcass characteristics of cattle adapted from RAMP to a high grain diet using 0, 2, or 4 steps.

	Treatment				
Item	4-STEP	2-STEP	0-STEP	SEM	*P*-value
Performance					
Initial BW, lb	645	645	645	36.3	0.82
Final BW, lb[1]	1392	1409	1397	48.2	0.33
DMI, lb/day					
39 days	20.2	20.1	19.7	0.81	0.26
Final	21.7	22.1	21.7	0.49	0.24
ADG, lb					
39 days	4.12	4.15	4.15	0.15	0.96
Final	4.00	4.09	4.02	0.07	0.35
F:G[2]	5.41	5.41	5.38	—	0.85
Carcass traits					
LM area, in[2]	14.0	14.1	14.2	0.41	0.53
12 rib fat, in	0.56	0.58	0.55	0.02	0.41
Yield Grade[3]	3.26	3.32	3.16	0.07	0.30
Marbling[4]	545	550	542	11.5	0.85

[1]Final BW was calculated from HCW using a common dressing percentage of 63%.
[2]Statistics performed on G:F, inverse of G:F presented.
[3]Calculated as 2.5+ (2.5 x 12th rib fat) + (0.2 x 2.5[KPH]) + (0.0038 x HCW)-(0.32 x LM area).
[4]400 = Slight, 500 = Small, 600 = Modest.

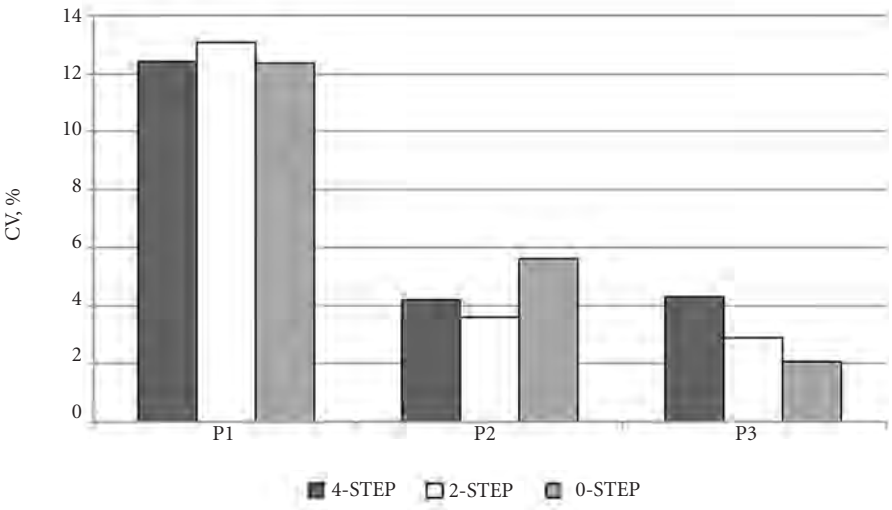

Figure 1. DMI variation (shown as CV) over three time periods (P1: all days before feeding a common finishing diet; days 1-27 or 1-28, P2: first six days of finishing diet 1, and P3: first six days on the common finishing diet). Treatments shown left to right in chart: 4-STEP, 2-STEP, 0-STEP.

and heart fat (KPH) using the following formula: 2.5+ (2.5 x 12th rib fat) + (0.2 x 2.5[KPH]) + (0.0038 x HCW)-(0.32 x LM area). Carcass adjusted performance was calculated using a common dressing percentage (63%) to determine final BW, ADG and F:G.

Performance data and carcass characteristics were analyzed using the MIXED procedure of SAS. Pen was the experimental unit, treatment was a fixed effect, and weight block was treated as a random effect. Treatment comparisons were made using pairwise comparisons when the F-test statistic was significant at an alpha level of $P = 0.10$. Among day DMI variance and DMI for each pen were analyzed for three time periods (all days before feeding F1; days 1-24 or 1-28, the first six days F1 was fed, and the first six days on F2) using the MIXED procedure of SAS (SAS Inst. Inc, Cary, N.C.) Mean variance and DMI for each pen were then used to calculate coefficient of variance (CV) for DMI for each period. Prevalence of liver abscesses was analyzed using the GLIMMIX procedure of SAS using binomial distribution with the logit link function and block as a random effect.

Results

Ten steers were removed from the study for health reasons unrelated to treatment (4-STEP=5, 2-STEP = 3, 0-STEP= 2; $P > 0.69$) and are not included for analysis. Of removed steers, three were digestive deads occurring over 90 days into the feeding period (two from 4-STEP and one from 0-STEP). Adaptation program did not affect DMI ($P > 0.20$) during the adaptation period or over the entire feeding period (Table 2). Daily gain and F:G were similar ($P > 0.20$) among treatments on day 39 and over the entire finishing period. Carcass traits and incidence of liver abscesses were not affected by adaptation method ($P > 0.30$). Liver abscess prevalence was very low at 3% overall which may suggest that acidosis was minimal in this trial.

Intake variation was evaluated over three time periods as DMI variance, since DMI were different during these time periods intake variation is shown as a CV in Figure 1. Dry matter intake over the first six days of F1 (P2) was lower for 0-STEP when compared to 2-STEP ($P < 0.01$) and 4-STEP ($P < 0.01$; data not shown). Also during that time period, DMI was lower for 2-STEP when compared to 4-STEP ($P = 0.05$). Among day DMI variance for the first six days cattle were fed F1 (P2) was for lower for 2-STEP when compared to 0-STEP ($P = 0.02$). During the first six days of F2 (P3), DMI variance for 0-STEP was lower when compared to 4-STEP and numerically lower than 2-STEP ($P = 0.14$). Although, individual intake variation is masked in a pen setting, among day intake variation is one of the measures of subacute acidosis available in pen studies. Cattle transitioned directly from RAMP to a finishing ration had greater among day intake variation and lower DMI after the abrupt transition (P2) but actually had less intake variation following a transition to a final finishing diet (P3). Cattle fed RAMP for 10 days can be transitioned to a finishing ration containing 47.5% Sweet Bran abruptly without negatively affecting performance.

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Effects of Abruptly Transitioning Cattle from RAMP® to a Finishing Diet on Ruminal pH and Feed Intake

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Summary

A metabolism trial was conducted to evaluate transitioning cattle from RAMP® directly to a finishing diet without an adaptation period. Adaptation programs included either a 4-step system that decreased RAMP (100 to 0%) while increasing inclusion of the finishing ration (0 to 100%) gradually over 4 steps or a 1-step system where cattle were fed RAMP for 10 days and switched directly to a 47.5% Sweet Bran® finishing ration on day 11. Abruptly transitioning cattle in 1 step to a finishing ration containing 47.5% Sweet Bran decreased average pH while increasing time below pH 5.3 and pH variation compared to the 4-STEP system. Eating time increased as a result of 1-step when cattle were on the final finishing ration.

Introduction

Grain adaptation programs using RAMP have been shown to increase ADG and improve feed efficiency over the entire finishing period compared to traditional grain adaptation with alfalfa hay (*2012 Nebraska Beef Cattle Report*, p.85). Improved performance during the finishing period may be due to a reduction in subclinical acidosis or a change in eating behavior. A feedlot study found that cattle fed RAMP for 10 days can be transitioned rapidly to a 47.5% Sweet Bran finishing ration in as little as three days using 3 steps, or in four days using 1 step without negatively affecting performance (*2013 Nebraska Beef Report,* pp. 78-79). The objective of the current metabolism study was to evaluate the effects of transitioning cattle from RAMP directly to a finishing ration without an adaptation period on DMI, eating behavior, and ruminal pH of ruminally fistulated steers.

Procedure

A 35-day metabolism trial was conducted using seven ruminally fistulated steers (BW = 1,065 ± 110 lb). Treatments were imposed during the grain adaptation period (Table 1). Control steers (n = 4) were gradually adapted to a finishing diet using a 4-step system (4-STEP) which decreased RAMP inclusion (100 to 0%) while increasing inclusion of finishing ration (0 to 100%) equally over 4 periods (4, 6, 6, and 6 days), RAMP was mixed with finishing ration 1 (47.5% Sweet Bran, 40% high-moisture corn (HMC), 7.5% alfalfa hay (AH) and 5% supplement, DM basis; F1) and fed as a single diet. The 1 step adaptation system (1-STEP; n = 3) involved feeding RAMP for 10 days and switching directly to F1 on d 11. F1 was fed for 14 days for 1-STEP and 6 days for 4-STEP. Following F1, a second finisher (F2), which contained (DM basis) 25% Sweet Bran, 22.5% modified distillers grains with solubles, 40% HMC, 7.5% AH and 5% supplement, was fed for 7 and 11 days for 4-STEP and 1-STEP, respectively. All diets contained 25 g/ton Rumensin® and 12 mg/lb thiamine. Steers were individually housed in box stalls and were offered *ad libitum* access to feed and water and fed once daily at 0800 hour. Feed intake was continuously monitored using feed bunks suspended on load cells to determine intake rate and meals per day. Feed refusals were collected daily, weighed, and a 10% representative sample was retained and dried in a forced-air oven at 60°C for 48 hours to obtain DMI.

Wireless pH probes were placed into the rumen of each steer for the trial duration. Each probe was attached to a weighted enclosure designed to maintain the electrode in the ventral sac of the rumen. Ruminal pH was recorded at 1 minute intervals. On days 9 and 22 of the trial each probe was briefly removed from the rumen, before feeding, to download pH data and recalibrate the probe.

Data from the first days of F1 and F2 were analyzed to compare the two systems using the GLIMMIX procedure of SAS (SAS Inst. Inc., Cary, N.C.) Steer was the experimental unit

Table 1. Dietary composition (%) and days for 4-STEP or 1-STEP RAMP adaptation (DM).

Adaptation:	1	2	3	4	Finisher 1	Finisher 2
4-STEP (day)	(1-4)	(5-10)	(11-16)	(17-22)	(23-28)	(29-35)
RAMP	100	75	50	25	—	—
Alfalfa	—	1.9	3.8	5.6	7.5	7.5
HMC[1]	—	10	20	30	40	40
Sweet Bran	—	11.9	23.7	35.6	47.5	25
MDGS[2]	—	—	—	—	—	22.5
Supplement[3]	—	1.2	2.5	3.8	5	5
1-STEP (day)	(1-10)				(11-24)	(25-35)
RAMP	100				—	—
Alfalfa	—				7.5	7.5
HMC[1]	—				40	40
Sweet Bran	—				25	25
MDGS[2]	—				—	22.5
Supplement[3]					5	5

[1]High moisture corn.
[2]Modified distillers grain with solubles.
[3]Supplement formulated to provide 25 g/ton Rumensin and 12 mg/lb thiamine (DM).

and was treated as a random effect, and day was treated as a repeated measure.

Results

Intakes of F1 and F2 were similar statistically for 4-STEP and 1-STEP ($P > 0.4$; Table 2). One steer on 1-STEP had reduced DMI (50%) for two days along with low ruminal pH and high pH variation within d on F1, suggesting acidosis. After the period of reduced intake, DMI increased to a level consistent with other animals on the 1-STEP treatment for the remainder of the trial. Although 1-STEP likely caused acidosis in this steer, the 1-STEP treatment has been evaluated in a feedlot study and no adverse effects on performance were observed when compared to 4-STEP (*2013 Nebraska Beef Report* pp. 80-81). Eating time was greater for 1-STEP compared to 4-STEP when fed F1 ($P = 0.02$) or F2 ($P = 0.07$), but meals/day were similar ($P > 0.65$) across treatments for F1 and F2. A change in eating time suggests the abrupt step changed eating behavior.

Average ruminal pH was lower while fed F1 ($P = 0.03$) or F2 ($P = 0.02$) for 1-STEP cattle compared to 4-step (Table 2; Figure 1). Cattle adapted with 1-STEP had greater time below pH 5.3 and pH 5.6 while fed F1 ($P = 0.03$) or F2 ($P = 0.01$) compared to 4-STEP. While on F2, 1-STEP cattle had a lower minimum pH ($P = 0.01$) compared to 4-STEP. Magnitude of pH change and pH variance were not different ($P > 0.44$) while cattle were fed F1. However, magnitude of pH change and ruminal pH variance were greater ($P < 0.04$) for 1-STEP compared to 4-STEP for F2. Abruptly transitioning cattle from RAMP to high-grain finishing diets containing 47.5% Sweet Bran decreased average pH while increasing time below pH 5.3 and pH variation compared to the 4-STEP system. Eating behavior was affected by 1-STEP with cattle eating longer each day when compared to 4-STEP. This change in behavior was likely due to lower ruminal pH but could reduce acidotic insults if this behavior continues throughout feeding period.

Table 2. Effects of 4-STEP or 1-STEP adaptation methods on intake, intake behavior, and ruminal pH the first six days cattle were fed finisher 1 (F1) and finisher 2 (F2).

	First 6 days of F1			First 6 days of F2		
Item	4-STEP	1-STEP	*P*-value	4-STEP	1-STEP	*P*-value
DMI, lb/day	27.2	25.2	0.53	23.8	27.4	0.40
Intake Rate, %/hour	16.9	20.6	0.12	17.4	18.7	0.47
Eating time, min	310	368	0.02	304	397	0.07
Meals/day, n	9.5	8.9	0.77	8.7	9.1	0.65
Average pH	5.84	5.60	0.03	5.83	5.64	0.02
Maximum pH	6.63	6.37	<0.01	6.49	6.58	0.23
Minimum pH	5.26	5.07	0.06	5.29	5.04	0.01
pH change	1.38	1.29	0.47	1.20	1.55	0.03
pH variance	0.127	0.099	0.44	0.084	0.158	0.04
Time < 5.6, min	471	807	0.03	403	762	0.01
Area < 5.6[1]	96	217	0.02	71	210	0.02

[1]Area under curve (magnitude of pH < 5.6 by minute).

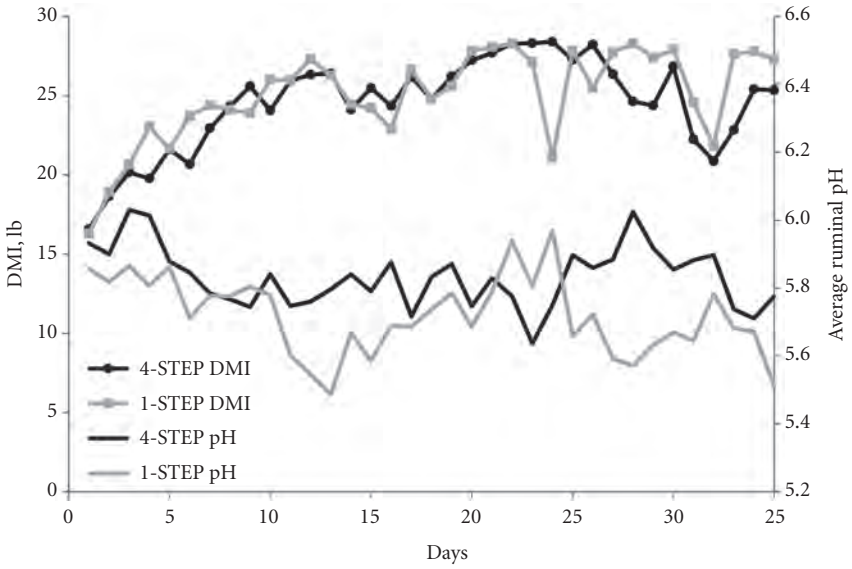

Figure 1. DMI and average ruminal pH of cattle transitioned to a finishing in 1-STEP or 4-STEPs.

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Using RAMP® for Receiving Cattle Compared to Traditional Receiving Diets

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Summary

Performance of newly arrived 570 lb steer calves fed RAMP or a control ration was evaluated in two trials completed in 2010 and 2011. Treatment diets were fed for an average of 31 days in year1 and 24 days in year 2. Diets included a control receiving diet consisting of alfalfa hay, Sweet Bran®, dry rolled corn, and supplement or RAMP which is a complete starter ration containing a high level of Sweet Bran and a minimal amount of forage. Across both years, RAMP improved F:G but was due to increased ADG in year 1 and decreased DMI in year 2. Feeding RAMP to newly arrived calves improved feed efficiency the first three weeks cattle were in the feedlot.

Introduction

RAMP is a complete starter ration developed by Cargill, which contains a high level of *Sweet Bran* and a minimal amount of forage. RAMP is intended to serve as an alternative to a mixture of grain and forage for receiving cattle or adapting cattle to grain, therefore eliminating a large portion of the forage needed in feedlots and the need to mix a starter diet. Feeding RAMP to newly received calves has been shown to increase ADG and improve F:G (*2012 Nebraska Beef Cattle Report,* p. 87). The objective of this study was to repeat the previous study completed in 2010 in order to compare performance and health characteristics of cattle fed RAMP during the receiving period to cattle fed a traditional receiving diet across multiple years.

Procedure

Two receiving trials were conducted in October of 2010 and 2011 at the University of Nebraska–Lincoln Agricultural Research and Development Center (ARDC) near Mead, Neb.. to evaluate effects of feeding RAMP on cattle performance during the receiving period. Crossbred steers (year 1: n=642; BW= 582±27.1 lb, year 2: n=758; BW= 567±33.7 lb) were received over two consecutive days in 2010 and 2 days, one week apart in 2011. Steers were blocked by arrival date and location within the feedlot yielding 2 blocks in year 1 and 3 blocks in year 2. Cattle were allocated randomly based on processing order to 34 pens in year 1 and 44 pens in year 2, resulting in approximately 15 to 20 steers per pen balanced within replications. During processing in year 1, steers were identified with an individual ear tag, individually weighed, vaccinated with Bovishield™ Gold 5, Somubac®, and Dectomax® Injectable, and orally drenched with Safe-Guard. Thirteen days after initial processing, cattle were revaccinated with Bovishiel Gold 5, Ultrabac® 7/ Somubac, injected with Micotil and weighed. Processing in year 2 was the same as year 1 with the following exceptions: Safe-Guard was not administered and cattle were not revaccinated until the end of the trial and were not given Micotil.

Treatments included a control receiving diet (CON;35% alfalfa hay, 30% Sweet Bran, 30% dry rolled corn, and 5% supplement; DM basis) and RAMP, a complete starter ration (formulated and provided by Cargill Inc, Blair, Neb.) that contained a high level of Sweet Bran with a minimal amount of forage. All diets contained 25 g/ton Rumensin and 12 mg lb thiamine. Steers were offered *ad libitum* access to treatment diets for 30 or 31 days in year 1 and 21, 24, or 28 days in year 2 (by block). Following the feeding period, cattle were limit-fed a common diet (47.5% Sweet Bran, 23.75% grass hay, 23.75 alfalfa hay, and 5% supplement; DM basis) at 2% of BW for five days before collecting ending BW to minimize variation in gut fill. Ending BW were averages of two-day weights. Initial BW was not shrunk because steers were weighed within 12 hours of arrival and had no access to feed before weighing.

Performance data for both years were analyzed using the MIXED procedure of SAS (Sas Inst. Inc., Cary, N.C.) with pen as the experimental unit. Treatment, year, and treatment × year were treated as fixed effects and block as a random effect. Incidence of Bovine Respiratory Disease (BRD) was evaluated as the rate of respiratory illness or the number of steers treated for BRD in a pen divided by the number of steers in that pen. Incidence of BRD was then analyzed using the GENMOD procedure of SAS. Incidence of BRD was affected by year and DMI, consequently the final model contained DMI, treatment, and year. No significant effect of block or treatment × year existed so they were removed from the model. Treatment means for BRD incidence were calculated using the PROC MEANS function of SAS.

Results

There was a year × treatment interaction for ADG ($P = 0.05$) and DMI ($P < 0.01$), therefore performance data are presented by year in Table 1. Feeding RAMP increased ADG ($P < 0.01$) compared to CON in year 1, but in year 2 ADG was not different ($P = 0.93$). In year 1, DMI was not different ($P = 0.11$). However in year 2, CON cattle had greater DMI

Table 1. Performance of cattle fed RAMP® or a control receiving diet in 2010 or 2011.

	2010		2011		*P*-values	
Item	Control	RAMP	Control	RAMP	Treatment[1]	Treatment × year
Initial BW, lb	576	577	572	572	0.88	0.88
Ending BW, lb	673	686	658	659	0.31	0.26
DMI, lb/day	15.7[a]	16.2[a]	14.0[b]	12.8[c]	0.04	0.05
ADG, lb	3.24[a]	3.59[b]	3.51[ab]	3.53[ab]	0.11	<0.01
Feed:Gain[2]	4.80	4.46	3.98	3.63	<0.01	0.55
Incidence of BRD, %	5.5	7.1	12.7	16.4	0.28	0.49

[1]Main effect of treatment across years.
[2]Data analyzed as G:F with the inverse presented as F:G.
[a,b]Means within a row without a common superscript are different ($P < 0.10$).

($P < 0.01$) compared to cattle fed RAMP. No year × treatment interaction was observed for F:G or incidence of BRD. Across both years, RAMP improved ($P<0.01$) F:G compared to CON (4.39 and 4.05, respectively). Incidence of BRD was not different ($P = 0.27$) due to treatment across years (9.6 and 12.4% for CON and RAMP, respectfully). Starting cattle on RAMP improves F:G early in the feeding period when compared to a traditional receiving diet.

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Utilization of Soybean Hulls When Fed in Combination with MDGS in Finishing Diets

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Summary

A finishing trial evaluated the effects of feeding different levels of soyhulls with modified distillers grains plus solubles (MDGS) on feedlot cattle performance. Soyhull inclusion level was 0, 12.5, 25, or 37.5% of diet DM. As soyhulls replaced dry rolled corn (DRC), ADG decreased linearly (4.22 vs 3.48) and F:G increased linearly in response to increasing levels of soyhulls. When comparing the feeding value of soyhulls relative to corn, feeding values decreased from 70 to 60% of corn as dietary inclusion of soyhulls increased from 12.5 to 37.5% of DM. Results show that as inclusion of soyhulls in the diet increase, ADG and F:G becomes poorer.

Introduction

Soybean hulls are a co-product from the soybean processing industry, where the soybean is de-hulled leaving a highly digestible, fibrous feed. Previous research (*Journal of Animal Science,* 2010, 88:E143) with diets including 35% soyhulls along with distillers grains, improved animal performance when compared to traditional corn-corn silage based diets. With this, minimal research exists when feeding different levels of soyhulls in place of corn in diets containing distillers grains plus solubles. Therefore, the objective of this experiment was to 1) determine optimum level of soyhulls in a feedlot finishing diet with modified distillers grains plus solubles (MDGS) and 2) assess the energy value of soyhulls relative to corn.

Procedure

A 117-day finishing study was conducted at the University of Nebraska–Lincoln Haskell Agricultural Laboratory in Concord, Neb. A randomized block design utilized 167 crossbred yearling steers (871 ± 48 lb). Prior to initiation of trial, steers were limit fed at 2% BW (a common diet) for four days to limit gut fill variation. Initial BW was established by weighing steers on two consecutive days (days 0 and 1) with cattle stratified by BW, blocked by day 0 BW into three blocks (light, medium, heavy), and assigned randomly to pens. Pens were assigned randomly to one of four treatments with six or seven steers per pen and six pens per treatment.

Dietary treatments (Table 1) consisted of pelleted soyhulls (ADM, Fremont, Neb.) fed at 0, 12.5, 25, or 37.5% diet DM while replacing dry rolled corn (DRC). All diets included 25% MDGS, 15% corn silage, and 5% liquid supplement. The liquid supplement was formulated to provide 318 mg/steer Rumensin® and 90 mg/steer Tylan® daily. The supplement contained limestone, salt, trace minerals, and vitamins to meet animal requirements. The nutrient composition of soyhulls was 57% NDF, 13.2% CP, and 3.8% ether extract.

Steers were implanted with Revalor®-S on day 0 and harvested at Greater Omaha Pack (Omaha, Neb.) on day 118. Hot carcass weight (HCW) and liver scores were recorded on day of slaughter. After a 48-hour chill, USDA marbling score, 12th rib fat depth, and LM area were collected. A common dressing percentage of 63% was used to calculate carcass adjusted performance to determine final BW, ADG, and F:G. Yield grade was calculated from the following formula: 2.5 + (2.5 x 12th rib fat) – (0.32 x LM area) + (0.2 x 2.5 [KPH]) + (0.0038 x HCW).

The NRC (1996) model was used to predict animal performance based on dietary energy content and intake. With input variables of diet composition, initial BW, final BW, ADG, and DMI known, the energy value of soyhulls relative to corn was calculated for each pen. Total digestible nutrients were assumed to be 90% for corn, 72% for corn silage, and 112.5% for MDGS in all diets. The net energy (NE) adjusters for the 0% level were adjusted to equal observed ADG for that treatment. The NE adjusters were set at 80.2%. With NE adjusters held constant, the percent TDN value for soyhulls was adjusted until the observed ADG for each pen was met using observed DMI. The energy value was then calculated by taking the percent TDN value of soyhulls divided by percent TDN of corn for each level.

The feeding value of soyhulls relative to corn was calculated for each inclusion level of soyhulls by taking the G:F (the inverse of F:G) of soyhulls minus G:F of 0% inclusion level, divided by the 0% G:F, then divided by the decimal percentage of inclusion level of soyhulls.

Table 1. Diet composition for diets containing 0% to 37.5% soyhulls (DM basis).

	Soyhulls, % Diet DM			
Ingredient[1], %	0	12.5	25	37.5
DRC	55.0	42.5	30.0	17.5
MDGS	25.0	25.0	25.0	25.0
Soyhulls	—	12.5	25.0	37.5
Corn Silage	15.0	15.0	15.0	15.0
Supplement	5.0	5.0	5.0	5.0

[1]DRC = dry rolled corn; MDGS = modified distillers grains solubles.

Table 2. Effect of soyhulls inclusion on cattle performance and carcass characteristics.

	Soyhulls, % Diet DM					*P*-value	
Item	0	12.5	25	37.5	SEM	Lin.[1]	Quad.[2]
Performance							
Initial BW, lb	869	870	872	872	2	0.23	0.92
Final BW, lb[3]	1364	1343	1331	1279	11	<0.01	0.19
DMI, lb/day	26.8	26.6	26.9	25.9	0.2	0.04	0.10
ADG, lb	4.22	4.04	3.93	3.48	0.10	<0.01	0.19
Feed:Gain[4]	6.33	6.58	6.85	7.46		<0.01	0.37
Energy Value[5], %		88	84	82	4	<0.01	0.28
Feeding Value,[6] %		70	70	60			
Carcass Characteristics							
HCW, lb	859	846	839	806	7	<0.01	0.18
Marbling[7]	591	585	564	566	11	0.07	0.75
LM area, in^2	13.0	13.1	13.0	12.8	0.2	0.54	0.31
12th rib fat, in	0.49	0.47	0.48	0.48	0.03	0.78	0.82
Calculated YG	3.48	3.29	3.20	2.98	0.11	<0.01	0.90

[1]Lin. = *P*-value for the linear response to Soyhulls inclusion.
[2]Quad. = *P*-value for the quadratic response to Soyhulls inclusion.
[3]Calculated from carcass weight, adjusted to 63% common dressing percent.
[4]Analyzed as G:F, the reciprocal of F:G.
[5]Calculated from percent TDN of soyhulls, divided by percent TDN of corn (90%).
[6]Percent of corn feeding value calculated as percent different in G:F from control divided by inclusion.
[7]Marbling Score: 400 = Slight, 500 = Small, 600 = Modest, etc.

Performance and carcass characteristics were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C). Pen was the experimental unit and block was treated as a fixed effect. Orthogonal contrasts were constructed to determine the response curve (linear, quadratic, and cubic) for soyhulls level in the diet.

Results

As soyhulls level increased (Table 2), DMI decreased linearly ($P = 0.04$) as did ADG ($P < 0.01$). A 4.3% decrease in ADG was observed between levels 0% and 12.5% soyhulls, and a 17.5% decrease between 0% and 37.5% soyhulls. Feed conversion (F:G) increased linearly ($P < 0.01$) as levels of soyhulls increased, with a 3.9% increase in F:G observed from 0 to 12.5% soyhulls. Level of soyhulls had no effect on LM area or 12th rib fat, but showed a tendency ($P = 0.07$) for a linear decrease in marbling score. Both yield grade and HCW decreased linearly ($P < 0.01$) as inclusion of soyhulls in the diet increased, with steers fed 0% soyhulls having 53 lb heavier HCW than those fed 37.5% soyhulls.

The energy values of soyhulls relative to corn decreased linearly ($P < 0.01$) from 88 to 82% when inclusion of soyhulls increased from 12.5 to 37.5% in finishing diets. Feeding values of soyhulls were 70, 70, and 60% of corn when soyhulls were included at 12.5, 25, or 37.5% diet DM, respectively. These values were much lower than the values observed when using the NRC model. When looking at animal performance (i.e., ADG), the NRC model appears to overestimate the energy value of soyhulls, especially at higher inclusion levels. A reduction of 2% in energy value of soyhulls when comparing 25 to 37.5% inclusion doesn't explain the loss in gains that was actually observed. Therefore, the use of feed conversion (G:F) may accurately predict the feeding value of soyhulls observed by producers.

These data suggest that with increasing levels of soyhulls in the diet, DMI and ADG decrease; and F:G increases. As inclusion level of soyhulls increased, the cattle were leaner and lighter with same days on test. Based on results of this study, it appears that soyhulls should be included at levels of 12.5% or less in finishing diets for yearling steers and the price relative to corn is critical for economics. In contrast, a calf-fed study conducted with soyhulls in combination with wet distillers grains plus solubles (*2013 Nebraska Beef Cattle Report,* pp. 88-89) suggests that response to levels of soyhulls was much better than in the current study. Differences observed between studies could be partially attributed to the type and inclusion level of distillers grains utilized.

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Effects of Feeding Increasing Levels of Soyhulls in Finishing Diets with WDGS

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Summary

The effects of including 0, 12.5, 25, or 37.5% soyhulls fed in combination with 40% wet distillers grains solubles (WDGS) were evaluated. Gain was greatest at the 12.5% inclusion level, but similar ADG was observed between 0 and 25% inclusion levels. Feed conversion (F:G) decreased by 2.4% and HCW increased 13 lb when including 12.5% soyhulls in the diet compared to steers fed 0% soyhulls. Therefore, results from this study suggest that 12.5% soyhulls can replace a portion of corn in finishing diets that contain WDGS and achieve greater performance when fed to calf-feds.

Introduction

The use of co-products, such as soybean hulls, is rarely included in the finishing ration at elevated levels. Previous research, (*2013 Nebraska Beef Cattle Report,* pp. 86-87) has demonstrated that with increasing dietary inclusion of pelleted soyhulls, performance of steers decreased linearly, along with the feeding value relative to corn. However, this research was performed with yearling steers along with the use modified distillers grains plus solubles (MDGS) in the diet. Therefore, our objective was to determine the optimum level of ground soyhulls, replacing corn, when fed with wet distillers grains plus solubles (WDGS) in finishing diets for calf-feds.

Procedure

Crossbred steer calves (n = 160, BW = 801 ± 36 lb) were utilized in a randomized block design. Prior to initiation, steers were backgrounded for approximately 45 days. Dietary treatments (Table 1) consisted of ground soyhulls (ADM, Lincoln, Neb.) at 0, 12.5, 25, and 37.5% diet DM while replacing a 1:1 blend of dry rolled corn (DRC) and high moisture corn (HMC). Wet distillers grains plus solubles (40%), sorghum silage (8%), and supplement (4%) were included in all diets. The supplement was formulated for 30 g/ton of Rumensin® and to provide 90 mg/steer daily of Tylan®. Cattle were adapted over a 17-day period by increasing the inclusion of corn blend and soyhulls, while decreasing the level of sorghum silage from 35 to 8% (DM). The nutrient composition of soyhulls was 57% NDF, 12.9% CP, and 3.7% ether extract.

Prior to initiation of trial, steers were limit fed (a common diet) at 2% BW for five days to minimize variation in gut fill. Steers were weighed two consecutive days (days 0 and 1) to establish initial BW. Calves were blocked by day 0 BW, stratified by BW within blocks (light, medium, heavy), and assigned randomly to pen. Pens were assigned randomly to one of four treatments with eight steers per pen and five pens per treatment. The energy values and feeding values of soyhulls were calculated the same way as a previous study (*2013 Nebraska Beef Cattle Report,* pp. 89-90). Total digestible nutrients were assumed to be 90% for DRC, 93% for HMC, 60% for sorghum silage, and 117% for WDGS in all diets. The net energy (NE) adjusters for the 0% diet were adjusted to equal observed ADG for that treatment. The NE adjusters were set at 83.4% based on performance of the 0% diet. Pens were then evaluated where TDN of soyhulls was modified to equal observed ADG after setting observed DMI.

Steers were implanted on day 1 with Revalor®-IS, re-implanted with Revalor®-S on day 47, and harvested at Greater Omaha Pack, Omaha, Neb., on day 139. On day of slaughter, hot carcass weights (HCW) and liver scores were collected. After a 48-hour chill, USDA marbling score, 12th rib fat depth, and LM area were collected. Yield grade was calculated from the following formula: 2.5 + (2.5 x 12th rib fat) – (0.32 x LM area) + (0.2 x 2.5 [KPH]) + (0.0038 x HCW). Final BW, ADG, and F:G were calculated from HCW adjusted to a common dressing percentage (63%).

Table 1. Diet composition for diets containing 0% to 37.5% soyhulls (DM basis).

	Soyhulls, % Diet DM			
Ingredient[1], %	0	12.5	25	37.5
DRC	24.0	17.75	11.5	5.25
HMC	24.0	17.75	11.5	5.25
WDGS	40.0	40.0	40.0	40.0
Soyhulls	—	12.5	25.0	37.5
Sorghum Silage	8.0	8.0	8.0	8.0
Supplement[2]	4.0	4.0	4.0	4.0

[1]DRC = dry rolled corn; HMC = high moisture corn; WDGS = wet distillers grains solubles.
[2]Supplement formulated to provide 375 mg/daily Rumensin and 90 mg/daily of Tylan.

Table 2. Effect of soyhulls inclusion on cattle performance and carcass characteristics.

	Soyhulls, % Diet DM					*P*-value	
Item	0	12.5	25	37.5	SEM	Lin.[1]	Quad.[2]
Performance							
Initial BW, lb	791	792	793	793	1	0.20	0.64
DMI, lb/day	22.7	23.1	22.1	22.0	0.5	0.18	0.57
ADG, lb[3]	3.88	4.03	3.85	3.69	0.09	0.09	0.12
Feed:Gain[4]	5.85	5.71	5.75	5.95		0.45	0.12
Energy Value[5], %		86	98	94	7	0.84	0.46
Feeding Value[6], %		119	107	95			
Carcass Characteristics							
HCW, lb	836	849	834	821	8	0.13	0.13
Marbling[7]	580	573	573	565	18	0.57	0.99
LM area, in^2	12.84	12.92	12.98	13.16	0.24	0.35	0.83
12th rib fat, in	0.60	0.53	0.52	0.49	0.04	0.04	0.61
Calculated YG	3.58	3.43	3.33	3.19	0.13	0.06	0.98

[1]Lin. = P-value for the linear response to Soyhulls inclusion.
[2]Quad. = P-value for the quadratic response to Soyhulls inclusion.
[3]Calculated from carcass weight, adjusted to 63% common dressing percent.
[4]Analyzed as G:F, the reciprocal of F:G.
[5]Calculated from percent TDN of soyhulls, divided by percent TDN of corn (90%).
[6]Percent of corn feeding value calculated as percent different in G:F from control divided by inclusion.
[7]Marbling Score: 400 = Slight, 500 = Small, 600 = Modest, etc.

Performance and carcass characteristics were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C) with animals removed from analysis. Pen was the experimental unit and block was treated as a fixed effect. Orthogonal contrasts were constructed to determine the response curve (linear, quadratic, and cubic) for soyhulls level in the diet.

Results

Two steers died due to bloat, one fed 0% and one 37.5% soyhulls; two steers were removed from the study (one each on 25 and 37.5% soyhulls) due to bloat and not included in the analysis. As inclusion level of soyhulls in the diet increased, a tendency for a linear decrease in ADG ($P = 0.09$) was observed (Table 2). Numerically, response in ADG appeared quadratic with greatest ADG being observed at the 12.5% inclusion level resulting in 3.8 and 9.2% greater gains compared to inclusion levels 0 and 37.5%, respectively. No statistical differences in DMI across inclusion levels were observed ($P > 0.17$). Feed conversion (F:G) tended to respond quadratically ($P = 0.12$) with feed efficiency improving by 2.4% (0 vs 12.5%) and then slightly increasing at the 25% inclusion level, but numerically steers fed 25% soyhulls were still 1.7% more efficient than those fed 0% soyhulls. There were no differences in HCW, marbling score, or LM area ($P > 0.12$); however, numerically steers fed 12.5% soyhulls resulted in 13 lb heavier HCW (0 vs 12.5%) and also 28 lb greater than 37.5%. As inclusion level increased, 12th rib fat decreased linearly ($P = 0.04$), as did calculated yield grade ($P = 0.06$).

The energy values relative to corn were 86, 98, and 94% at soyhull inclusion levels of 12.5, 25, and 37.5%, respectively. Based on animal performance, the energy value at 12.5% does not support the response in performance that we observed and appears to be underestimating the energy value of soyhulls. With the use of G:F (the inverse of F:G), the feeding value of soyhulls was calculated for 12.5, 25, and 37.5% inclusion. Feeding values were 119, 107, and 95% of corn, respectively. These values reflect the performance responses that were observed resulting in a more accurate assessment for producers when comparing the feeding value of soyhulls to corn in diets that contain WDGS.

Feeding up to 25% soyhulls may effectively reduce the inclusion level of corn in the diet and achieve similar gains with lower feed conversions. Gain was numerically greatest at the 12.5% level where feed conversions were lowest. This study would suggest that the optimum inclusion level of soyhulls in the finishing diet is 12.5%, resulting in increased ADG, decreased F:G, and increased HCW when fed to calf-feds. This response is different than a similarly designed study conducted with yearlings where we observed poorer ADG and F:G with increasing levels of Soyhulls (*2013 Nebraska Beef Cattle Report,* p. 86-87).

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Including NEXT ENHANCE® Essential Oils in Finishing Diets on Performance With or Without Rumensin® and Tylan®

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Summary

Finishing cattle performance was evaluated using NEXT ENHANCE essential oils in finishing diets. Treatments consisted of 1) control (CON), 2) NEXT ENHANCE at 300 mg/day (NE), 3) Rumensin and Tylan at 360 and 90 mg/day, respectively (RT), or 4) NEXT ENHANCE plus Rumensin and Tylan (NERT). No NEXT ENHANCE by Rumensin/Tylan interaction was observed. Steers fed Rumensin/Tylan had decreased F:G and increased live final BW and marbling score. The prevalence of liver abscesses decreased 46% when steers were fed Rumensin/Tylan. Including NEXT ENHANCE in finishing diets did not impact performance or carcass characteristics.

Introduction

Increasing feed costs is a major driver in determining profitability for producers. Today, feed additives are included in rations to improve production efficiency (i.e., feed efficiency); therefore, increasing the likelihood of economic returns. NEXT ENHANCE is a nature plant extract composed of garlic oil and cinnamaldehyde that previously has been shown to alter rumen fermentation and improve ADG and feed efficiency. Therefore, the objective of this study was to evaluate the effects of NEXT ENHANCE essential oils on performance and carcass characteristics of cattle fed finishing diets with or without Rumensin and Tylan.

Procedure

Calf fed steers (n = 400; BW = 642 ± 64 lb) were utilized in an experiment at the Panhandle Research Feedlot. Calves were processed within 24 hours of arrival with Bovi-Shield® Gold, Vision® 7, Somnubac®, Ivomec, were branded, and given an electronic and visual identification tag. Prior to initiation of trial and approximately six days from receiving, calves were limit fed a 50% alfalfa, 35% corn silage, and 15% wet distillers grains solubles (WDGS; DM basis) diet at 2% BW for seven days to eliminate gut fill variation. Steers were weighed consecutively on days 0 and 1 to establish initial BW, blocked by day 0 BW, stratified within blocks (light, medium, heavy), and assigned randomly to 40 pens (10 steers/pen). Treatments (n=4) were assigned randomly to pens. On day 9, all steers were re-vaccinated with Bovi-Shield® Gold and Somnubac and implanted with Component® TE-IS. Steers were re-implanted on day 80 with Component TE-S.

A common basal diet was used for all four treatments (Table 1) consisting of 53% dry rolled corn, 25% WDGS, 16% corn silage, and 6% supplement (DM basis). Only one basal supplement was used and feed additives were included via micromachine. Treatments consisted of a control containing no additives (CON), NEXT ENHANCE formulated at 300 mg/d (NE), Rumensin and Tylan formulated at 360 and 90 mg/day, respectively (RT), or NEXT ENHANCE formulated at 300 mg/day plus Rumensin (360 mg/day) and Tylan (90 mg/day; NERT). The experiment was a randomized block design with a 2x2 factorial arrangement of treatments. One factor was the presence or absence of NE and the other factor was presence or absence of RT.

Table 1. Composition of dietary treatments.

Ingredient	% of diet DM
DRC[1]	53
WDGS[1]	25
Corn Silage	16
Supplement	6
Nutrient Composition, %	
CP	13.9
Ca	0.52
P	0.40
K	0.92
Ether Extract	4.84
NDF	22.3
Starch	42.4

[1]DRC = dry rolled corn; WDGS = wet distillers grains plus solubles.

Cattle from the medium and heavy blocks were harvested on day 141 and the light block on day 161 at Cargill Meat Solutions (Fort Morgan, Colo.). Data collected were HCW, LM area, marbling score, 12th rib fat depth, and liver scores. Yield grade was calculated from the following formula: 2.5 + (2.5 x 12th rib fat) – (0.32 x LM area) + (0.2 x 2.5 [KPH]) + (0.0038 x HCW). Final BW, ADG, and F:G were calculated using a common dressing percentage of 63%.

During the study, four steers died on treatment NE due to BRD, urinary calculi, or brisket disease (2,1,1), respectively. BRD was the cause of one dead on both NERT and RT treatments. Two steers were removed due to lameness or BRD and one animal died from urinary calculi on CON treatment. Animal performance and carcass characteristics were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, N.C) with pen being the experimental unit and animals removed from analysis. The model included the effects of additive, oil, and additive x oil interaction. Occurrences of liver abscesses were

Table 2. Effect of including feed additives on cattle performance and carcass characteristics.

Item	Treatment[1]				SEM	*P*-value		
	CON	NE	RT	NERT		NE[2]	RT[3]	NE x RT[4]
Performance								
Initial BW, lb	650	650	650	650	47	0.44	0.80	0.70
Final BW, lb[5]	1226	1232	1246	1243	41	0.81	0.07	0.59
DMI, lb/day	22.3	22.5	22.1	22.1	0.6	0.58	0.16	0.46
ADG, lb[5]	3.91	3.95	4.04	4.02	0.11	0.85	0.07	0.61
Feed:Gain[5]	5.68	5.68	5.46	5.46	0.03	0.87	<0.01	0.96
Carcass Characteristics								
HCW, lb	773	777	785	783	26	0.80	0.07	0.59
Dressing, %	62.7	62.8	62.6	62.4	0.2	0.98	0.27	0.53
Marbling[6]	522	530	557	554	11	0.76	<0.01	0.48
LM area, in^2	12.20	12.09	11.99	12.16	0.14	0.75	0.46	0.15
12th rib fat, in	0.58	0.60	0.61	0.59	0.02	0.90	0.55	0.17
Calculated YG	3.39	3.48	3.56	3.46	0.11	0.92	0.19	0.10
Liver abscess[7], %	24.7	29.2	13.1	16.2	—	0.37	<0.01	0.97
A, %	9.4	13.5	4.0	9.1	—	0.10	0.08	0.56
A+, %	14.6	15.6	9.1	7.1	—	0.77	0.03	0.59

[1]CON = Control, NE = NEXT ENHANCE, RUMT = Rumensin+Tylan, NERT = NEXT ENHANCE + Rumensin+Tylan
[2]NE = *P*-value for the main effect of NEXT ENHANCE inclusion.
[3]RT = *P*-value for the main effect of Rumensin/Tylan inclusion.
[4]NE x RT = *P*-value for the NEXT ENHANCE x Rumensin/Tylan interaction.
[5]Calculated from carcass weight, adjusted to 63% common dressing percent.
[6]Marbling Score: 400 = slight, 500 = small, 600 = modest, etc.
[7]Liver score: A = 3 or 4 abscesses; A+ = 4+ abscesses.

analyzed using the GLIMMIX procedure of SAS.

Results

No interactions were observed in this study (Table 2); therefore, only the main effects will be discussed. Feeding NE at 300 mg/day had no effect on DMI, ADG, or F:G ($P \geq 0.58$), suggesting the use of NE showed no statistical impact on animal performance. There was a tendency ($P = 0.07$) for increased final BW and ADG when including RT in the diet. A 3.9% decrease ($P < 0.01$) in F:G was observed with the use of RT. The main effect of NE had no impact ($P \geq 0.75$) on HCW, marbling score, LM area, or 12th rib fat. Cattle fed RT showed a tendency ($P = 0.07$) for a 9 lb increase in HCW and also a significant increase ($P < 0.01$) in marbling score. As expected, with the presence of RT, incidence of liver abscesses decreased 46% ($P < 0.01$).

In summary, feeding NE in finishing diets did not influence DMI, ADG, F:G, or carcass characteristics. When Rumensin and Tylan are included in the diet, data from this study shows that F:G was improved and prevalence of liver abscesses decreased.

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The Effect of Commensal Microbial Communities on the Fecal Shedding of Shiga Toxin-Producing *E. coli* (STEC) in Beef Cattle

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Summary

This ongoing study compares the gut microbial community composition between shedding steers high in shiga toxin-producing E. coli (STEC) counts and low-shedding steers. Shedders were identified among 170 beef animals over three time periods using selective microbiological culture media. The isolated bacterial cultures were confirmed to be STEC using PCR, 16s rRNA sequencing and a shiga toxin immunoassay. The most abundant strains found in the cattle feces were those belonging to the serogroups O111 (40.3%) and O157:H7 (37.3%), with O103 (8.3%), O26 (6.0%), O83 (4.5%), and O55 (3.0%) being detected in much lower numbers . Out of the 52 animals which were identified as super-shedders of STECs which were selected for microbial community analysis, 61.54% shed STEC in at least two of the three sampling time points. Currently, work is being carried out to evaluate the microbial community composition of the identified STEC high-shedding and low-shedding cattle populations using 454-pyrosequencing.

Introduction

Shiga toxin-producing *E. coli* (STEC) have been a major public health concern in recent times because of their association with foodborne disease outbreaks. This has resulted in many recalls that have been costly to the beef industry and has also impacted consumer confidence.

The major serotype of public health significance within the STEC group is *E. coli* O157:H7 and much effort has been expended to understand the prevalence, transmission, and disease-causing traits of this organism. However, the other strains of STEC, such as O111, O103, O145, O45, O26, O121 and many more, commonly referred to as the non-O157 STEC, have not received nearly as much attention and as a consequence, relatively little is known about their ecology in cattle and disease-causing capacity in humans. In the backdrop of last year's outbreak of hemolytic uremic syndrome (HUS) and hemorrhagic colitis in Germany, caused by *E. coli* O104:H4 the importance of detecting and reducing non-O157:H7 STEC shedding is critical.

Reducing the load of pathogenic STEC at pre-harvest can lead to significant improvements in the safety of beef. It has been shown that the prevalence of STEC among cattle in a pen varies widely (*2001 Nebraska Beef Cattle Report*, p. 81). The exact reason(s) why certain animals within a pen shed high numbers of STEC whilst others that comingle with them within the same pen do not shed is currently unknown. To this end, we hypothesize that competition for nutrients, colonization space, etc. between STEC and native microbial communities within the intestinal tract of cattle may play a role to determine whether a steer sheds or not and whether the animal becomes a high-shedder or low-shedder. Using high throughput genome-sequencing technologies we aim to characterize the microbial communities of STEC high-shedding and low-shedding cattle populations to identify particular microbial populations which may have a protective effect against the colonization of cattle by STEC.

Procedure

During August and September 2011, rectal grab samples of feces were collected weekly for three weeks from 170 animals housed at the UNL research facility Agricultural Research and Development Center (ARDC) near Mead, Neb. Each of these fecal samples was subjected to microbiological analysis to detect and quantify Shiga toxin-producing E. coli (STEC) in feces. Briefly, for each fecal sample 10 g was diluted in 90 ml of phosphate-buffered tryptic soy broth and was blended with a stomacher (AES Laboratoire, France) at 200 rpm, for one minute. From each fecal suspension, a 1-ml aliquot was removed and 50 microliters was plated on the surface of a CHROMagar™ STEC plate (CHROMagar, Paris, France) using a spiral plater (IUL Instruments, Barcelona, Spain) and incubated overnight at 42°C. Characteristic colonies (mauve color) were counted and the number of STEC/g of feces was calculated. Based on these results, candidate STEC high-shedding and low-shedding animals were identified. Four characteristic STEC colonies were selected from each high-shedding fecal sample and cultured in Tryptic Soy Broth. These cultures were then archived until further analysis to confirm shiga toxin production. To determine the serotype(s) of STEC, DNA was extracted from the archived bacterial cultures of the 52 highest-shedding steers using the Quick Extract™ bacterial DNA extraction solution (Epicenter Biotechnologies, Madison, Wisc.) according to manufacturer's protocol. The full length 16s rRNA gene was amplified with the polymerase chain reaction (PCR) using universal 16s rRNA primers (Park et al., 2003) and sequenced after puri-

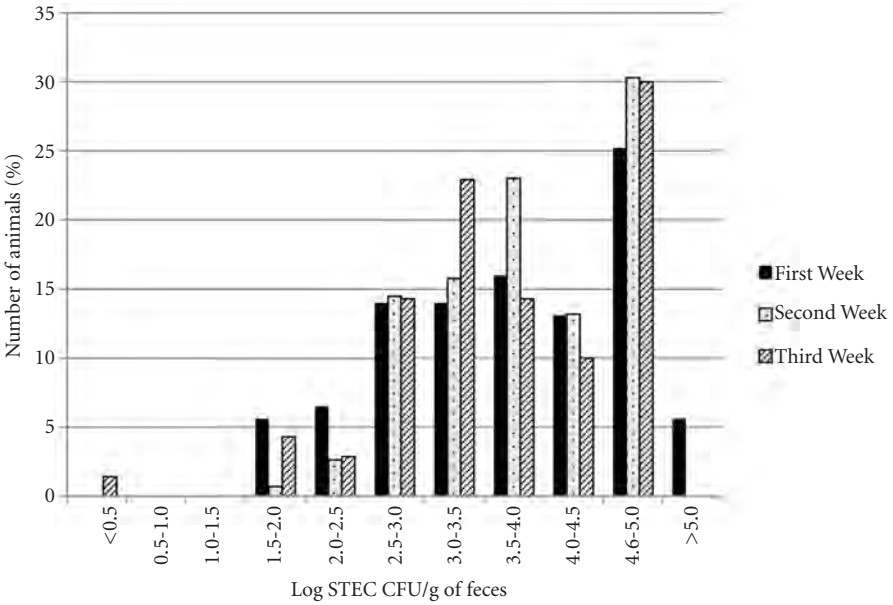

Figure 1. Number of beef animals associated with different levels of STEC shedding during all three sampling time points.

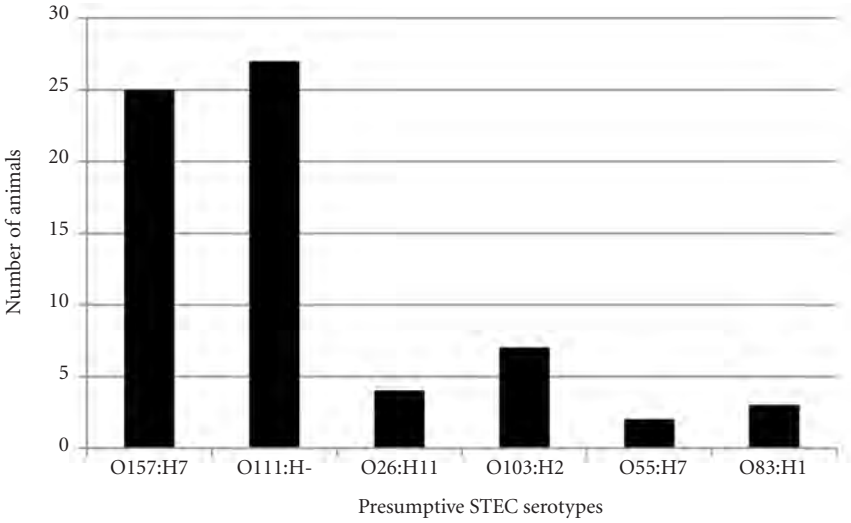

Figure 2. Number of animals shedding different STEC serotypes based on sequence matches to known sequences available in RDP Database.

fication using shrimp alkaline phosphatase and exonuclease I treatment (Sambrook, Fritsch, and Maniatis, 1989). The 16s rRNA sequences that were generated were compared to known 16s rRNA sequences of bacteria using the Ribosomal Database Project (*http://rdp.cme.msu.edu/*) and sequences available at the National Center for Biological Information (NCBI). The bacterial cultures were also screened for the presence of shiga toxin genes (*stx* 1 and *stx* 2) using PCR as described previously (Paton and Paton, 1998) serotype specific primers and also for the production of shiga toxin(s) using the ProSpecT Shiga Toxin *E. coli* Microplate Assay (Remel, Lenexa, Kansas) to further confirm that the particular isolates were STEC.

Results

Figure 1 presents the number of cattle associated with different levels of STEC shedding during the three sampling time points. Animals shedding >4 log cfu/g of feces were considered to be high shedders and those shedding ≤2.5 log cfu/g were considered to be low-shedders. Among the 52 high shedding animals selected for microbial community analysis, 16 (30.77%) shed STEC at levels >4 log cfu/g of feces during all three sampling time points, and 32 (61.54%) shed STEC at levels >4 log cfu/g of feces in at least two of the three sampling time points. However, three animals that started off as low-shedders during the first week were shedding STEC at high levels by the third week and one animal which started as a high-shedder in the first week was shedding low levels of STEC in the third week. In the first week of sampling, 6 animals shed STEC in excess of 5 log cfu/g of feces but during the second and third week none of the animals shed STEC at such high levels.

Figure 2 represents the number of beef steers shedding different serotypes of STEC based on 16s rRNA sequencing results, serotype specific PCR and Latex agglutination tests. The most common serogroups found in the cattle feces were those belonging to the serogroups O111 (40.3%) and O157 (37.3%), with O103 (8.3%), O26 (6.0%), O83 (4.5%), and O55 (3.0%) being encountered in much lower numbers.

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Hormonal Residues in Feedlot Pens and Runoff

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Summary

Two identically designed trials were conducted in separate years at the University of Nebraska Haskell Agricultural Laboratory, Concord, Neb., using 192 crossbred heifers (96/trial). Within a trial, heifers were assigned randomly to 2 groups (3 pens/group): 1) treatment (TRT) animals were administered synthetic hormones via subcutaneous implants (Ralgro and Revalor-H) and fed Melengesterol Acetate (MGA), or 2) control (CON) animals with no synthetic hormone provided.

Gains and feed conversions were 18.8 and 7.5% better, respectively, for TRT, while CON had 16.7% greater choice and prime carcasses. In runoff samples, progesterone was greater for CON. With the exception of androsterone, average hormonal concentrations in pen surface samples were less than 11 ng/g and concentrations of all compounds were not different across treatments. Results indicate that low levels of both natural and synthetic hormones are found on the feedlot surface and in runoff from feedlot pens.

Introduction

Over 90 percent of the cattle fattened in the United States are finished in feedlots on diets high (70-80%) in grain. Of the feedlots in the U.S., approximately 90 percent administer growth hormones by implants. These growth promoting implants are manufactured from compounds that mimic steroidal hormone activity in the animal. There is rising concern that natural and synthetic hormones found in livestock waste could reach groundwater and surface waters causing disturbances in aquatic ecosystems. The objective of this study was to quantify hormone concentrations in various stages of the manure pathway. No previous study has directly compared implanted and unimplanted cattle regarding the hormones found in manure. The data generated in this study provides an insight to the potential concentrations of both natural and synthetic steroid hormones leaving the feedlot (*Environmental Science & Technology*, 2012, 46:1352).

Procedure

For each of two identically designed trials, 96 previously processed (vaccinated with Vision 7 and Vista Once) heifers with an average weight of 852 pounds were assigned to 6 pens (3 pens/treatment) of 16 heifers/pen. Prior to the cattle going on test, pen preparation included removal of all manure deposited from previous studies and building up of mounds with fresh soil.

All cattle were fed a common ration at approximately 95% of ad libitum for 3 days prior to trial initiation, and had no access to water the night prior to processing to minimize fill differences. Upon trial initiation, cattle were re-weighed, re-vaccinated (Vision 7) and moved to the finishing ration. Also at trial initiation, cattle assigned the hormone treatments were implanted (Ralgro). All cattle were fed a common finishing ration for the duration of the trial, with the TRT cattle receiving an MGA supplement top-dressed in the bunk. On day 35, TRT cattle were re-implanted (Revalor-H) and all cattle were weighed. On average, cattle were on feed 126 days (year 1, 111 days; year 2, 141 days).

Data Collection

To minimize contamination, all personnel handling cattle wore nitrile gloves and boot covers any time cattle were handled and upon pen entry. Gloves and boot covers were also changed when moving from CON to TRT pens and CON cattle were always handled first.

Dry matter intakes were recorded daily and weights were obtained on days 1 and 35 as well as at trial termination.

Pen surface samples were collected prior to trial initiation, on days 7, 45, and upon termination of the trial. Prior to sampling, all equipment was cleaned with methanol. Each pen sample was a composite of 15 sub-samples taken from the pen

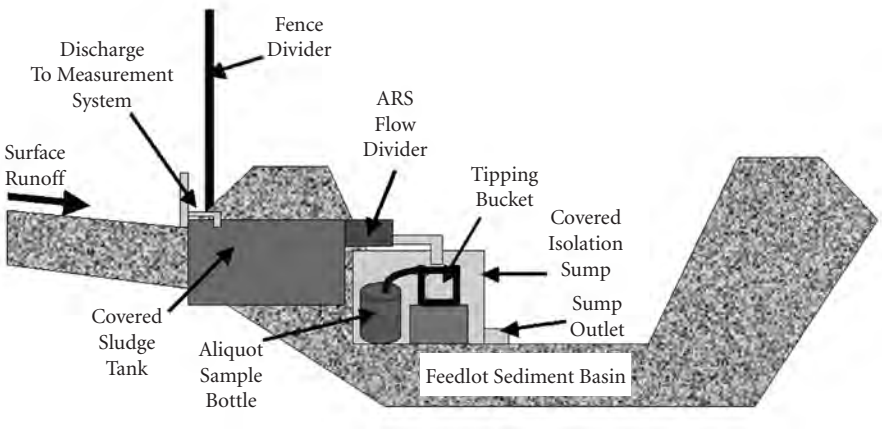

Figure 1. Diagram of runoff sampler.

Table 1. Performance and carcass data.

	CON	TRT	% Change
Heifers, n	96	96	10.2%
DMI, lb/day[1]	20.54	22.63	18.8%
ADG, lb/day[1,2]	2.84	3.37	-7.5%
F:G[2]	7.32	6.77	
Choice (Ch) + Prime (Pr), %	87.50	72.92	-16.7%
Yield Grade	2.85	2.96	3.7%

[1]($P < 0.05$)
[2]Based on a common dressing percent of 62.

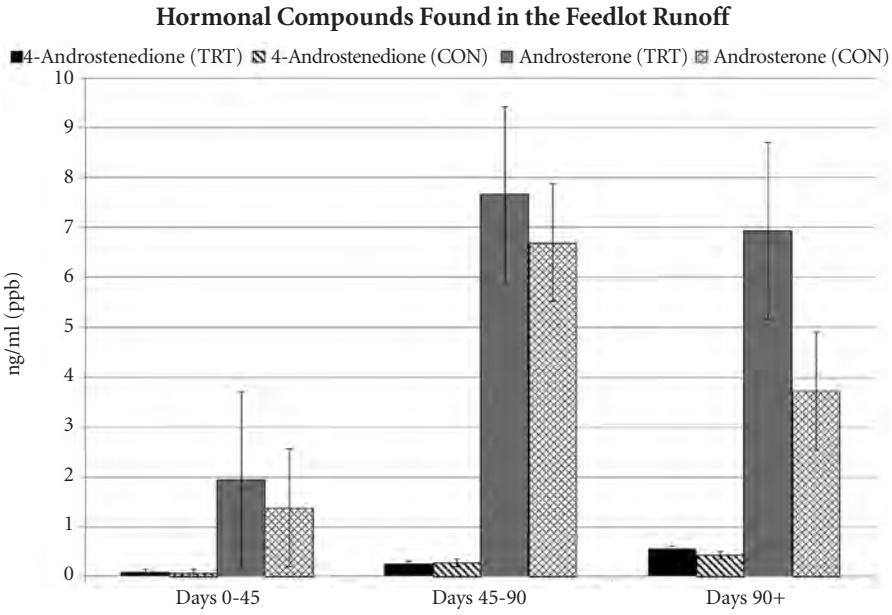

Figure 2. Androgenic compounds in feedlot runoff.

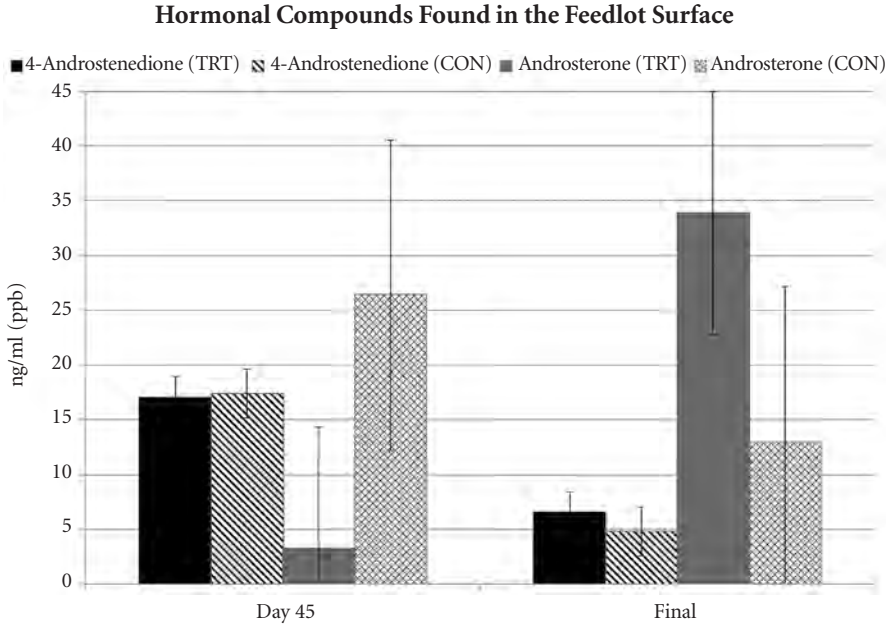

Figure 3. Androgenic compounds on the feedlot surface.

plus four sub-samples taken from the alley directly below the pen. Samples were obtained using a bulb planter pushed into the surface until hardpan was reached, but no more than 1 inch deep. Samples were stored in foil pouches inside plastic bags. During sampling, soil samples were held in a cooler with ice packs. Sampling always began in the CON pens. Different sampling equipment was used for the CON and TRT pens. Upon completion of each sampling day, all samples were placed in a freezer until analysis.

Runoff water samples were obtained from the alley below each pen during precipitation events during the post 45-day implant period of the first year and throughout the second year. To facilitate runoff sample collection, earthen berms were placed on the two sides and the down slope end of the alley below each pen. The runoff sampling device used in this study consisted of a galvanized steel tank fitted with a runoff splitter, tipping bucket mechanism, event data logger, and sampling jars, as shown in Figure 1. The tank served as a settling basin for large suspended materials which, if not removed, would have blocked the slots of the splitters. One-ninth of the runoff leaving the tank through the splitter was directed to the tipping bucket for flow volume measurement and runoff sampling. Tipping buckets were fitted with a pulse counter to count the number of tips during each runoff event. Data loggers were used to record the number of tips. The total volume of runoff was calculated using the total number of tips and the geometry of the tipping bucket.

Runoff water samples of approximately 250-300 mL were collected in amber glass collection jars during each runoff-creating rainfall event. Runoff and sediment samples were kept frozen until analysis. Data were analyzed using MIXED procedures of SAS (SAS Inst. Inc., Cary, N.C.). Pen was used as the experimental unit. Year and year x treatment effects

(Continued on next page)

were included in the model for data obtained over both years.

Results

The purpose of administering hormones is to improve performance, so enhanced performance of TRT groups was expected. The TRT cattle consumed 10.2 % more feed and had an 18.8% higher ADG but tended to have lower quality grades than CON cattle (Table 1). The TRT cattle tended to be more efficient but also tended to have more dark cutters.

Due to the large variation observed in some compounds, means and standard deviation are shown graphically (Figures 2-6). By the end of the study, hormonal compounds in both runoff and surface samples were not found to be significantly different, and for many of the compounds, levels were very small or undetectable.

In the runoff, androgens such as 4-androstenedione and androsterone were found to have the greatest numerical concentrations when compared to other compounds. Concentrations in TRT samples tended to be greater than in CON samples (Figure 2). At the end of the study, progesterone concentrations in the runoff were low (<1 ppb) but were found to be slightly greater in CON versus TRT pens.

Androgenic hormonal compounds were also found to be similar between TRT and CON samples in samples obtained from the feedlot surface (Figure 3).

There was a trend for zeranol compounds to be greater in CON pens, but by the end of the study, that trend was less apparent (Figure 4).

Of the estrogenic compounds shown in Figure 5, estrone and 17β-estradiol tended to be greater in TRT pens at the end of the trial.

Testosterone was not detected in the feedlot surface samples. Progesterone, as shown in Figure 6, in feedlot surface samples reflected a similar trend to that in the runoff. It tended to be greater for CON pens, which is likely due to these heifers not being fed MGA, thus they were going through active reproductive cycles.

Based on this study, it appears that synthetic hormones administered to beef cattle (particularly TBA) are metabolized and are generally not found on the feedlot surface and runoff. At the end of the study, nearly all hormonal compounds found were at low concentrations (<10 ppb). Further dilutions of these compounds could occur when the manure is spread on land application areas.

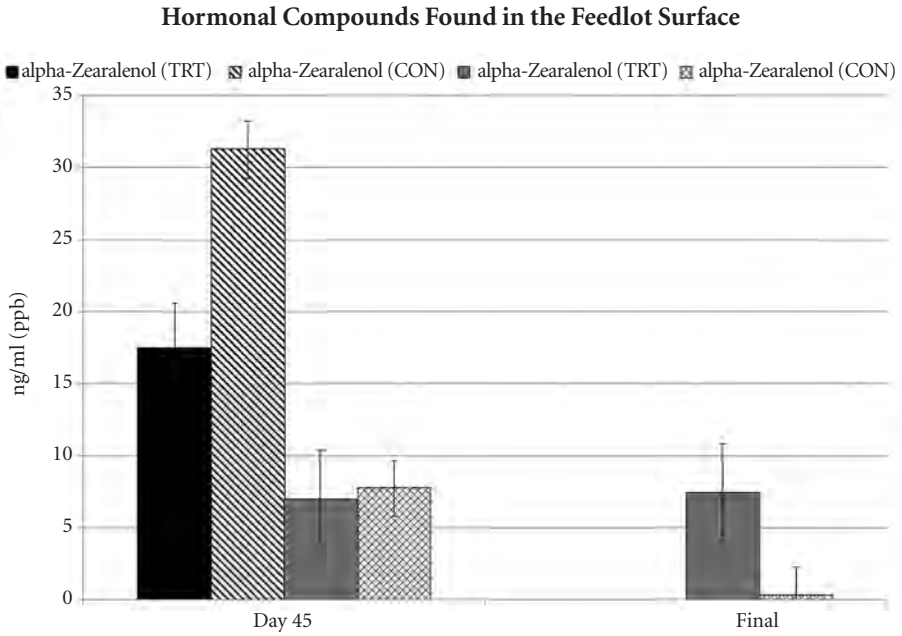

Figure 4. Zeranol compounds on the feedlot surface.

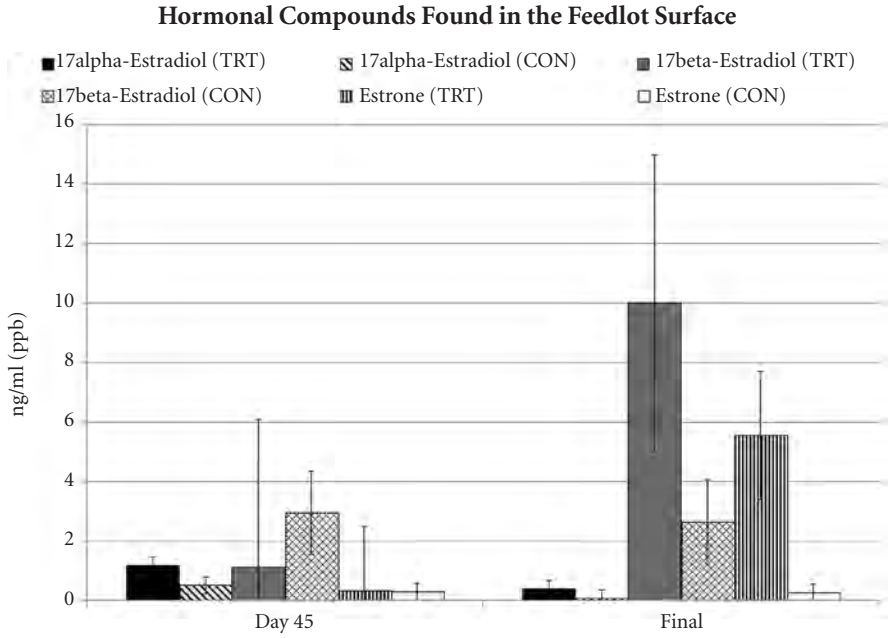

Figure 5. Estrogenic compounds on the feedlot surface.

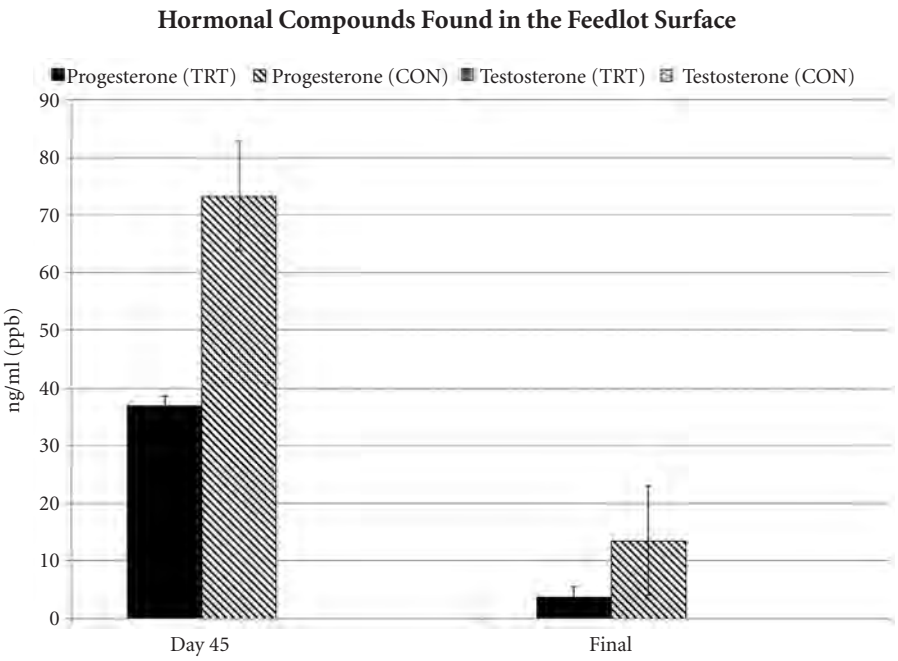

Figure 6. Progesterone and testosterone on the feedlot surface.

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[2] Funding provided by US EPA-STAR Program Grant Number R883423

Additional data from this study are published in: Effect of Growth Promotants on the Occurrence of Endogenous and Synthetic Steroid Hormones on Feedlot Soils and in Runoff from Beef Cattle Feeding Operations. Shannon L. Bartelt-Hunt, Daniel D. Snow, William L. Kranz, Terry L. Mader, Charles A. Shapiro, Simon J. van Donk, David P. Shelton, David D. Tarkalson, and Tian C. Zhang. *Environmental Science & Technology* 2012 *46* (3), 1352-1360.

Anaerobic Digestion of Finishing Cattle Manure

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Summary

Utilizing manure from cattle fed distillers grains in anaerobic digesters improved methane production and DM degradation of manure compared to manure from cattle fed no distillers grains. Manure from cattle fed in open lot pens had soil contamination which decreased OM content and led to decreased total methane production (L/day), but not when expressed as methane/g OM. If ash buildup is avoided, open lot manure can be used as anaerobic digester feedstock.

Introduction

A traditional grain ethanol system that utilizes distillers grains for cattle feed and cattle manure for biogas generation to power the ethanol plant has been referred to as a "closed loop" system. Distillers grains from the ethanol plant are fed to feedlot cattle and manure from the feedlot is used to feed anaerobic digesters. Biogas produced by anaerobic fermentation within the digester is then used to power the ethanol plant and excess heat from the ethanol plant can be used to heat the digester. The effluent or material removed from the digester can be used as fertilizer for crop production to produce grain for ethanol production. Numerous studies have looked at the impact of feeding distillers grains to cattle. Likewise, studies have evaluated optimal conditions for microbial growth within anaerobic digesters; but, not the impact of feeding distillers grains on manure digestion. Experiment 1 was conducted to determine if feeding distillers grains to cattle impacts manure characteristics and changes methane production within anaerobic digesters. Experiment 2 was conducted to determine if open lot manure with soil contamination is a viable feedstock for anaerobic digesters as a large majority of the cattle in Nebraska are fed in open lot pens.

Procedure

Seven small scale (1-L) anaerobic digesters were utilized to study biogas generation from feedlot cattle manure. In Experiment 1, manure treatment was due to diet fed and consisted of a corn based control diet (CONT) or manure from a diet with wet distillers grains plus solubles replacing 40% of the corn (WDGS). For Experiment 2, treatment was manure from two types of cattle housing systems. Manure was collected from cattle in complete confinement (LOASH) or from cattle fed in open lot pens with a soil surface (SOIL). Complete cattle diets are shown in Table 1. For both trials, digesters were continually stirred, temperature was maintained at 37°C (99°F) and pH was maintained between 6.5 and 7.5 through the addition of sodium hydroxide. A constant flow of N_2 gas was pumped through the digesters to ensure that anaerobic conditions were maintained and to allow for measurement of methane concentration with a known gas flow using a flow meter attached to each digester. Concentration of methane was measured twice per day. Knowing flow rate and methane concentration allows for amount produced per day to be evaluated.

Complete manure collection (urine and feces) for Experiment 1 was done on four steers per treatment for three days prior to the start of the trial. Manure was mixed and subsampled for analysis of DM, OM and mineral content. Based on DM, manure was frozen in individual allotments equal to one days feeding for each digester. Each day, seven individual cups were thawed and hot water was added to bring the volume to 50 mL of slurry that was 9% DM. The digesters were allowed to stabilize for 37 days and daily sampling was performed for 5 days. Treatments were then switched and digesters were allowed to stabilize for 37 days followed by 5 days of measurements, thus all treatments were evaluated in all digesters.

For Experiment 2, manure was collected from cattle on a 40% DGS diet in confinement very similar to Experiment 1, or from cattle in open feedlot pens fed a similar diet. Open feedlot pens were cleaned at the end of the feeding period with manure piled in the pens and subsampled. Manure was freeze dried and ground through a 1-mm screen before being

Table 1. Composition of diets fed to cattle for manure collection and digester feeding.

	Experiment 1		Experiment 2	
Ingredient, % of DM	CONT	WDGS	LOASH	SOIL
Dry rolled corn	82.5	47.5	47.5	25.5
High moisture corn	—	—	—	25.5
WDGS[2]	—	40	40	—
MDGS[2]	—	—	—	40
Alfalfa Hay	7.5	7.5	7.5	—
Corn Stover	—	—	—	4
Molasses	5	—	—	—
Supplement	5	5	5	5
Urea	0.986	—	—	—
Monensin, g/ton	30	30	30	30
Tylosin, g/ton	8	8	8	8
Thiamine, g/ton	11	11	11	11

[1]Treatments were due to cattle diet, CONT and WDGS, or due to type of cattle housing with cattle in complete confinement (LOASH) or open lot pens (SOIL).
[2]WDGS = wet distillers grains plus solubles; MDGS = modified distillers grains plus solubles

Table 2. Degradation of manure and methane production within anaerobic digesters.

Experiment 1	CONT	WDGS	SEM	*P*-value
DMD, %	42.7	44.9	1.1	0.05
OMD, %	51.0	52.9	1.1	0.10
Methane, L/day	0.55	0.63	0.05	0.10
Methane, L/g OM fed	0.12	0.14	0.01	0.05
Methane, L/g OM degraded	0.24	0.26	0.03	0.44
Experiment 2	LOASH	SOIL	SEM	*P*-value
DMD, %	39.0	19.9	2.8	<0.01
OMD, %	46.7	24.8	3.1	<0.01
Methane, L/day	0.48	0.23	0.07	<0.01
Methane, L/g OM fed	0.10	0.19	0.03	0.01

[1]Treatments in Experiment 1 were due to cattle diet, a corn based diet (CONT) or a 40% WDGS diet (WDGS). Experiment 2 treatments were due to type of cattle housing with cattle in complete confinement (LOASH) or open lot pens (SOIL).

fed to digesters as a slurry. Digesters on the two treatments were fed an equal amount of DM per day which resulted in LOASH digesters being fed approximately 70% more OM per d. Digesters were allowed to stabilize for 37 days after which measurements were taken on five consecutive days. Three digesters were on the LOASH treatment and 4 digesters on the SOIL treatment. Three of the four digesters on SOIL failed within 10 days due to ash buildup within the digester. Results reported come from 3 digesters on LOASH and the 1 remaining digester on SOIL. Pseudo-replication for statistical analysis was obtained from repeated measures taken on each digester with five days of measurements for OM and DM degradation and methane concentration measured twice per day for 5 days.

Results

Experiment 1—Diet impact

Nutrients (minus OM) were approximately doubled in effluent compared to manure due to the degradation of OM within the digesters. The WDGS effluent had increased N, P and Na compared to CONT effluent ($P < 0.01$). Digesters fed CONT manure had DM degradation of 42.7% and OM degradation of 51.0% (Table 2). Feeding slurry from cattle fed WDGS slightly increased DM degradation to 44.9% ($P = 0.05$) and OM degradation to 52.9% ($P = 0.10$). Methane production was 0.55 L/day for CONT and 0.63 L/day for WDGS ($P = 0.10$). This is equal to 0.12 and 0.14 L/g OM fed for CONT and WDGS, respectively ($P = 0.05$). Methane produced per g of OM degraded was not different between treatments ($P = 0.44$). This suggests that differences in methane produced are due to rate of OM degradation and not due to more methane being produced from that amount of OM. Because diets containing distillers grains are less digestible than corn-based diets (*2013 Nebraska Beef Report*, p. 62 Nuttelman wet vs dry metabolism study) manure from cattle consuming distillers grains contains greater amounts of OM, much of which is highly digestible fiber. This is available for degradation by microbes within anaerobic digesters. The change in OM composition of manure from distillers grains fed cattle may be causing microbial compositional changes that result in increased OM degradation.

Experiment 2

Both DM and OM degradation of manure were greater in LOASH than SOIL ($P < 0.01$; Table 2). Total methane production was greater for LOASH at 0.48 L/day compared to 0.23 L/day for SOIL ($P < 0.01$). The low OM SOIL manure produced 0.19 L methane/g OM fed compared to 0.10 L/g OM fed for LOASH digesters. Consistent with the current results, past research suggests that feeding lower levels of OM reduces the overall amount of methane produced while increasing the amount of methane produced per g of OM fed. Feeding greater amounts of SOIL manure would result in greater OM to be degraded, but would also result in more rapid ash buildup. These small scale digesters were not able to handle the ash load and three out of the four failed. The greater concentration of ash or soil in the manure, the more inefficient and challenging it is for methane production, partially due to decreases in OM to microbe interactions. Furthermore, we do not understand how soil microbes influence methane production and OM degradation within anaerobic digesters. Open lot manure appears to be a viable feedstock for anaerobic digesters if ash buildup could be avoided.

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Development of 2-Rib and 3-Rib Beef Chuck Subprimal

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Michelle E. Semler,
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Summary

Under current U.S. fabrication methods the beef forequarter is divided into chuck and rib subprimals at the fifth/sixth rib junction. Forequarter breaks at the third/fourth and fourth/fifth rib junctions were evaluated in six beef carcasses each. Chuck roll subprimals from both fabrication methods were prepared. All muscles were weighed and a shear force assessment was conducted on steaks from the Longissimus dorsi*. There were no differences in tenderness between 3, 4, or 5 rib Longissimus dorsi steaks, and all steak locations assessed were rated as tender. These data suggest an alternative break point between the rib and chuck could increase value of the carcass.*

Introduction

The beef forequarter accounts for 52% of total carcass side weight. A majority of product marketed from the chuck primal is comprised of roasts with a range of muscles and variability in palatability. Currently the chuck is separated from the remainder of the beef forequarter by a division behind the fifth rib. The separation of the chuck and rib between the fifth and sixth ribs is somewhat arbitrary and bound by tradition. By altering the location of the chuck/rib break, steaks that are now cut from the chuck roll could be fabricated from a new subprimal which would allow the remainder of the chuck roll to be sold as roasts. Altering the break of the chuck/rib also could improve the short rib offerings currently available to international customers. In order to successfully develop a new subprimal, yield evaluations and product tenderness need to be fully assessed.

Procedure

Twelve Choice, YG 3 beef carcasses, weighing 800-850 lb, were tested for alternative forequarter fabrication. Alternative fabrication commenced with the removal of the *Latissimus dorsi* (lifter meat). The cartilaginous tip of the scapula was then located and an incision was made anterior following the seam posterior to the elbow. Pulling the scapula anterior, the knife was kept close to the medial side of the scapula, leaving the S*ubscapularis* on the suspended carcass. Once the medial side of the scapula was free from the carcass, a cut could be made that would free the thoracic limb from the forequarter.

Two fabrication methods were evaluated based solely on location of the chuck/rib break. Both fabrication methods resulted in a rib primal starting at rib seven; one rib posterior from traditional fabrication. Fabrication Method A resulted in a 3-rib subprimal: separation of the chuck and rib between ribs three and four. Fabrication Method B resulted in a 2-rib subprimal: separation of the chuck and rib between ribs four and five.

The 2-rib and 3-rib subprimals were weighed whole, and then vacuum packaged, transported to the University of Nebraska–Lincoln Loeffel Meat Laboratory and aged at 35˚F for 21 days. The length and width of the subprimals were measured using a cloth measuring tape prior to further fabrication.

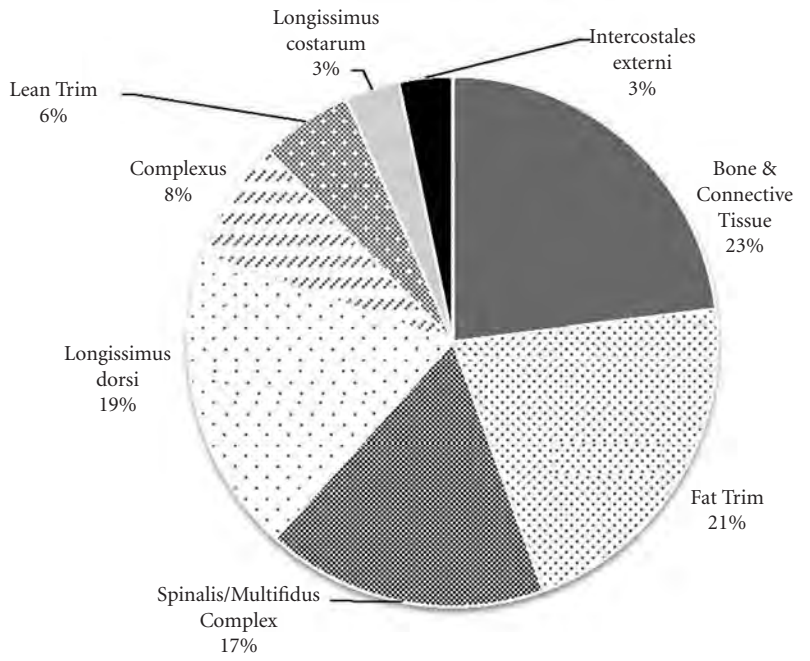
After aging, both the 2-rib and 3-rib subprimals were fabricated similarly to obtain individual muscles. Exterior fat was first removed and chuck muscles (*Longissimus dorsi, Longissimus costarum, Complexus, Spinalis/Multifidus dorsi, Serratus ventralis, Intercostales interni, ligamentum nuchae*, fat, connective tissue, and lean trim) were excised from the subprimal and weighed. *Longissimus dorsi* 1" thick steaks were cut from an anterior, medial, and posterior location in Method A, and anterior and posterior location in Method B. All steaks were cooked on a Hamilton Beach Indoor-Oudoor Grill to an internal temperature of 170˚F. Cooked steaks were then placed on a plastic tray and overwrapped with oxygen permeable film. Steaks were stored at 39˚F for 24 hours prior to being sampled for Warner Bratzler Shear Force (WBSF).

Cooked steaks were retrieved from the cooler and had cores prepared. Due to size, only four ½-inch cores were retrieved from anterior fabrication method A steaks, whereas all other steaks from both fabrication methods A and B had six ½-inch cores. These cores were sheared using a tabletop WBSF machine. Results were recorded for each core sheared.

Table 1. Warner-Bratzler shear force (lb) of *Longissimus dorsi* steaks from 2-rib and 3-rib subprimals.

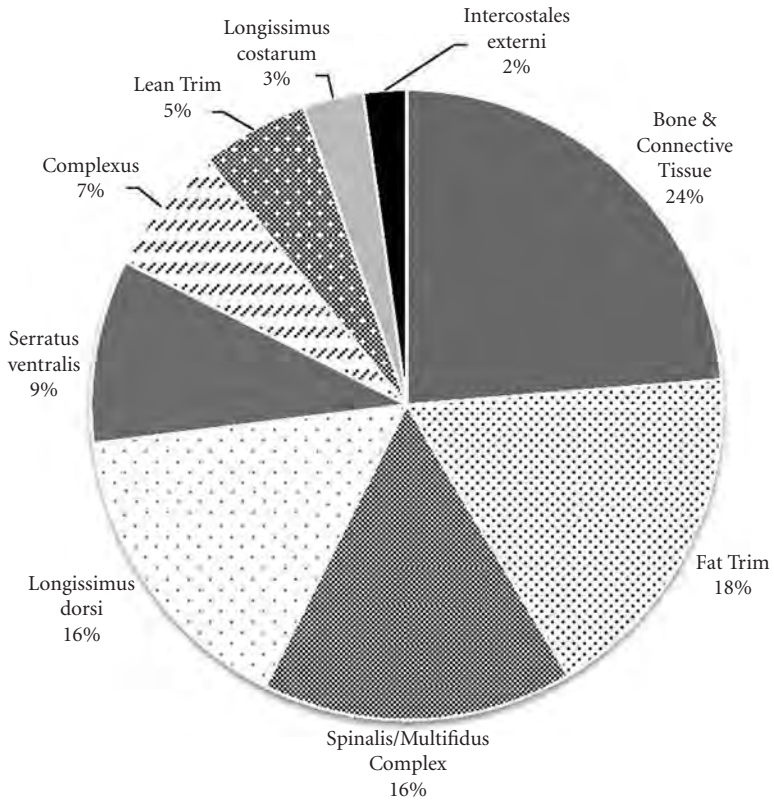
	Subprimal Fabrication Style[1]	
Steak Location[2]	2-rib	3-rib
Anterior	6.42	7.29
Middle	—	8.10
Posterior	6.20	7.92
P-value	0.49	0.39
SEM	0.19	0.26

[1]Two subprimal fabrication styles were utilized: 2-rib (ribs 5-6) and 3-rib (ribs 4-6). In both cases the rib primal was split at the sixth/seventh rib.
[2] Steaks (1 in) were cut from the *Longissimus dorsi* at the listed locations. No middle steak was obtained from the 2-rib subprimal.



2-rib (fourth/fifth rib through sixth/seventh rib) subprimal muscles obtained by single muscle fabrication methods. Percentage calculated on a per weight basis.

Figure 1. Least square means of tissue composition yields from 2-rib subprimal.



3-rib (third/fourth rib through sixth/seventh rib) subprimal muscles obtained by single muscle fabrication methods. Percentage calculated on a per weight basis.

Figure 2. Least square means of tissue composition percentages from 3-rib subprimal.

Results

A sizeable subprimal, suitable for cutting into steaks, would be available through the development of a 2 or 3-rib subprimal. An added 3.45 lb of total subprimal weight was captured in the 3-rib subprimal when compared to that of the 2-rib subprimal (8.26 vs 4.81 lb). This added weight would account for seven additional 1 inch *Longissimus dorsi* steaks in the 3-rib subprimal and four steaks in the 2-rib subprimal. Given that this innovative subprimal is a combination of chuck and rib muscles, it would be expected that this new subprimal would be marketed at an intermediate price. Since the chuck is priced much lower than the primal rib, an intermediate price should result in a net gain in value.

Both alternative rib subprimals had lean yield values of greater than 60%. The *Longissimus dorsi, Spinalis dorsi*, and *Complexus* comprised the largest proportion of muscles in both subprimals (Figures 1, 2). These muscles are present in chuck eye and anterior ribeye steaks and are generally tender.

There were no significant differences in WBS between steak locations in either the 2-rib or 3-rib subprimals (Table 1). Tenderness classification of beef cuts have been recommended for application in the industry based on WBS results. According to those recommendations all *Longissimus dorsi* steaks from the 2-rib and 3-rib subprimals had WBS values less than 8.0 lb, rating them as tender product.

Based on these results *Longissimus dorsi* steaks from ribs three through six were consistently tender and could offer additional value from a 2-rib or 3-rib subprimal cuts. The 2-rib and 3-rib subprimal offerings could provide a value-added product for producers, versatility for processors, and tender steaks for consumers.

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[1]Justine J. Hosch, graduate student; Kim A. Varnold, graduate student; Lasika S. Senaratne-Lenagala, graduate student; Michelle E. Semler, graduate student; Michael D. Chao, graduate student; Chris R. Calkins, professor, University of Nebraska–Lincoln Department of Animal Science, Lincoln, Neb.

Differences in Beef Strip Loin Steaks of Steers Due to the Inactive Myostatin Mutation

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Summary

Strip loins from steers with genotypes containing zero, one, or two copies of the inactive myostatin mutation (IM) (n = 20, 22, and 16, respectively) were obtained. Loins were cut into 1-inch steaks where total number of steaks and total numbers of steaks with gluteus medius (often called vein steaks) were noted. Loins from zero copy cattle had a higher total number of steaks, but no difference in proportion of steaks, both with and without the gluteus medius compared to one and two copy cattle. This study indicates that increasing copies of the IM mutation has no impact on the proportion of steaks containing the gluteus medius muscle within the strip loin.

Introduction

The inactive myostatin allele is a negative regulator of myogenesis and causes an increase in muscle fiber number (hyperplasia) caused by base pair deletions, which is the primary reason for approximately 20% increase in skeletal muscle mass in Piedmontese cattle (Kambadur et al *Genome Research,* 1997*)*. Cattle with two copies of the inactive myostatin allele possess nearly twice the number of muscle fibers than other cattle and yield extremely lean and heavily muscled carcasses.

Toward the posterior end of the strip loin the GM increases in size while the *Longissimus lumborum* decreases in size and narrows. Steaks containing the GM also include a piece of connective tissue separating the GM and LD that will appear on both sides of the steak. Such steaks, called vein steaks, are lower in value than strip steaks without the GM. (Figure 1) This research was conducted to determine if cattle with two copies of the inactive myostatin gene would produce a greater number and greater percentage of strip loins containing the *Gluteus medius* (GM) when compared to cattle with zero and one copy of the inactive myostatin allele.

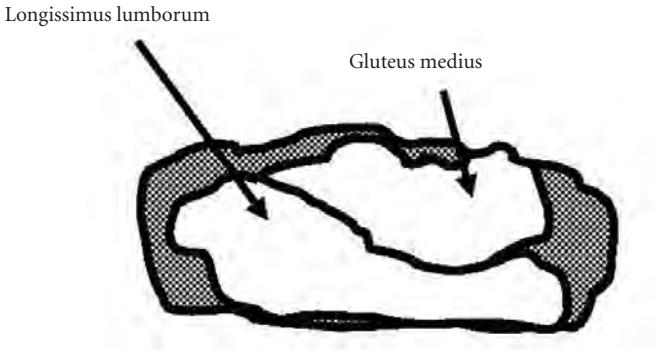

Figure 1. Illustration showing vein steak from posterior end of strip loin.

Procedure

All steers (n = 20, 22, and 16 carrying 0, 1, and 2-copies of the inactive myostatin mutation, respectively) were individually fed the same diet for 182 days, and then finished for 50 days, for a total of 232 days on feed. At three days postmortem strip loins were collected from the carcasses (n = 58). Each strip loin was then measured for loin weight, loin length, sirloin face width, rib face width, sirloin tail length, rib tail length, and fat thickness at the rib face. The loins were then cut into 1-inch thick steaks and the following information was gathered for each: total number of steaks, total number of vein steaks, total number of non-vein steaks, and weight of each individual steak.

Data was analyzed using a completely randomized design in SAS (Version 9.1) with the fixed effects being the different inactive myostatin mutations and random effect of the animal was used. Analysis of Variance (ANOVA) was performed using the Proc Mixed procedure with mean separation determined using LS MEANS and DIFF LINES options of SAS, with significance determined at $P \leq 0.05$.

Results

Despite having an increase in strip loin weight (Table 1), strip loins from cattle containing one or two copies of the inactive myostatin allele were shorter and wider, yielding fewer total steaks and fewer vein steaks (Table 2) than loins from cattle containing zero copies of the myostatin allele. This was reflected by greater mean steak weight (Table 2) for one and two copy samples. The two copy samples had a lower number of total steaks ($P < 0.001$) and number of veins steaks ($P < 0.001$) than zero and one copy samples. When comparing two copy to zero and one copy the number

Table 1. Dimensional measurements of strip loin from cattle with 0, 1, or 2 copies of the inactive myostatin allele.

	Number of Inactive Myostatin Alleles				
Measurements	0	1	2	SEM	*P*-Value
Fat Thickness (in)	0.56[a]	0.27[b]	0.13[c]	0.031	<.01
Loin Weight (kg)	4.99[b]	5.48[a]	5.10[a]	0.149	0.03
Loin Length (in)	15.31[a]	14.80[a]	13.61[b]	0.231	<.01
Sirloin Face Width (in)	8.90[b]	9.62[a]	9.53[a]	0.140	0.02
Rib Face Width (in)	7.47[b]	8.39[a]	8.66[a]	0.135	<.0001
Sirloin Tail Length (in)	2.57[b]	3.00[a]	2.43[b]	0.137	0.01
Rib Tail Length (in)	1.17[ab]	1.25[a]	1.03[b]	0.059	0.02
Fat Thickness over Loin (in)	0.62[a]	0.27[b]	0.15[c]	0.038	<.01

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$).

Table 2. Number, weight, and proportion of vein steaks from strip loin from cattle with 0, 1, or 2 copies of the inactive myostatin allele.

	Number of Inactive Myostatin Alleles				
Steak Trait	0	1	2	SEM	*P*-value
Number of Loins Analyzed	20	22	16		
Total Steaks	14.7[a]	13.77[b]	12.38[c]	0.233	<.01
Number Vein Steaks	4.6[a]	4.18[b]	3.56[c]	0.151	<.01
Non-Vein Steaks	10.15[ab]	9.5[a]	8.87[b]	0.238	0.09
% of Vein Steaks in Loin	31.37	30.39	28.82	1.068	0.21
Combined Weight of Steaks (g)	4993.37[b]	5446.37[a]	5093.29[ab]	137.653	0.05
Total Weight of Vein Steaks (g)	1569.101	1704.30	1505.81	68.119	0.12
% Weight of Vein Steaks	31.42	31.35	29.35	1.109	0.30
Mean Steak Weight (g)	339.5[b]	396.6[a]	410.1[a]	0.052	<.01

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$).

of non-veins steaks ($P = 0.0009$) was greater. The numeric and weight percentages of vein steaks did not differ among genotypes (Table 2). Thus, increasing copies of the myostatin allele was not detrimental to the percentage of vein steaks derived from the strip loin.

These data indicate that increasing copies of the myostatin allele have no impact on the proportion of vein steaks in the strip loin. Strip loins from cattle with one copy and two copies yielded fewer total one inch steaks that were wider and heavier. This could impact the attractiveness of steaks to consumers because they would represent a larger portion size at equal thickness or a thinner steak if cut to constant weight.

[1]Michelle E. Semler, graduate student; Chris R. Calkins, professor; Galen E. Erickson, professor, University of Nebraska–Animal Science Department, Lincoln, Neb.

Variation in Composition and Sensory Properties for Beef Short Ribs

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Jerilyn E. Hergenreder
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Summary

Beef short ribs (2-12) were collected from both sides of 10 Choice beef carcasses. Short ribs from the left side were utilized in a yield assessment and the right sides were prepared for a trained sensory panel. Ribs 9-12 had the greatest percent fat per rib and lower percent lean. Ribs 5-7 were intermediate in percent lean. Rib 5 was similar to ribs 9-10 for tenderness, and ribs 11-12 were rated least tender. Ribs 6-8 were rated highest for juiciness and ribs 5 and 11 were rated least juicy. No differences in off-flavor intensity existed among samples. These data suggest differences in short rib fabrication could be used to add value to the carcass.

Introduction

Historically rib short ribs (6-8) are valued 40% above chuck short ribs (2-4). The *Serratus ventralis* is a large fan-shaped muscle that overlies the ribs, and thus comprises a large component of lean present in short ribs. Sensory properties and yield differences between individual short ribs is unknown. Modifications to the chuck-rib break would result in a divergence of short rib offerings. In addition, beef ribs 9-12 are currently boned and marketed as finger meat, but the ventral portion of these ribs contains sizeable lean tissue. Therefore the objective of this was to determine composition and sensory differences among short ribs.

Procedure

Twenty short rib sub-primals were identified on both the left and right side of Choice, YG 3 carcasses weighing between 800 and 850 lb. The carcasses entered commercial production, with the chuck and rib primals separated at the 5-6 rib junction. Short ribs were removed from the chuck primal (ribs 2-5) and from the rib primal (ribs 6-12), were vacuum packaged and aged for 21d post mortem at 2˚C. Ribs 9-12 were fabricated from the ventral half of beef ribs 9-12, as the dorsal half had minimal lean tissue.

Yield Evaluation

Prior to fabrication, the chuck and rib short ribs from the left side were weighed whole and distances of width, length, and depth were measured using a cloth measuring tape. Each rib was individually cut from its respective sub-primal, dividing the lean in half between ribs.

Each rib was then boned, and the associated bone, lean, and fat from each rib was physically separated and weighed.

Sensory Evaluation

Chuck and rib short ribs from the right side of the carcass were sliced into ¼-inch slices using a band saw. Each rib was separated from their subsequent counterpart by dividing the lean between ribs in half. This cutting style allowed for the lean associated with an individual rib to be sampled during panel sessions. Individual short rib slices were cooked on a Rival 11 inch square electric skillet at 204˚C for 45 seconds per side. Short rib pieces were then transferred to a second frying pan at 149˚C for four minutes time per side. Cooked short rib slices were then kept in a preheated countertop warmer no longer than 15 minutes prior to serving.

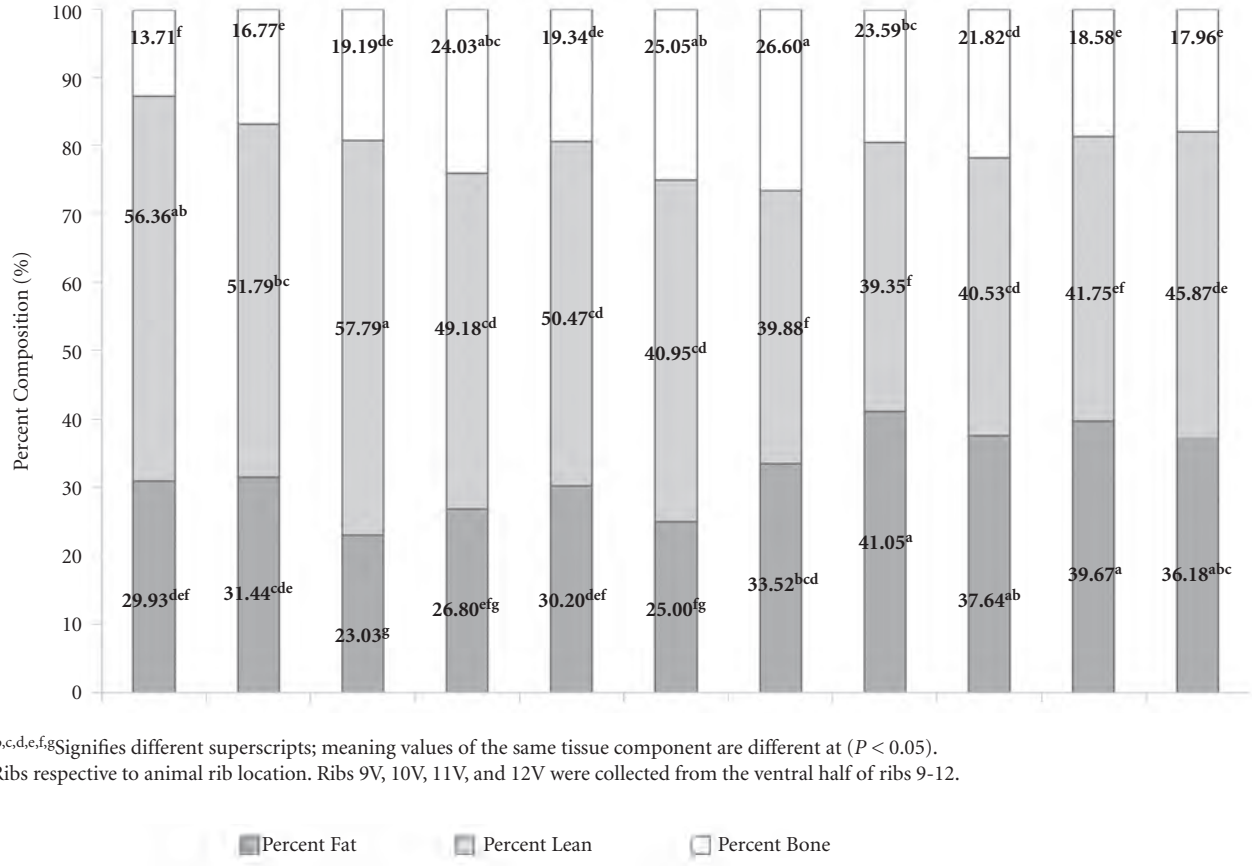
For sensory analysis, ribs 2-12 were served to a trained taste panel to distinguish organoleptic differences between rib locations based on 8-point scales for tenderness (1 = extremely tough – 8 = extremely tender), juiciness (1 = extremely dry – 8 = extremely juicy), and off flavor intensity (1 = extremely mild – 8 = extremely intense).

Results

Ribs 9-12 had the largest percentage of separable fat per rib (over 35%) and thus lower percentage lean on a rib-by-rib basis (Figure 1). Similar in fat composition, ribs 4, 5, and 7 had the least amount of fat present (23-26%). Ribs 5-7 were similar and intermediate in percent lean at roughly 50%. Ribs 5-8 contained a greater percentage of bone, with ribs 2-4, 6, 11, and 12 having less than 20% bone per rib.

In taste panel ratings, ribs 2-4, and 6-9 were similar in tenderness and were rated the most tender among samples (Table 1). Rib 5 was similar to ribs 9 and 10 for tenderness, and ribs 11 and 12 were rated least tender among samples. Ribs 6-8 were rated highest for juiciness, and ribs 5 and 11 were rated least juicy. There were no differences in off-flavor intensity among samples.

By evaluating the ventral half of short ribs from ribs 9-12, it was determined they offered similar sensory properties to that of chuck



a,b,c,d,e,f,gSignifies different superscripts; meaning values of the same tissue component are different at ($P < 0.05$).
[1]Ribs respective to animal rib location. Ribs 9V, 10V, 11V, and 12V were collected from the ventral half of ribs 9-12.

Figure 1. Least square means for short rib composition based on physical separation of tissue.

Table 1. Least square means for short rib sensory analysis

	Sensory property[1]		
Rib[2]	Tenderness rating	Juiciness rating	Off-flavor rating
2	5.07^{abc}	4.76^{bcd}	2.47
3	5.11^{abc}	4.89^{bcd}	2.27
4	5.21^{ab}	4.72^{cd}	2.21
5	4.72^{d}	4.05^{f}	2.36
6	5.40^{a}	5.29^{a}	2.63
7	5.28^{ab}	5.08^{ab}	2.46
8	5.32^{ab}	5.01^{abc}	2.44
9V	5.02^{bcd}	4.81^{bcd}	2.12
10V	4.81^{de}	4.61^{de}	2.52
11V	4.31^{e}	4.30^{ef}	2.47
12V	4.29^{e}	4.72^{cd}	2.38

a,b,c,d,e,f,Means in the same column with different superscripts are significantly different ($P < 0.05$).
[1]Sensory property ratings based on an 8-point hedonic scale: tenderness (1 = extremely tough – 8 = extremely tender), juiciness (1 = extremely dry – 8 = extremely juicy), and off flavor intensity (1 = extremely mild – 8 = extremely intense).
[2]Ribs respective to animal rib location. Ribs 9V, 10V, 11V, and 12V were collected from the ventral half of ribs 9-12.

short ribs. By adding the ventral half of ribs 9-12 to US beef short rib offerings, an added 2.86 lb of short ribs would be available, compared to 1.5 lb from this location that would be marketed as beef rib fingers.

Given the similarities in tenderness, and increased yield values, short ribs from the chuck sub-primal could be added to that of the rib short rib sub-primal. Chuck short ribs could also be sold at a value similar to that of rib short ribs.

[1]Justine J. Hosch, graduate student; Kim A. Varnold, graduate student; Lasika S. Senaratne, graduate student; Jerilyn E. Hergenreder, graduate student; Chris R. Calkins, professor, University of Nebraska–Lincoln Department of Animal Science, Lincoln, Neb.

An Evaluation of the Extended Sirloin Cap Coulotte

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Lasika S. Senaratne-Lenagala
Michelle E. Semler
Michael D. Chao
Chris R. Calkins[1]

Summary

Fabrication methods for the beef carcass are strongly based on tradition. Extended sirloin caps were removed with a knife prior to round/sirloin fabrication. Steaks from the cap were cut parallel or perpendicular to muscle fiber direction. Steaks, regardless of cutting style, were more tender, juicier, and had less connective tissue towards the anterior of the cap. Lower shear force values also occurred at the anterior tip. Steaks cut parallel to muscle fiber direction had lower shear force values compared to perpendicular cut steaks.

Introduction

Under normal U.S. beef carcass fabrication methods, the point of round-sirloin separation results in a portion of the *Biceps femoris* (BF) remaining on the sirloin. Tenderness mapping (*2011 Nebraska Beef Cattle Report,* pp. 105-107) has shown that the two most proximal BF steaks are the most tender region of the muscle in the round. Warner Bratzler Shear Force values have indicated these steaks are tender and thus could be potentially marketed as premium to other round steaks. To evaluate the feasibility of an extended sirloin cap, the objectives of this study were to determine the point of round/sirloin separation to produce an extended sirloin cap and to evaluate different steak fabrication styles, both parallel and perpendicular to muscle fiber orientation.

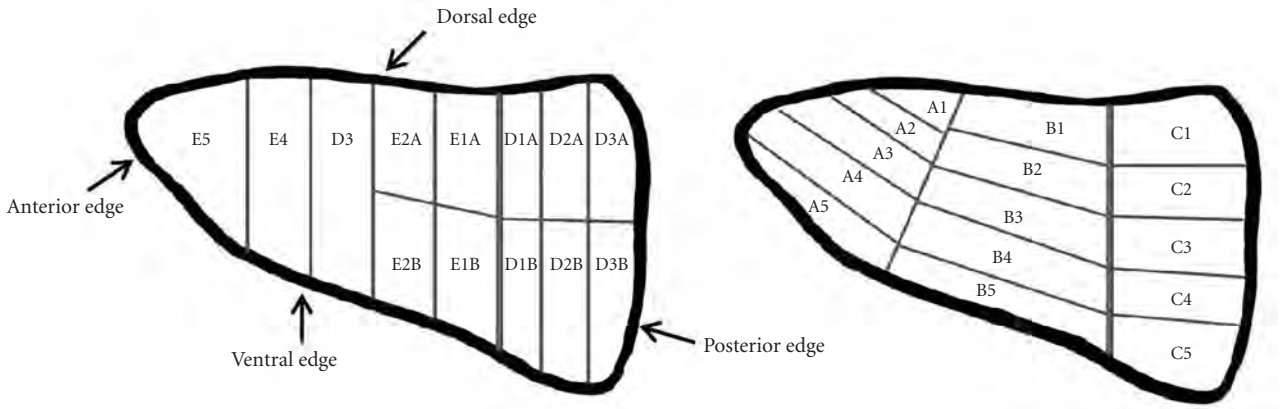
Procedure

The right side of 20 USDA Choice, YG 3 beef carcasses weighing 800-850 lb were selected. The *Biceps femoris* was removed using the aitch bone (pelvic bone) as an anatomical landmark. The cut was made at the proximal end of the semitendinosus, perpendicular to the long axis of the Biceps femoris. The extended sirloin cap from each carcass was weighed whole both untrimmed and trimmed, and length, width, and height (cm) of the cap was measured. The extended sirloin caps were vacuum packaged and transported to the University of Nebraska–Lincoln Loeffel Meat Laboratory under refrigeration and were aged for 25 d at 39°F prior to steak fabrication.

To evaluate steak cutting method, and its effect on tenderness in the extended sirloin cap, two steak fabrication styles were utilized: parallel (n = 10) and perpendicular (n = 10) to muscle fiber direction (Figure 1). These fabrication styles were conceived after mapping the fiber direction of the extended sirloin cap (Figure 1). All steaks were cut 1 in thick. In both cutting methods a divisional cut was made from dorsal to ventral edge approximately 3 in anterior from the posterior cut surface. This divisional cut was marked by a fat seam on the dorsal side, as well as the end to a slight bulge in the BF.

Steaks from 10 extended sirloin caps, five from each steak fabrication method, were subject to WBS evaluation. Steaks were grilled on Hamilton Beach Indoor/Outdoor grills to an internal temperature of 170°F. Steaks were placed on a tray and covered with oxygen-permeable film and placed in a 39°F cooler. Twenty hours later, ½" cores were taken from the cooked steaks and sheared using a tabletop WBS machine. Results were recorded for each core sheared.

Steaks from ten extended sirloin caps, five from each steak fabrication method, were subject to sensory panel evaluation. Steaks were cooked on a Hamilton Beach Indoor/Outdoor grills to an internal temperature of



Top left: Location and designation of steaks fabricated parallel to muscle fiber direction.
Top right: Location and designation of steaks fabricated perpendicular to muscle fiber direction.

Figure 1. Steak fabrication methods for extended sirloin caps.

Table 1. Sensory attributes and connective tissue of steaks fabricated parallel to muscle fiber direction.

Steak	Sensory Attribute[1]				
	Juiciness	Tenderness	Connective Tissue	Off-flavor	WBS
E5	5.74^{ab}	6.71^{ab}	6.49^{a}	3.37	6.23^{cd}
E4	5.89^{a}	6.79^{a}	6.35^{ab}	3.24	7.59^{cd}
E3	5.51^{ab}	6.26^{ab}	6.22^{ab}	3.32	7.24^{cd}
E2A	5.59^{ab}	6.15^{bc}	5.76^{abc}	3.44	7.57^{cd}
E2B	4.71^{de}	5.32^{e}	4.81^{de}	3.20	6.05^{d}
E1A	5.73^{ab}	6.01^{cd}	5.70^{bc}	3.27	10.63^{ab}
E1B	5.25^{bc}	5.27^{e}	4.43^{ef}	3.32	6.29^{cd}
D1A	5.23^{bc}	5.97^{cd}	5.76^{abc}	3.21	11.35^{ab}
D1B	4.73^{de}	5.38^{e}	4.75^{def}	3.39	7.39^{cd}
D2A	4.82^{cde}	5.53^{de}	5.27^{cd}	3.45	10.32^{ab}
D2B	5.21^{bcd}	4.71^{f}	4.23^{f}	3.32	9.06^{bc}
D3A	5.55^{ab}	5.97^{cd}	5.31^{cd}	3.26	12.19^{a}
D3B	4.61^{e}	5.34^{e}	4.91^{de}	3.15	12.03^{a}
P-value	<0.001	<0.001	<0.001	0.98	<0.0001
SEM	0.29	0.33	0.39	0.54	0.64

$^{a, b, c, d, e, f, g, h}$Means in the same row having different superscripts are significant at $P < 0.05$.
[1]Sensory attributes rated by a trained sensory panel on tenderness (8 = extremely tender; 1 = extremely tough), juiciness (8 = extremely juicy; 1 = extremely dry), connective tissue (8 = no connective tissue; 1 = abundant amount) and off-flavor (8 = strong off-flavor; 1 = no off-flavor).

Table 2. Sensory attributes, connective tissue, and WBS results of steaks fabricated perpendicular to muscle fiber direction.

Steak	Sensory Attribute[1]				
	Juiciness	Tenderness	Connective Tissue	Off-flavor	WBS
A1	5.80^{a}	6.67^{a}	6.54^{a}	3.35^{ab}	5.21^{f}
A2	5.25^{ab}	6.41^{ab}	6.15^{abc}	3.13^{b}	6.05^{f}
A3	5.08^{bcd}	6.21^{abc}	6.22^{ab}	3.13^{b}	6.58^{ef}
A4	5.06^{bcd}	6.06^{bcd}	5.58^{cd}	3.10^{b}	6.71^{ef}
A5	4.84^{bcd}	5.42^{edf}	4.74^{efg}	3.78^{a}	7.99^{def}
B1	4.80^{bcd}	6.41^{ab}	6.18^{abc}	3.12^{b}	5.63^{f}
B2	5.03^{bcd}	5.32^{ef}	4.76^{ef}	3.08^{b}	7.44^{def}
B3	4.90^{bcd}	5.70^{cde}	5.22^{de}	3.30^{ab}	8.07^{def}
B4	4.73^{bcd}	4.95^{fg}	4.68^{efg}	3.10^{b}	10.10^{de}
B5	5.20^{abc}	4.78^{fg}	4.00^{gh}	3.28^{b}	9.86^{de}
C1	4.62^{cd}	5.99^{bcd}	5.59^{bcd}	3.31^{ab}	8.12^{def}
C2	4.90^{bcd}	5.76^{cde}	5.23^{de}	3.00^{b}	11.09^{d}
C3	4.86^{bcd}	5.15^{f}	4.28^{fgh}	3.26^{b}	14.63^{bc}
C4	4.58 ^{d}	4.54^{gh}	3.74^{h}	3.30^{ab}	16.85^{b}
C5	4.75^{bcd}	4.02^{h}	2.76^{i}	3.32^{ab}	21.21^{a}
P-value	0.0278	<0.001	<0.001	0.42	<0.0001
SEM	0.41	0.37	0.44	0.28	0.66

^{a,b,c,d,e,f,g,h,i}Means in the same row having different superscripts are significant at $P < 0.05$.
[1]Sensory attributes rated by a trained sensory panel on tenderness (8 = extremely tender; 1 = extremely tough), juiciness (8 = extremely juicy; 1 = extremely dry), connective tissue (8 = no connective tissue; 1 = abundant amount) and off-flavor (8 = strong off-flavor; 1 = no off-flavor).

170°F; after being flipped once at 85°F. Cooked steaks were cut into ½" individual cubes and kept warm in a preheated countertop warmer. The steaks were served to five trained panelists that evaluated at most seven samples per session. Each sample was evaluated for tenderness (8 = extremely tender; 1 = extremely tough), juiciness (8 = extremely juicy; 1 = extremely dry), connective tissue (8 = no connective tissue; 1 = abundant amount) and off-flavor (8 = strong off-flavor; 1 = no off-flavor).

Results and Discussion

Differences existed within extended sirloin caps regardless of cutting style, for tenderness, juiciness, connective tissue, and WBS results. Steaks fabricated parallel to muscle fiber direction had lower overall WBS values when compared to steaks fabricated perpendicular to muscle fiber direction. Steak C5, the most dorsal and posterior steak, had the highest ($P < 0.05$) WBS value.

Steaks fabricated parallel to muscle fiber direction were rated more tender (P <0.001) towards the anterior of the cap (Table 1) when compared to all other steaks. These steaks were also more juicy and had less connective tissue. Steaks from locations E (E2 and E1) and D (D1 – D3) that had been fabricated into dorsal and ventral halves had a tendency for steaks on the dorsal side to be less tender, less juicy, and greater amounts of connective tissue ($P < 0.001$).

Steaks fabricated perpendicular to muscle fiber direction had more desirable traits towards the anterior portion of the extended cap (Table 2). Steaks from location A were juicier, more tender, and had less connective tissue when compared to steak locations B and C ($P < 0.0001$). Steaks from location B and C were rated similar and intermediate for juiciness. Steaks from location B and C on the dorsal edge of the cap (steaks 4-5) were less tender and had significantly ($P < 0.05$) more connective tissue when compared to steaks from the ventral side of the cap (steaks 1-3). These results parallel those found when analyzing sensory data based on apparent region within the extended cap.

After assessing the sensory panel data and WBS an extended sirloin cap possibly could be excised from the carcass prior to fabrication of the sirloin/round. With lower WBS results and higher sensory panel ratings anterior to the divisional cut used in this study, it is recommended to produce a cap cut anterior from this point. To do so, the same anatomical landmarks for extended sirloin cap can be utilized — dorsal tip of the aitch bone to the lateral side of the carcass — but an adjustment of 3 inches anterior from that line is recommended. Steaks should be fabricated perpendicular to muscle fiber direction to maintain tenderness in this alternative cut.

[1]Justine J. Hosch, graduate student; Kim A. Varnold, graduate student; Lasika S. Senaratne-Lenagala, graduate student; Michelle E. Semler, graduate student; Michael D. Chao, graduate student; Chris R. Calkins, professor, University of Nebraska–Lincoln Department of Animal Science, Lincoln, Neb.

An Evaluation of Pelvic Bone Shape in Beef Carcasses

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Summary

Pelvic bones from the right side of twenty five beef carcasses were collected and analyzed to characterize the variation in bone shape. Two heifer and two steer carcasses were selected from five 100-pound weight ranges, starting at 600 lb. Aitch and hip bone pelvic pieces were weighed and 12 linear measurements collected. Weight of the hip bone, aitch bone, and total pelvic bone increased with increasing carcass weight. Aitch bone and pelvic lengths were longer for steers than heifers. Location of the cut separating beef sides had a major impact on shape of the exposed aitch bone. Inconsistencies in carcass splitting make it difficult to use differences in aitch bone shape as anatomical landmarks for altered carcass fabrication.

Introduction

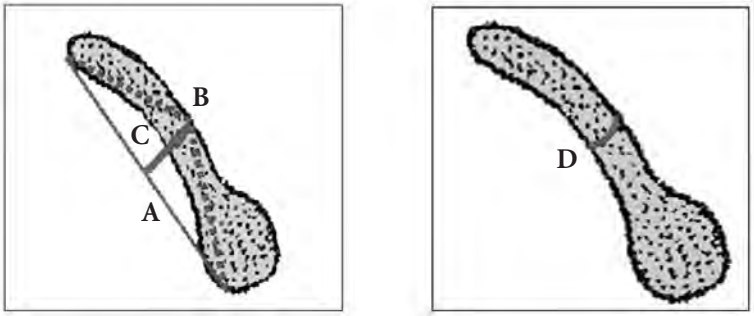
Alternative cuts of beef are highly sought in the market place by both consumers and retailers. Muscle profiling work (*2011 Nebraska Beef Cattle Report,* pp. 105-107) suggests the beef round has potential for the development of new cuts; specifically those that focus on single muscle fabrication. A defined anatomical landmark would be necessary for alternative fabrication methods in the beef round to occur. The anatomical location of the aitch bone (pelvic bone) is one of the visible indicators available in the round. Variation in pelvic bone shape and size in the beef carcass has not been characterized.

Procedure

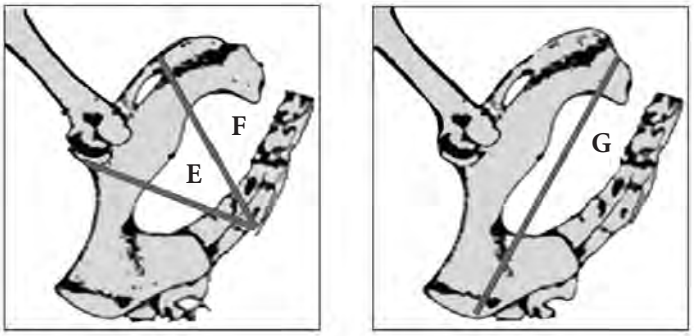
Pelvic bones from the right side of 25 A-maturity beef carcasses were collected to characterize the variation in bone shape due to gender and BW of animal at harvest. Carcasses were railed off to the re-grade bay and the pelvises from respective carcasses were identified. All 25 carcasses entered commercial production, and were split into round and sirloin primals. After fabrication of boneless round and sirloin cuts, two pieces of the pelvis were obtained — the hip portion from the sirloin and the aitch portion from the round — and transported to Loeffel Meat Laboratory at the University of Nebraska – Lincoln for measurement and analysis.

Prior to evaluation, both the hip and aitch bone pieces had additional connective tissue and lean removed. All hip and aitch bone pieces were then weighed and measured to determine the three-dimensional shape of the pelvis. Measurements were defined (Figure 1) prior to data collection with intentions to capture the true dimensional shape of the pelvis. In measurement definitions, aitch bone is the cut surface of the pelvic and *Symphysis pubis,* a result from splitting of the carcass. All hip and aitch bone dimensions were measured using a cloth measuring tape (in). Anatomical terms to describe measurement locations were assumed similar to those in a beef carcass hanging from the Achilles tendon.

Weights of the hip and aitch bone portions, as well as all of the dimensional measurements were analyzed independently using the PROC GLM procedure of SAS (SAS 2002-2008, Version 9.2. Cary, N.C.). CONTRAST statements were used to test for significance ($P \leq 0.05$) between sex, weight, and weight* sex interactions.



Linear measurements: A, aitch bone length; B, aitch bone depth; C, aitch bone angle; D, *symphysis pubis* circumference.



Linear measurements: E, pelvic depth 1; F, pelvic depth 2; G, pelvic length.

Figure 1. Anatomical locations of pelvic bone linear measurements.

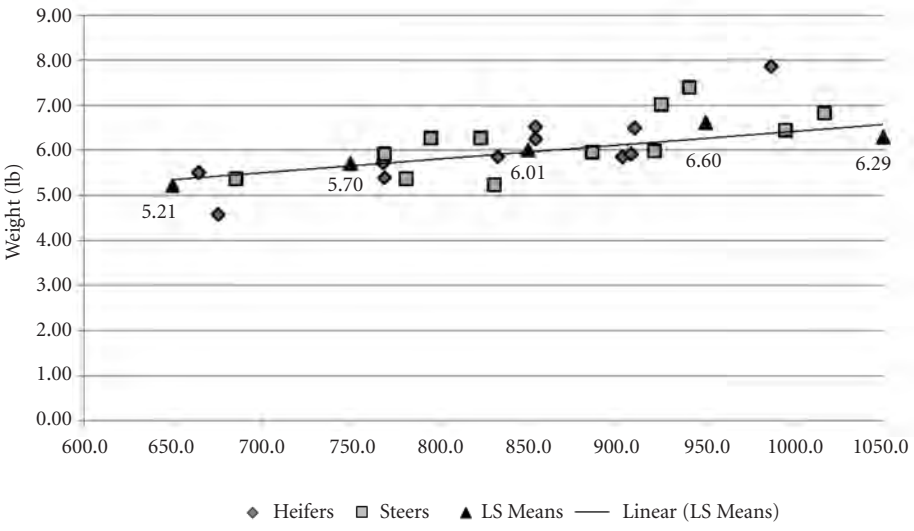


Figure 2. Least square means for total pelvic bone weight.

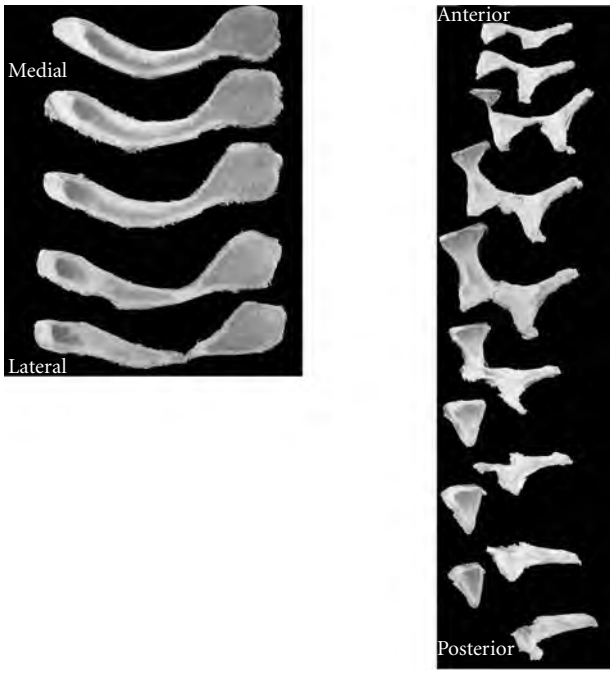


Figure 3. Differences in shape of aitch bone ball and angle of aitch bone from aitch bone pieces sliced parallel and perpendicular to the face of the aitch bone.

Above left: aitch bone shape resulting from inaccurate splitting of the beef carcass. Above right: aitch bone shape resulting from accurate splitting.

Figure 4. Differences in shape of aitch bone ball and angle of aitch bone as influenced by carcass splitting accuracy.

Results

Weight of the hip bone, aitch bone, and total pelvic bone increased linearly with increasing carcass weight (Figure 2). Carcass sex did not have an effect on weight of the pelvic bones. No difference existed between heifers and steers for aitch bone depth, aitch bone angle, *symphysis pubis* circumference, hook width, pin width, pelvic depth 1, and pelvic depth 2. Longer aitch bone length was observed in steers when compared to heifers (5.9 and 5.6 in, respectively). In addition, an increase in pelvic length was observed in steers when compared to heifers (15.4 and 14.3 cm). Carcass weight had no effect on any measurements.

Pelvises exhibiting extreme shape and size variation were sliced into ¼-in slices using a band saw, either perpendicular or parallel (Figure 3) to the face of the aitch bone. Perpendicular slices exhibited changes in the width of the aitch bone portion, and changes in pelvic width due to accuracy of carcass splitting. Similarly, slices parallel to the aitch bone face exhibited changes in the shape of the aitch bone (curved vs. planar), and shape of the aitch bone ball (circular vs. oblong) due to accuracy during carcass splitting. As the split progressed laterally from the true pelvic midline, the shape of the ball became distorted changing from circular to oblong in nature. Similarly the angle of the aitch bone increased, becoming more planar. These data suggest aitch bone shape is influenced by accuracy of carcass split (Figure 4) and gender differences are reflected in the pelvic bone characteristics. Due to great variation in the shape of the aitch bone, it is not feasible to use the ball of the aitch bone as a suitable anatomical landmark for alternative carcass fabrication.

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Color and Sensory Properties of Beef Steaks Treated with Antimicrobial Sprays

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Summary

Beef steaks were treated with different antimicrobial sprays (560 ppm bromine, commercial blend containing 2.48% lactic acid, acetic acid, and potassium hydroxide, 4.17% lactic acid, and an unsprayed control) to determine their antimicrobial effectiveness and effect on color and palatability properties. Consumer sensory panels for Psoas major steaks revealed samples treated with lactic acid were more preferred (P = 0.05) for juiciness and flavor (P = 0.01) than all other treatments. Lactic acid and the commercial blend were the most effective antimicrobial treatments (P < 0.01) against generic E-Coli. Steaks treated with the commercial blend product showed the lowest overall discoloration (P < 0.01) resulting in the greatest consumer appeal.

Introduction

Antimicrobials are widely used on the surface of fresh beef to reduce pathogens and extend shelf life. These antimicrobials may affect properties such as color of raw meat and sensory palatability properties such as juiciness, flavor, and off-flavor of cooked meat product. The objectives of this study were to determine the effectiveness of three different antimicrobial sprays on beef steaks (bromine, commercial blend [lactic acid 45-60%, acetic acid 23-30% and potassium hydroxide >1%], lactic acid, and an unsprayed control). As well, the effects of the three different antimicrobial sprays on color and sensory properties of beef steaks were evaluated using a consumer sensory panel.

Procedure

For microbial analysis, steaks for *Psoas major* (PM; n = 180) and *Gluteus medius* (GM; n = 180) were inoculated prior to treatment with approximately 3 log of generic *E-coli* and swabs for colony forming units (CFU's) were taken to estimate microbial load. Treatments were applied via direct spray on average 560 ppm bromine, 2.48% commercial blend, and 4.17% lactic acid at 130° F. Following treatment the microbial analysis steaks were swabbed once more for CFU's. Initial CFU measurements and CFU measurement after treatment were measured within a 24 hour period.

Non-inoculated PM (n = 176) and GM (n= 176) steaks were frozen immediately after treatment and thawed prior to being used for consumer and sensory evaluation and color measurements. Subjective percent discoloration was determined by a trained panel on raw steaks in vacuum packages to emulate what consumers would see. Objective color was measured using a Minolta Chromameter CR-400 with an 8 mm diameter measurement area, illuminant D65 and a 2° standard observer. Values for L* (brightness), a* (redness), and b* (blue to yellow) were recorded.

For consumer evaluation steaks were placed on a Hamilton Beach Indoor Outdoor grill and cooked on one side till steaks reached an internal temperature of 95°F. They were then turned over and cooked on the other side until they reached an internal temperature of 160°F. Steaks were then cut into 1-cm cubes and all treatments were served in random order. Taste panels were completed over two days with 176 PM steaks prepared for day one and 176 GM steaks prepared for day two. Consumers (n = 204) evaluated steaks on a scale of one to eight for juiciness and flavor (1 = extremely undesirable, 8 = extremely desirable) and off-flavor intensity (1 = extremely mild, 8 = extremely intense). Each individual steak was evaluated by five consumers.

Each steak type was analyzed separately. Statistical analysis was conducted using SAS and a completely randomized design with the main effect being the different microbial treatments and random effect of panelist was used (in taste panel only). Analysis of Variance (ANOVA) was performed using the GLIMMIX procedure with mean separation determined using LS MEANS and DIFF LINES options of SAS, with significance determined at $P \leq 0.05$.

Results

Steaks treated with lactic acid and commercial blend were the most effective antimcrobial treatment ($P < 0.01$) (Table 1 and Table 2) for

Table 1. Mean antimicrobial treatment effects on *Psoas major* steaks.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Log before	3.00	3.07	3.13	2.99		
Log after	2.49	2.54	2.17	1.89		
Log reduction	0.51[b]	0.50[b]	0.97[a]	0.98[a]	0.0978	<.01

[a,b]Means with different superscripts within the same row differ ($P < 0.05$).

Table 2. Mean antimicrobial treatment effects on *Gluteus medius* steaks.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Log before	2.73	2.78	2.68	2.59		
Log after	2.20	2.14	1.35	1.02		
Log reduction	0.54[b]	0.64[b]	1.33[a]	1.57[a]	0.1259	<.01

[a,b]Means with different superscripts within the same row differ ($P \leq 0.05$).

Table 3. *Psoas major* color and sensory properties.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Juiciness	4.75[ab]	4.68[b]	4.69[b]	4.99[a]	0.1246	0.05
Flavor	5.39[ab]	5.40[a]	5.19[b]	5.57[a]	0.1127	0.01
Off-Flavor Intensity	2.49	2.41	2.56	2.65	0.1511	0.16
Discoloration (%)	48.14[b]	51.00[b]	37.72[c]	67.85[a]	2.670	<.01
L* (%)	42.65[a]	42.10[ab]	42.23[ab]	41.00[a]	0.3735	0.06
a* (%)	14.73[a]	14.87[a]	15.37[a]	13.72[b]	0.2128	<.02
b* (%)	9.06	9.12	9.59	9.45	0.1851	0.22

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$).

Table 4. *Gluteus medius* color and sensory properties.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Juiciness	4.52	4.31	4.48	4.51	0.1286	0.33
Flavor	5.18	5.21	5.18	5.17	0.1073	0.99
Off-Flavor Intensity	2.75	2.65	2.74	2.83	0.1549	0.51
Discoloration (%)	43.60[b]	57.88[a]	31.82[c]	48.81[b]	2.568	<.01
L* (%)	40.11[b]	42.36[a]	40.36[a]	39.48[b]	0.3442	<.01
a* (%)	16.19[b]	15.26[c]	17.45[a]	16.08[bc]	0.2742	<.01
b* (%)	10.24[b]	10.58[b]	11.19[a]	11.09[a]	0.1477	0.02

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$).

both PM and GM steaks. When comparing percent discoloration (Tables 3 and 4) lactic acid treated PM steaks showed the largest percent discoloration ($P < 0.01$) compared to GM steaks where bromine treated revealed the largest percent discoloration ($P < 0.01$).

Consumer evaluation for PM steaks showed lactic acid samples were more desirable ($P = 0.05$) for juiciness and flavor ($P = 0.01$) when compared to control, bromine, and commercial blend samples. There were no significant preferences for off-flavor intensity among treatments for PM steaks. The GM steaks showed no significant preferences among treatments for juiciness, flavor, and off-flavor. In conclusion, lactic acid was the most effective for microbial treatment, but also showed the lightest color with the lowest L* value while commercial blend treated samples showed less overall discoloration and more redness (a*).

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Nutrient Differences of Beef from Steers with Different Genotypes for Myostatin

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Galen E. Erickson[1]

Summary

Strip loins and eye of rounds from steers genotyped as having zero, one, or two copies of the inactive myostatin (IM) mutation were obtained. Steaks for nutrient analysis were cut and frozen and steaks for tenderness were aged for 14 days and cooked fresh, never frozen. Meat from cattle with one copy and two copies were more tender than zero copy cattle for eye of round steaks. Homozygous IM cattle had less overall fat content and calories than homozygous normal cattle.

Introduction

Myostatin is a negative regulator of skeletal muscle mass. In cattle, the inactive myostatin gene is responsible for double muscling which causes an increase in muscle fiber number (hyperplasia). (Kambadur et al., *Genome Research,* 1997). We hypothesized that meat from cattle with two copies of the inactive allele would be equivalent in tenderness to cattle containing zero and one copies even though the product is leaner. This study was conducted to determine tenderness and nutrient composition differences of steers from different genotypes (0, 1, or 2 copies of the inactive myostatin allele).

Procedure

Fifty- nine steers (n = 21, 22, and 16 carrying 0, 1, and 2-copies of the inactive myostatin allele) were individually fed the same diet for 182 days, and then finished for 50 days, for a total of 232 days on feed. At 3 days postmortem samples were collected from the carcasses. Samples for nutrient analysis (proximate, lipid, and mineral content) were drawn from 58 strip loins (*Longissimus lumborum;* n = 20, 22, and 16*)* and 59 eye of rounds (*semitendinosus;* n = 21, 22, and 16) for 0, 1, and 2-copy genotypes, respectively. Steaks for nutrient analysis were cut to 0.5-inch thickness and trimmed to .125-inch subcutaneous fat and frozen.

After aging 14 days, steaks for Warner-Bratzler Shear Force (WBSF) determination were cut to 1-inch thickness. Initial temperature and weight were recorded for each steak before being cooked on a Hamilton Beach Indoor/Outdoor grill. Steaks were cooked to an internal temperature of 95°F and were then turned and cooked on the other side until the internal temperature reached 160°F. After cooking steaks were reweighed for a final weight and recorded to determine cooking loss. Steaks were wrapped in oxygen permeable film and placed in a cooler for 24 hr at 39°F. After 24 hours six cores (0.5 inch in diameter) were taken from each steak parallel with the muscle fiber direction and sheared to determine WBSF.

Data was analyzed using a completely randomized design in SAS (Version 9.1) with the fixed effects being the different inactive myostatin mutations and random effect of the animal was used. Analysis of Variance (ANOVA) was performed using the Proc Mixed procedure with mean separation determined using LS MEANS and DIFF LINES options of SAS (SAS Inst. Inc., Cary, N.C.), with significance determined at $P \leq 0.05$.

Results

Fat content ($P < 0.01$) and total calories ($P < 0.10$) were lower (Table 1 and Table 2), while moisture ($P < 0.01$) and protein content

Table 1. Proximate, lipid, and mineral analysis of strip loin from cattle with 0, 1, or 2 copies of the inactive myostatin allele.

Trait	Unit	Number of Inactive Myostatin Alleles			SEM	*P*-value
		0	1	2		
Number of Samples		20	22	16		
Proximate Analysis						
Moisture	%	58.92[c]	65.23[b]	70.45[a]	0.509	<.01
Protein	%	19.39[c]	20.82[b]	24.22[a]	0.291	<.01
Fat	%	20.72[a]	13.15[b]	3.49[c]	0.728	<.01
Ash	%	0.635[c]	0.828[b]	0.954[a]	0.042	<.01
Carbohydrates	%	1.028	0.78	1.34	0.354	0.50
Calories	kCal	298.40[a]	227.41[b]	148.7[c]	6.115	<.01
Lipid Analysis						
Cholesterol	mg/100g	43.35[b]	43.18[b]	48.31[a]	1.003	0.04
Saturated Fatty Acids	% of fat	46.70[b]	46.76[b]	49.94[a]	0.630	0.03
Monounsaturated Fatty Acids	% of fat	48.92[a]	47.70[a]	39.38[b]	0.765	<.01
Polyunsaturated Fatty Acids	% of fat	3.40[b]	4.32[b]	9.11[a]	0.521	<.01
Trans Fatty Acids	% of fat	0.99	1.19	1.57	0.067	<.01
Mineral Analysis						
Sodium	ppm	437.70[ab]	419.80[b]	443.52[a]	7.401	0.039
Potassium	ppm	2800.85[c]	3054.68[b]	3305.19[a]	47.470	<.01
Calcium	ppm	59.70[b]	75.53[a]	81.53[a]	3.927	0.03
Iron	ppm	13.072	13.99	12.51	0.519	0.935

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$)

Table 2. Proximate, lipid, and mineral analysis of eye of round from cattle with 0, 1, or 2 copies of the inactive myostatin allele.

		Number of Inactive Myostatin Alleles				
Trait	Unit	0	1	2	SEM	*P*-value
Number of Samples		21	22	16		
Proximate Analysis						
Moisture	%	69.36[c]	72.67[b]	73.89[a]	0.306	<.01
Protein	%	21.51[c]	23.44[b]	24.25[a]	0.185	<.01
Fat	%	7.88[a]	3.51[b]	0.78[c]	0.418	<.01
Ash	%	0.92[b]	1.05[a]	0.93[b]	0.040	0.02
Carbohydrates	%	1.08	0.31	0.47	0.339	0.11
Calories	kCal	178.71	140.77	117.63	3.654	<.01
Lipid Analysis						
Cholesterol	mg/100g	47.29[b]	48.86[b]	53.75[a]	0.741	<.01
Saturated Fatty Acids	% of fat	45.28[a]	45.10[a]	42.96[b]	0.549	0.04
Monounsaturated Fatty Acids	% of fat	49.54[a]	46.09[b]	36.41[c]	0.899	<.01
Polyunsaturated Fatty Acids	% of fat	4.30[c]	7.83[b]	19.61a	0.778	<.01
Trans Fatty Acids	% of fat	0.88	0.99	1.09	0.076	0.11
Mineral Analysis						
Sodium	ppm	418.77[a]	399.87[b]	408.11[ab]	5.985	0.42
Potassium	ppm	3483.76[b]	3684.41[a]	3754.31[a]	36.109	<.01
Calcium	ppm	42.63	43.03	45.31	1.532	0.38
Iron	ppm	14.06[a]	13.10[a]	10.94[b]	0.413	<.01

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$).

Table 3. Tenderness (shear force) and cooking loss of strip and eye of round steaks from cattle with 0,1, or 2 copies of the inactive myostatin allele.

	Number of Inactive Myostatin Alleles				
Trait	0	1	2	SEM	*P*-value
Strip Steak Cooking Loss (%)	15.04	18.88	18.64	1.957	0.25
Strip Steak Shear Force (kg)	2.62	2.79	2.87	0.095	0.13
Eye of Round Cooking Loss (%)	19.83	21.61	22.74	1.585	0.36
Eye of Round Shear Force (kg)	3.60[a]	2.99[b]	3.10[b]	0.052	<.01

[a,b]Means with different superscripts within the same row differ ($P \leq 0.05$).

($P < 0.01$) were higher in meat from cattle with two copies compared to zero copies of the myostatin mutation. The two copy samples had a lower percentage of monounsaturated fatty acids than zero copy and one copy ($P < 0.01$). The zero and one copy samples had a lower percentage of polyunsaturated fatty acids ($P < 0.01$) and a lower level of cholesterol ($P < .01$) than two copy. Meat from cattle with two copies of the inactive myostatin allele tended to have less iron and more calcium compared to zero copy and one copy and was inconsistent in content of other minerals. The one and two copy steaks from the eye of round were lower in shear force ($P < 0.01$) than zero copy; there were no differences in shear force among genotypes for strip steaks.

In conclusion, meat from cattle with two copies of the inactive myostatin mutation had less fat content and calories than those with zero copy. As well, meat from cattle with one copy and two copies were more tender than zero copy for the eye of round.

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Statistics Used in the Nebraska Beef Report and Their Purpose

The purpose of beef cattle and beef product research at University of Nebraska–Lincoln is to provide reference information that represents the various populations (cows, calves, heifers, feeders, carcasses, retail products, etc.) of beef production. Obviously, the researcher cannot apply treatments to every member of a population; therefore, he/she must sample the population. The use of statistics allows the researcher and readers of the *Nebraska Beef Report* the opportunity to evaluate separation of random (chance) occurrences and real biological effects of a treatment. Following is a brief description of the major statistics used in the beef report. For a more detailed description of the expectations of authors and parameters used in animal science see *Journal of Animal Science Style and Form* at: *http://jas.fass.org/misc/ifora.shtml*.

— **Mean** — Data for individual experimental units (cows, steers, steaks) exposed to the same treatment are generally averaged and reported in the text, tables and figures. The statistical term representing the average of a group of data points is mean.

— **Variability** — The inconsistency among the individual experimental units used to calculate a mean for the item measured is the variance. For example, if the ADG for *all* the steers used to calculate the mean for a treatment is 3.5 lb then the variance is zero. But, this situation never happens! However, if ADG for individual steers used to calculate the mean for a treatment range from 1.0 lb to 5.0 lb, then the variance is large. The variance may be reported as standard deviation (square root of the variance) or as standard error of the mean. The standard error is the standard deviation of the mean as if we had done repeated samplings of data to calculate multiple means for a given treatment. In most cases treatment means and their measure of variability will be expressed as follows: 3.5 ± 0.15. This would be a mean of 3.5 followed by the standard error of the mean of 0.15. A helpful step combining both the mean and the variability from an experiment to conclude whether the treatment results in a real biological effect is to calculate a 95% confidence interval. This interval would be twice the standard error added to and subtracted from the mean. In the example above, this interval is 3.2-3.8 lb. If in an experiment, these intervals calculated for treatments of interest overlap, the experiment does not provide satisfactory evidence to conclude that treatments effects are different.

— ***P* Value** — Probability (*P* Value) refers to the likelihood the observed differences among treatment means are due to chance. For example, if the author reports $P \leq 0.05$ as the significance level for a test of the differences between treatments as they affect ADG, the reader may conclude there is less than a 5% chance the differences observed between the means are a random occurrence and the treatments do not affect ADG. Hence we conclude that, because this probability of chance occurrence is small, there must be difference between the treatments in their effect on ADG. It is generally accepted among researchers when *P* values are less than or equal to 0.05, observed differences are deemed due to important treatment effects. Authors occasionally conclude that an effect is significant, hence real, if P values are between 0.05 and 0.10. Further, some authors may include a statement indicating there was a "tendency" or "trend" in the data. Authors often use these statements when *P* values are between 0.10 and 0.15, because they are not confident the differences among treatment means are real treatment effects. With *P* values of 0.10 and 0.15 the chance random sampling caused the observed differences is 1 in 10 and 1 in 6.7, respectively.

— **Linear & Quadratic Contrasts —** Some articles contain linear (L) and quadratic (Q) responses to treatments. These parameters are used when the research involves increasing amounts of a factor as treatments. Examples are increasing amounts of a ration ingredient (corn, by-product, or feed additive) or increasing amounts of a nutrient (protein, calcium, or vitamin E). The L and Q contrasts provide information regarding the shape of the response. Linear indicates a straight line response and quadratic indicates a curved response. P-values for these contrasts have the same interpretation as described above.

— **Correlation (r) —** Correlation indicates amount of linear relationship of two measurements. The correlation coefficient can range from B1 to 1. Values near zero indicate a weak relationship, values near 1 indicate a strong positive relationship, and a value of B1 indicates a strong negative relationship.

Animal Science

http://animalscience.unl.edu

Curriculum: The curriculum of the Animal Science Department at the University of Nebraska–Lincoln is designed so that each student can select from a variety of options oriented to specific career goals in professions ranging from animal production to veterinary medicine. With unique opportunities to double major in ***Grazing Livestock Systems*** (*http://gls.unl.edu*) or complete the ***Feedlot Management Internship Program*** (*http://feedlot.unl.edu/intern*)

Careers:

Animal Health
Banking and Finance
Animal Management
Consultant
Education
Marketing
Technical Service
Meat Processing
Meat Safety
Quality Assurance
Research and Development
Veterinary Medicine

Scholarships: The Animal Science Department also offers scholarships to incoming freshmen and upperclassmen. The department awards over $30,000 each year to Animal Science students.

ABS Global Scholarship
Baltzell-Agri-Products, Inc. Scholarship
Maurice E. Boeckenhauer Memorial Scholarship
Mike Cull Judging and Activities Scholarship
Don Geweke Memorial Award
Parr Young Senior Merit Award
Nebraska Pork Producers Association Scholarship
Waldo Family Farms Scholarship
Frank and Mary Bruning Scholarship
Art and Ruth Raun Scholarship
Animal Science Department Freshman Scholarship
Feedlot Management Scholarship
Robert Boeckenhauer Memorial Scholarship
Burnell Scholarship Fund
Doane Scholarship
Lincoln Coca-Cola Bottling Company Scholarship.
William J. and Hazel J. Loeffel Scholarship
Nutrition Service Associates Scholarship
Parr Family Student Support Fund
Chris and Sarah Raun Memorial Scholarship
Walter A. and Alice V. Rockwell Scholarship
Standard Manufacturing Co. Scholarship
Max and Ora Mae Stark Scholarship
D.V. and Ernestine Stephens Memorial Scholarship
Dwight F. Stephens Scholarship
Arthur W. and Viola Thompson Scholarship
Thomas H. Wake, III Scholarship
Frank E. Card Scholarship
Derrick Family Scholarship
G. H. Francke Livestock Judging Scholarship
Eric Peterson Memorial Award
Winkler Memorial Livestock Judging Scholarship