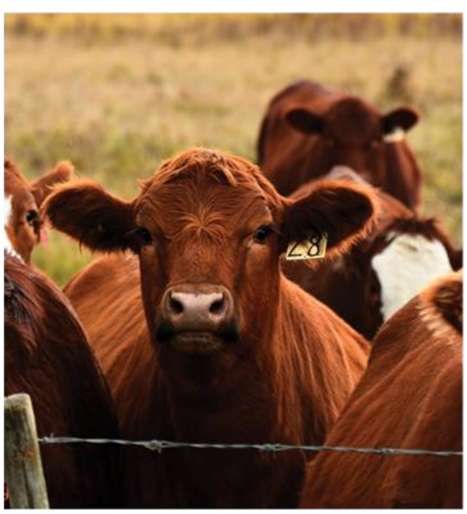
South Dakota State University
Department of Animal Science

South Dakota State University Extension

Animal Science Research Report

2024



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Statistics in the South Dakota State University Animal Science Report

The purpose of research at SDSU is to provide reference information that represents the various populations of livestock production. Since the researcher cannot apply treatments to every member of a population, he/she must sample the population. The use of statistics allows the researcher and readers the opportunity to evaluate separation of random occurrences and real biological effects of a treatment. The following is a brief description of the major statistics used in these proceedings.

- **Mean:** Data for individual experimental units (cows, pens of cattle, 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. However, if ADG for individual steers is 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: 3.50 ± 0.150. This would be a mean of 3.5 followed by the standard error of the mean of 0.150. 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 3.20 to 3.80 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 (or 95% sure that the difference was not due to random chance). Due to this small probability of chance, there must be a difference between the treatments in their effect on ADG. Authors may discuss tendencies in data when *P* values are between 0.06 and 0.15, because they are not confident the differences among treatment means are real treatment effects. With *P* values of 0.06 and 0.15 the chance random sampling caused the observed differences is 1 in 16.7 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 -1 to 1. Values near zero indicate a weak relationship, values near 1 indicate a strong positive relationship, and a value of -1 indicates a strong negative relationship.

- **Chi square (χ^2):** A statistical test used to compare observed results with expected results. The purpose of this test is to determine if a difference between observed data and expected data is due to chance, or if it is due to a relationship between the variables being studies. This is a nonparametric test used for data that don't follow the assumption of a normal distribution. The null hypothesis is that there are no differences between the variables. A $\chi^2 \leq 0.05$ is considered statistically significant, thus, the null hypothesis should be rejected in favor of the alternative hypothesis.

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Ruminant and Meat Science Research

Utilization of camera grading technology for bison carcass characteristics

Christina Bakker, Jessica Sparks, Keith Underwood, Kyle Grubbs, and Amanda Blair

Rationale and Approach

The United States Department of Agriculture (USDA) published the first beef grading standards in 1924. Since then, many changes have been made to the standards including the names of some grades and the factors that are evaluated. The current beef grading system evaluates indicators of carcass palatability (quality grades) and carcass yield (yield grades). Quality grades consider carcass maturity, lean color, and the amount of marbling within the ribeye of a beef carcass that has been cut, or ribbed, between the 12th and 13th ribs. Yield grades are calculated using the fat thickness opposite the ribeye, ribeye area, hot carcass weight, and the percentage of carcass weight made up by fat around the kidneys, heart, and pelvic area. The use of instruments to assess beef carcass grades has been approved since 2007 for yield grades and 2009 for quality grades. While beef grading standards have been extensively studied and established, no established grading system for bison carcasses exists in the United States. However, Canada has developed a bison grading system based on maturity, muscling, fat cover, and fat and lean color, allowing Canadian bison producers to capture value in a carcass-based marketing system. If desired by the US Bison industry, a grading system would ideally include a rapid measurement of the designated carcass characteristics.

The objective of this study was to evaluate the ability of beef camera grading technology to assess characteristics of bison carcasses.

Bison heifers (n = 201) were transported to a commercial packing facility and harvested at 28 months of age. The heifers were from both grain and grass finishing systems to provide variation in carcass characteristics. Carcasses were ribbed between the 12th and 13th ribs and allowed to bloom, similar to beef grading protocols. Expert USDA graders evaluated ribeye area, backfat thickness and marbling score on one side of each carcass. Additionally, USDA personnel captured images of the same side using the calibrated hand-held portion of a VBG2000 image processing system. The VBG2000 system is approved for the evaluation of beef carcasses in the U.S. but has not been approved for bison carcasses due to the absence of an official grading system and the required calibration standards.

Findings

Positive correlations were observed between USDA graders and camera measurements for yield grade, backfat thickness, ribeye area, and marbling scores (Table 1). Strong correlations ($R > 0.50$) were observed between the camera and USDA graders for yield grade calculations and backfat measurements. Moderate correlations ($0.30 < R < 0.50$) were observed for ribeye area and marbling measurements.

Implications

Bison carcass data captured using a beef grading camera were correlated with expert grader evaluations. This means that the VBG2000 camera system is capable of accurately measuring carcass characteristics of bison carcasses according to beef carcass standards. However, validation of a suitable camera grading system for bison will require additional investigation including calibration and adjustments for bison carcass characteristics and the development of a bison carcass grading system.

Acknowledgements

The authors express their gratitude to USDA AMS and to Darrell Dowd, Willie Horne, and Leonard Woody who served as the expert graders for this project. We also thank Turner Enterprises, Inc. for their support of this project and allowing use of their animals for grading.

Table 1. Correlations of bison carcass characteristics between VBG2000 image processing system and USDA expert grader evaluations.

Variables	R-value	P-value
Camera YG & Calculated YG[1]	0.98	<0.01
Camera YG & Calculated Grader YG	0.83	<0.01
Calculated Camera YG & Calculated Grader YG	0.83	<0.01
Camera Backfat & Grader Backfat	0.68	<0.01
Camera REA & Grader REA	0.47	<0.01
Camera Marbling & Grader Marbling	0.45	<0.01

[1]Calculated Yield Grade (YG): calculated using regression equation and given carcass parameters: YG = 2.5 +(2.5*Adjusted Backfat) + (0.20*kidney, pelvic, heart fat, %) – (0.32*ribeye area [REA]) + (0.0038*hot carcass weight)

Animal Science Research Report 2024

Influence of Finishing Systems on Carcass Characteristics, Composition, and Fatty Acid Profile of Bison Bulls

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Rationale and Approach

Bison were hunted to near extinction in North America in the 1800s; however, numbers have rebounded to approximately 440,000 head currently. Despite growing popularity, carcass and nutritional attributes of bison are not well characterized. Both bison bulls and heifers are marketed for meat production in the United States, and bulls represent a greater proportion of the slaughter mix. In addition, both grain- and grass-finishing systems are utilized within the industry, further contributing to product variation. Thus, the objective of this study was to determine the influence of grain- and grass-finishing systems on carcass characteristics of bison bulls and composition of bison steaks. Bulls grazed native pasture until approximately 25 months of age, then were assigned to grain-finishing ($n = 98$) or grass-finishing ($n = 98$) treatments. Bulls were slaughtered at approximately 30 months of age. Hot carcass weight, ribeye area, backfat thickness, kidney fat percentage, marbling score, and instrumental color (L^* - lightness, a^* - redness, and b^* - yellowness) of the ribeye and subcutaneous fat were recorded. Skeletal maturity, lean maturity, and fat color were subjectively scored by trained personnel. Strip loins were collected from a subsample and fabricated into 1-inch steaks for determination of proximate analysis (proportion of water, protein, fat, and ash), cholesterol, and fatty acid profile.

Findings

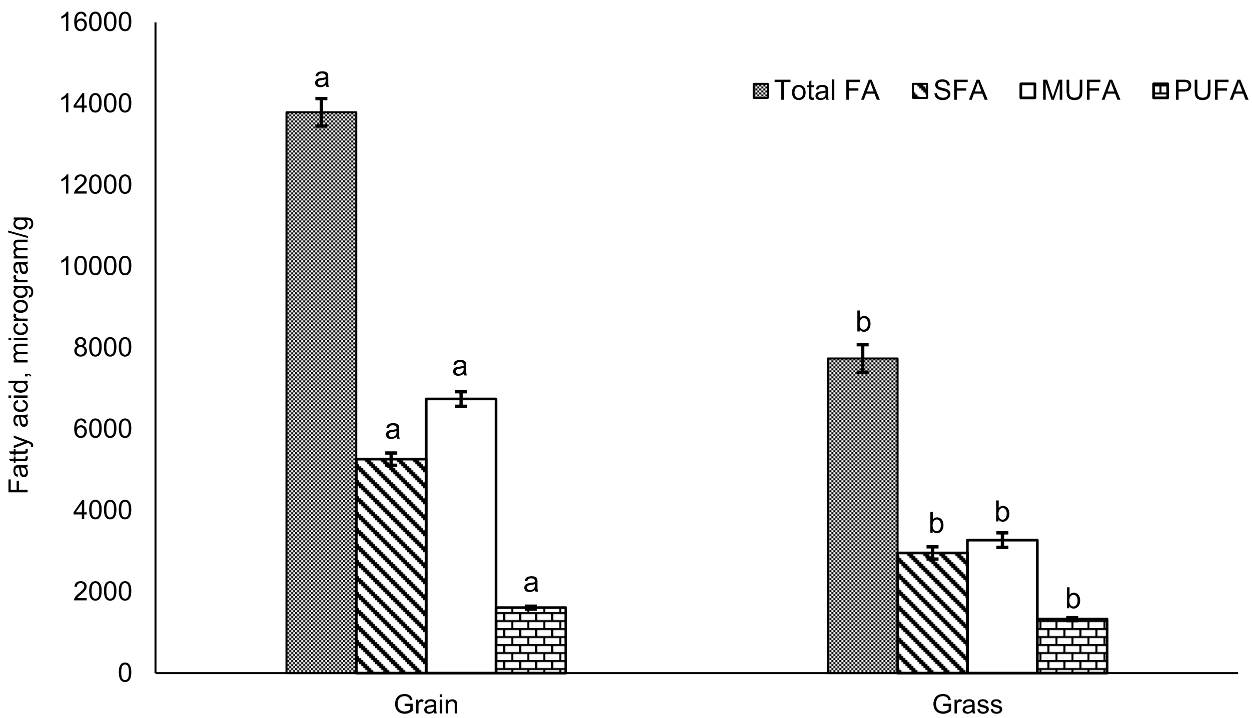
Carcass data are shown in Table 1. Grain-finished bulls had greater ($P < 0.0001$) hot carcass weights, dressing percentage, ribeye area, backfat thickness, kidney fat percentage, and marbling score. When color was evaluated objectively with a handheld colorimeter the a^* (redness) and b^* (yellowness) values of the ribeye and a^* (redness) value of subcutaneous fat were greater ($P < 0.0001$) for grain-finished bulls. However, the L^* (lightness) and b^* (yellowness) values of subcutaneous fat were greater ($P < 0.0001$) for grass-finished bulls indicating a more yellow fat color. When evaluated subjectively by a trained evaluator, a greater proportion ($P < 0.001$) of grain-finished carcasses had moderately bright red lean color, whereas a greater proportion ($P < 0.0001$) of grass-finished carcasses had moderately yellow fat color. Treatment did not influence ($P > 0.05$) skeletal maturity or pH. Steaks from grain-finished bulls had an increased percentage of crude protein ($P < 0.0001$), fat ($P < 0.0001$), and ash ($P < 0.001$) content but less ($P < 0.0001$) moisture (data not shown in tabular form). Steaks from grain-finished bison bulls had increased ($P < 0.0001$) total fatty acid, saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs), and polyunsaturated fatty acids (PUFAs) on a concentration basis (Figure 1). However, when analyzed as a percentage of total fatty acids, SFAs were similar ($P > 0.05$) between finishing treatments, while PUFAs were increased ($P < 0.0001$) in grass-finished steaks and MUFAs were increased ($P < 0.0001$) in grain-finished steaks.

Implications

Finishing system can impact the composition, carcass characteristics, and nutrient profile of meat from bison bulls. Given these differences in carcass and nutritional attributes, it could be beneficial for bison producers to use these distinctions to market desirable attributes of bison meat accordingly.

Acknowledgements

This research was supported by state and federal funds appropriated to South Dakota State University including support from the South Dakota State University Agriculture Experiment Station, USDA National Institute of Food and Agriculture through the Hatch Act (Accession #1020088), by Turner Institute of EcoAgriculture, USA (Grant #3P0510), and the South Dakota State University Center of Excellence for Bison Studies.



[ab]The SE bars represent the variation within each treatment. Within each fatty acid category, means without common letters differ ($P < 0.0001$).

Figure 1. Effect of finishing treatment on the fatty acid composition (concentration basis) of strip loin steaks from grain- or grass-finished bison bulls.

Table 1. Effect of finishing system on live weight and carcass characteristics of grain- or grass-finished bison bulls.

Variable	Treatments			
	Grain[1]	Grass[1]	SEM[2]	*P*-value[3]
Live weight, lb	1058	913	5.97	<0.0001
Hot carcass weight, lb	637	511	4.20	<0.0001
Dressing percentage, %	60.3	55.9	0.179	<0.0001
Ribeye area, in^2	10.1	9.3	0.088	<0.0001
Backfat thickness, in	0.39	0.10	0.008	<0.0001
Kidney fat, %	2.56	0.97	0.057	<0.0001
Marbling score[4]	185	105	4.357	<0.0001
Subjective skeletal maturity[5]				
Moderate, %	3.06	0.00	1.740	0.9739
Slight, %	96.94	100.00	1.740	0.9739
Lean maturity[5]				
Pale Red, %	0.00	1.02	1.015	0.9761
Red, %	7.14	11.22	3.189	0.3275
Slightly Bright Red, %	57.14	75.51	5.000	0.0077
Moderately Bright Red, %	34.69	12.24	4.808	0.0004
Bright Red, %	1.02	0.00	1.015	0.9761
Subjective external fat color[5]				
Yellow, %	0.00	3.06	1.740	0.9739
Moderately Yellow, %	12.24	39.80	4.944	<0.0001
Slightly White, %	37.76	8.16	4.897	<0.0001
Moderately White, %	48.98	15.31	5.050	<0.0001
White, %	1.02	33.67	4.774	0.0002
Objective lean color[6]				
L*	36.07	35.93	0.203	0.6419
a*	22.15	20.93	0.144	<0.0001
b*	7.68	6.72	0.010	<0.0001
Objective subcutaneous fat color[7]				
L*	74.27	76.01	0.256	<0.0001
a*	3.80	2.52	0.161	<0.0001
b*	15.17	18.62	0.258	<0.0001
Ultimate pH	5.68	5.65	0.013	0.1393

[1]Treatments: Grain= bison bulls (n = 98) backgrounded on grain and finished for 146 days with ad libitum access to grass hay, alfalfa, and corn prior to slaughter. Grass = bison bulls (n = 98) remained on native pasture until slaughter.
[2]Standard error of the mean
[3]Probability of difference among least square means
[4]Marbling score: 100 = Practically Devoid^0, 200 = Traces^0
[5]Subjective skeletal maturity, lean maturity, and external fat color assigned by USDA grader.
[6]Objective color measurement recorded on the exposed ribeye; L*: 0 = Black, 100 = White; a*: Negative values = green; Positive values = red; b*: Negative values = blue; Positive values = yellow.
[7]Objective color measurement of subcutaneous fat recorded on the external surface of the carcass, opposite the exposed ribeye; L*: 0 = Black, 100 = White; a*: Negative values = green; Positive values = red; b*: Negative values = blue; Positive values = yellow.

Influence of vegetative diversity during the stocker phase on carcass characteristics and economic returns of beef steers

Sydni Borders, Jameson Brennan, Christina Bakker, Keith Underwood, Kyle Grubbs, John Jaeger, Ken Olson, Amanda Blair

Rationale and Approach

Stocking rate can influence the profitability and performance of both rangeland and livestock. Adjustments in this metric can create differences in vegetative composition and diversity of rangeland over time. At the South Dakota State University Cottonwood Field Station, a long-term grazing study has been conducted with 3 levels of grazing intensity (low = 0.32 AUM/acre, moderate = 0.40 AUM/acre, and high = 0.72 AUM/acre) since 1942 creating three distinct plant communities of rangeland vegetation, ranging from highly diverse (lightly grazed) to shortgrass dominated (heavily grazed) (Dunn et al., 2010). These differences have been shown to affect growth and performance during the stocker phase, however little is known about how differences in growth during this phase affect subsequent carcass performance and value. Therefore, the objective of this research was to determine the influence of vegetative composition and diversity driven by grazing history during the stocker phase on carcass traits and economic returns of beef steers. Yearling steers (n = 134, 116, 131, in 2020, 2021, 2022, respectively) were randomly assigned to the long-term grazing pastures. At the completion of the stocker phase, steers were weighed, transported to the Kansas State University Agricultural Research Center at Hays, KS where they maintained their pasture groups for finishing. Steers were harvested when estimated to achieve a compositional endpoint similar to industry standards, and hot carcass weight (HCW), backfat thickness, ribeye area (REA), marbling score, and USDA Quality and Yield grades were recorded. Production (HCW/acre) and economic return per carcass and per acre were calculated.

Findings

Stocking rate did not influence (P > 0.05) weight at the end of the stocker phase, carcass traits or carcass value (Table 1). However, differences were detected between years (Table 2). Steers were lighter (P < 0.001) in 2022 than in 2020 and 2021 and had greater (P < 0.001) HCW, backfat, yield grade, and marbling scores in 2021 compared to 2020 and 2022, while REA was similar (P > 0.05) in 2021 and 2022 but larger (P < 0.05) than in 2020. Carcass value in 2020 was less (P < 0.001) than 2021 and 2022, which did not differ (P > 0.05). Stocking rate and year interacted (P < 0.01) for HCW (lb per acre) and carcass value per acre. Body weight produced per acre at the end of the stocker phase differed (P < 0.01) among all three treatments with heavy stocking rate yielding the greatest and light stocking rate yielding the least (data not in tabular form). Hot carcass weight and value per acre increased (P < 0.01) as stocking rate increased with the interaction caused by years; whether moderate stocking differed (P < 0.0) from light or heavy stocking (data not in tabular form).

Implications

Differences in vegetative composition driven by stocking rate did not carryover to impact carcass traits. However, heavier stocked pastures returned greater overall beef production and economic value due to the increase in animals produced per unit of land demonstrating that stocking rate can influence the profitability of an operation without negatively impacting carcass traits.

References

Dunn, B. H., A. J. Smart, R. N. Gates, P. S. Johnson, M. K. Beutler, M. A. Diersen, and L. L. Janssen. 2010. Long-term production and profitability from grazing cattle in the northern mixed grass prairie. *Rangeland Ecology & Management* 63:233-242.

Table 1. Least square means for stocking rate on live weight, carcass characteristics, and value.

	Treatments				
	Light	**Moderate**	**Heavy**	**SEM[1]**	***P*-value**
End Weight[2], lbs	815.9	802.6	800.9	6.79	0.283
Hot carcass weight, lbs	877.9	866.7	868.4	6.32	0.437
Ribeye area, in^2	13.47	13.34	13.48	0.156	0.786
12th rib fat thickness, in	0.657	0.665	0.628	0.020	0.421
Calculated yield grade	3.44	3.47	3.32	0.085	0.437
Marbling score[3]	513.10	515.39	529.73	8.044	0.272
Carcass Value, $/hd	1891	1865	1846	19.2	0.300
USDA Yield Grade[4]					
Yield Grade 2, %	23.31	16.05	24.52	4.66	0.567
Yield Grade 3, %	43.82	44.88	55.45	4.52	0.446
USDA Quality Grade[4]					
Upper 2/3 Choice, %	40.38	48.39	44.70	4.655	0.623
Low Choice, %	38.90	32.11	34.91	5.201	0.703

[1] Standard error of the mean
[2] Body weights of steers at the end of the stocker phase
[3] Marbling score: $400=Small^0$, $500=Modest^0$, $600=Moderate^0$
[4] Calculated proportions of USDA Quality and Yield Grade (model did not converge for USDA Select, USDA Prime, USDA Yield Grade 1,4,5).

Table 2. Least square means for year effect on live weight, carcass characteristics, and value.

Item	Years 2020	2021	2022	SEM[1]	*P*-value
End Weight[2], lbs	846.6[a]	852.6[a]	720.1[b]	6.79	<0.001
Hot carcass weight, lbs	798.8[a]	975.1[b]	839.0[a]	6.32	<0.001
Ribeye area, in^2	13.03[a]	13.69[b]	13.57[b]	0.156	0.035
12th rib fat thickness, in	0.555[a]	0.745[b]	0.650[c]	0.0197	<0.001
Calculated yield grade	3.085[a]	3.872[b]	3.272[a]	0.0850	<0.001
Marbling score[3]	492.7[a]	574.2[b]	491.3[a]	8.044	<0.001
Carcass Value, $/hd	1429[a]	2099[b]	2075[b]	19.2	<0.001
USDA Yield Grade[4]					
Yield Grade 2	41.77	7.614	24.21	4.29	0.176
Yield Grade 3	54.45	39.39	50.45	4.64	0.386
USDA Quality Grade[4]					
Upper 2/3 Choice	40.19	54.71	38.74	4.74	0.348
Low Choice	52.33	13.37	48.80	4.41	0.160

[1] Standard error of the mean
[2] Body weights of steers at the end of the stocker phase
[3] Marbling score: 400=Small^0, 500=Modest^0, 600=Moderate^0
[4] Calculated proportions of USDA Quality and Yield Grade (model did not converge for USDA Select, USDA Prime, USDA Yield Grade 1,4,5).

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Effects of peri-castration pain management strategies on feed and water intake, performance, and blood cortisol levels of weaned beef steers

Andrea K. Brandner, Cody L. Wright, Ana Clara B. Menezes

Rationale and Approach

Beef cattle seed stock producers commonly delay castration of non-sale bulls until after weaning data has been collected, reported, and analyzed by breed associations. Production practices that can be implemented to reduce discomfort will likely not only reduce stress on the animal but may also result in them returning to normal feeding behavior and growth more quickly. One method that has been evaluated previously to reduce the discomfort an animal experiences during castration is the administration of anesthetic and analgesic medications immediately prior to the procedure. Therefore, objectives of this study were to identify if pain management strategies at the time of castration impact feed and water intake, performance, or blood cortisol levels in weaned beef steers. Thirty black Angus and Simmental Angus cross bulls (Average 8 ± 1 mo, BW=600 ± 100lbs) were randomly assigned to 1 of 3 treatment groups: 1) Control (CON; *n* = 10 bulls), castrated via banding ; 2) Analgesic (M; *n* = 10 bulls), received an analgesic (meloxicam; 1 mg/kg BW) immediately after banding; and 3) Anesthetic + analgesic (ML; *n* = 10 bulls), received an intra-scrotal and intra-cord anesthetic (total lidocaine 15-20 ml + 10% sodium bicarbonate) injection immediately prior to banding and an analgesic (meloxicam; 1 mg/kg BW) immediately after banding. Blood collections to measure blood cortisol levels were taken on days -7, -0, +0 (day of castration pre and post-procedure, respectively), 1, and 8.

Findings

While administering analgesics or anesthetics may reduce discomfort, the results of this study showed that these pain management practices do not significantly impact ($P \geq 0.07$) on feed (CON = 16.33 lbs; M = 17.03 lbs; ML = 17.77 lbs) and water intake (CON = 46.07 lbs; M = 50.79 lbs; ML = 49.79 lbs), performance (CON = 761.48 lbs; M = 786.98 lbs; ML = 731.78 lbs), or blood cortisol levels (CON = 1.01 ug/dL; M = 1.19 ug/dL; ML = 1.38 ug/dL).

Implications

These data indicate that peri-castration pain management strategies can be adopted at the producers' managerial discretion.

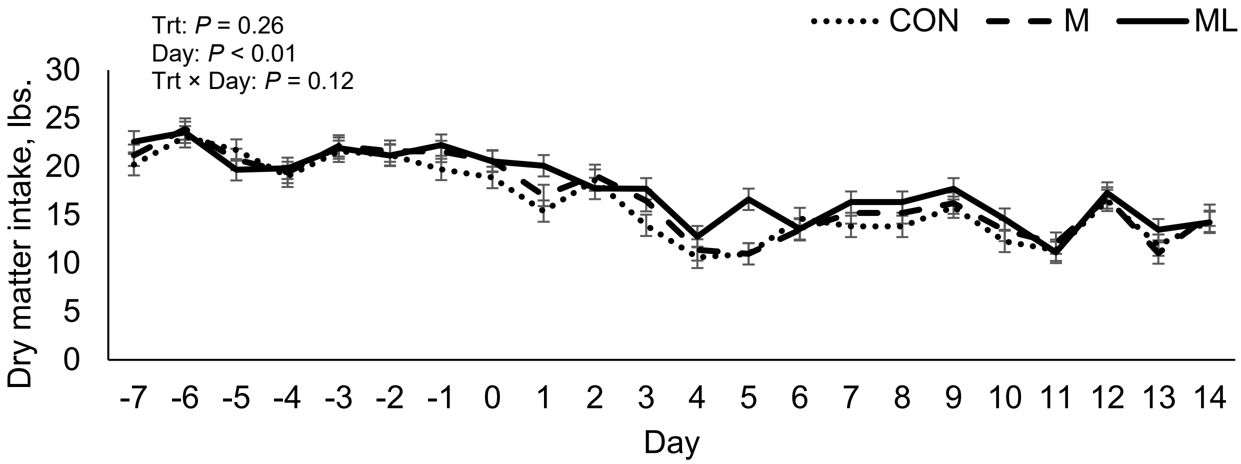

Figure 1. Effects of peri-castration pain management strategies on feed intake. CON, control: No analgesic or anesthetic; M, Analgesic (Meloxicam; 1 mg/kg BW) immediately after banding; ML, Intra-scrotal and intra-cord anesthetic injection (Lidocaine; 15-20 ml + 10% sodium bicarbonate) immediately prior to banding and analgesic immediately after banding.

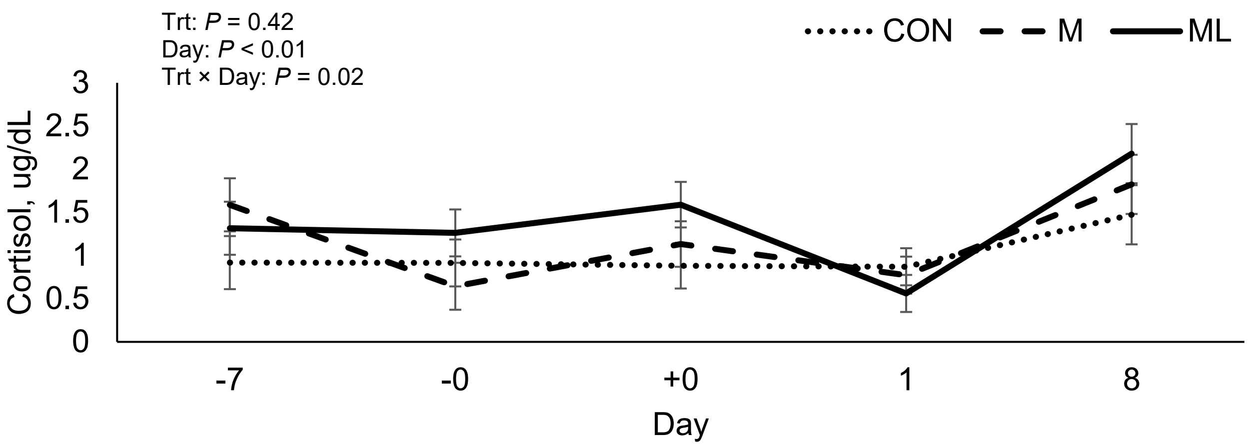

Figure 2. Effects of peri-castration pain management strategies on blood cortisol levels. CON, control: No analgesic or anesthetic; M, Analgesic (Meloxicam; 1 mg/kg BW) immediately after banding; ML, Intra-scrotal and intra-cord anesthetic injection (Lidocaine; 15-20 ml + 10% sodium bicarbonate) immediately prior to banding and analgesic immediately after banding. Day -0 refers to blood collected right before castration and day +0 refers to blood collected right after castration.

Acknowledgements

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Influence of beef carcass weight on rate of desmin proteolysis in four muscles

Clay J. Carlson, Christina E. Bakker, Keith R. Underwood, Amanda D. Blair, Judson K. Grubbs

Rationale and Approach

Proteolysis is the breakdown or degradation of proteins that causes meat to become more tender as it ages. Analyzing proteolysis can refine understanding and improve prediction of tenderness in beef. Proteolysis of desmin, a protein that aids in keeping muscle structure organized, has been correlated with tenderness. In a live animal, desmin would be intact. As muscle ages postmortem, the intact desmin is degraded. Due to the correlation between desmin degradation and tenderness values, measuring the disappearance of intact desmin can indicate differences in tenderness between samples. Many factors influence the proteolysis of desmin postmortem. One factor that could influence the proteolysis of desmin that is not well understood is the animal's weight at slaughter. Cattle producers strive to increase average daily gain and feed conversion, resulting in heavier cattle at younger ages. Meat processors can improve efficiency by increasing rail weight given the same number of carcasses. As a result, average beef hot carcass weight (HCW) has increased by approximately 165 pounds in the last 30 years (USDA-ERS, 2022). This study aimed to determine the influence of beef HCW on the proteolysis of desmin in four muscles: the eye of round, New York (NY) strip, ribeye, and Denver cut. Twelve carcasses were categorized in two groups: Heavyweight (HW; HCW = 973-1,007 lbs.) or Lightweight (LW; HCW = 753-787 lbs.). Samples were collected from the muscles listed above at 2, 4, 6, 8, 12, 24, and 48 hours, 5 and 10 days postmortem. After collection, samples were vacuum packaged and frozen until analyzed. To analyze proteolysis, proteins were separated using SDS-PAGE gels. Western blotting methods were used to image and analyze the disappearance of intact desmin.

Findings

No HCW by aging time interactions were detected in any of the muscles evaluated. In the Denver cut and ribeye, there was less proteolysis in the HW group (Figure 1). There was no difference in proteolysis between the weight groups in the NY strip and eye of round (Figure 1). In all four muscles, desmin degraded throughout aging (Table 1). In the Denver cut and the eye of round, there were no differences in degradation until 5 and 10 days postmortem. In the ribeye and NY strip, degradation differences were detectable as early as 8 hours postmortem, indicating proteolysis began earlier in these muscles.

Implications

Carcass weight alters total desmin proteolysis in the Denver cut and ribeye, which could result in decreased tenderness in HW carcasses in those muscles. These data suggest that the contribution of proteolysis to tenderness of NY strip and eye of round steaks will not be affected by the size of the beef carcass slaughtered. Other factors, such as rigor, pH, and connective tissue, can also influence tenderness. Therefore, further research should be conducted to determine the effects of HCW on meat quality.

Acknowledgements

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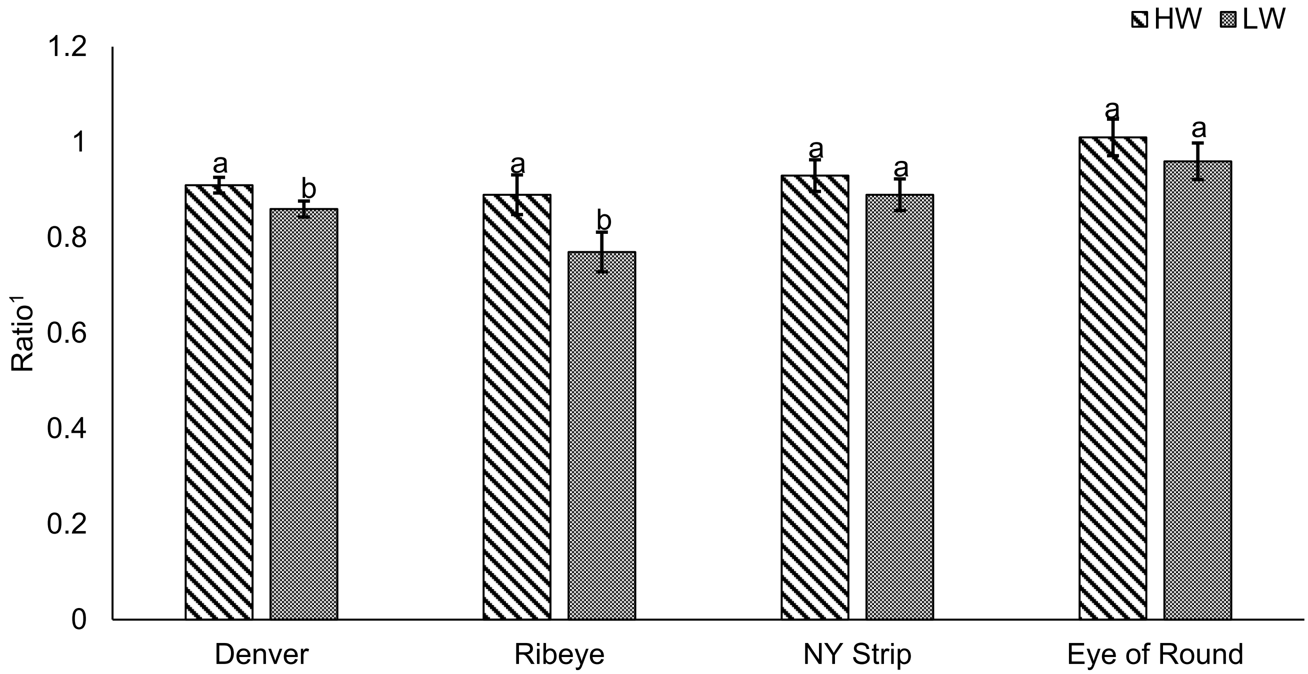
Table 1: Ratio of intact desmin in Denver, Ribeye, NY Strip, and Eye of Round cuts through 10 days postmortem[1]

	Aging Time									
Cut	**2[2]**	**4[2]**	**6[2]**	**8[2]**	**12[2]**	**24[2]**	**48[2]**	**5[2]**	**10[2]**	***P*-Value**
Denver	0.95[a]	0.93[a]	0.95[a]	0.95[a]	0.91[a]	0.89[a]	0.94[a]	0.74[b]	0.70[b]	< 0.0001
Ribeye	1.04[a]	1.02[ab]	0.99[abc]	0.92[bcd]	0.9[bcd]	0.89[cd]	0.85[d]	0.48[e]	0.37[f]	< 0.0001
NY Strip	1.16[a]	1.12[ab]	1.11[ab]	1.09[ab]	1.03[bc]	0.99[c]	0.88[d]	0.69[e]	0.52[f]	< 0.0001
Eye of Round	1.11[a]	1.06[a]	1.07[a]	1.10[a]	1.08[a]	1.02[a]	1.00[a]	0.77[b]	0.66[b]	< 0.0001

[abcdef] Data points within a row lacking common superscripts differ ($P < 0.05$).

[1]A lower ratio indicates more proteolysis of intact desmin has occurred.

[2] Samples were collected at 2, 4, 6, 8, 12, 24, and 48 hours, 5 and 10 days postmortem



[ab]Data points within a muscle lacking a common superscript differ (*P* < 0.05).
[1]A lower ratio indicates more proteolysis of intact desmin has occurred.

Figure 1: Ratio of intact desmin in Denver, Ribeye, NY Strip, and Eye of Round cuts from heavyweight (HW) or lightweight (LW) carcasses

Animal Science Research Report 2024

Influence of By-O-Reg+ Beef inclusion on growth performance and carcass traits of beef steers

Bergin DeBruin, Christina Bakker, Kyle Grubbs, Keith Underwood, Warren Rusche, Zachary Smith, and Amanda Blair

Rationale and Approach

Conventional cattle production often includes the addition of growth promotants such as antibiotics and ionophores (Berthiaume et al., 2006), which have been shown to improve animal health and increase feed efficiency within the beef industry (Barreras et al., 2013; Bergen & Bates, 1984). However, in recent years government agencies have enforced more stringent regulations on utilization of these additives in livestock diets, such as the Veterinary Feed Directive (FDA, 2017). As antimicrobial resistance has become a large concern to producers, natural alternatives have been investigated for their potential to deliver a similar function in growth performance. These natural alternatives include probiotics, yeast products, enzymes, and essential oils (Beck & Biggs, 2022). Essential oils are naturally occurring secondary plant metabolites that have been shown to exhibit antimicrobial and antioxidant activity and have grown in popularity due to interest in natural programs (Simitzis, 2017). However, plant source, composition, and activity of these essential oils creates variation in animal response (Pukrop, Campbell, & Schoonmaker, 2019) and research is needed to evaluate the effects of these compounds on growth performance, as well as their impact on carcass traits.

The objective of this study was to determine the influence of inclusion of an oregano-based essential oil (By-O-Reg+ Beef, Advanced Ag Products, Canton, SD) on growth performance, and carcass traits of yearling steers finished in an all-natural program. Yearling steers (n = 128) were allotted to 16 pens (n = 8 pens/treatment with 8 steers/pen) and pens were assigned to two treatments: 1) no essential oil additive (Control) or 2) By-O-Reg+ fed at 4 grams/head daily (OEO). The final finishing diet [12% CP; 61.75 NEg (Mcal/cwt)] consisted of dry-rolled corn, modified distillers grains, grass hay, sorghum silage, and a liquid supplement containing vitamins and minerals to exceed nutrient requirements and not containing any additional medication. Steers were transitioned from a 70% concentrate diet to a 90% concentrate finishing diet over a 14-day period. Steers remained on the finishing diet until harvest at a commercial packing facility on d 149 and carcass data were recorded.

Findings

Growth performance responses are displayed in Table 1. No differences (P < 0.05) were detected between treatment groups for final body weight, average daily gain, dry matter intake, gain:feed, or gain efficiency (calculated as average daily gain at same DMI). Net energy for maintenance and net energy for gain did not differ (P < 0.05). The proportion of each treatment group removed from study, treated for digestive disorders or subject to death loss did not differ (P < 0.05). Carcass trait responses are displayed in Table 2. Treatment did not influence (P < 0.05) hot carcass weight, dressing percentage, ribeye area, rib fat thickness, marbling score or yield grade. In addition, estimated body fat and actual final body weight did not differ (P < 0.05) between treatment groups.

Implications

These data indicate that the inclusion of an oregano-based essential oil supplement has limited impact on the growth performance and carcass traits of steers finished in an all-natural system.

Acknowledgement

This research was supported by state and federal funds appropriated to South Dakota State University including support from the South Dakota State University Agriculture Experiment Station, USDA National Institute of Food and Agriculture through the Hatch Act (Accession #1020088), and by Advanced Ag Products, Canton, SD (Grant #3P3168).

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Table 1. Growth performance and health outcomes for finishing cattle fed an oregano-based essential oil (By-O-Reg+ Beef) or a control diet containing no essential oil[1].

	Treatment			
Item	**Control**	**By-O-Reg**	**SEM**	***P*-value**
Steers, n	62	62	-	-
Pens, n	8	8	-	-
Initial BW, lbs	739	739	0.3	0.45
Final BW, lbs	1260	1253	10.1	0.55
Cumulative				
Average Daily Gain, lbs	3.50	3.45	0.068	0.52
S.D. ADG[2]	0.327	0.401	0.0492	0.15
Dry Matter Intake, lbs	22.5	22.5	0.39	0.97
Gain:Feed	0.156	0.154	0.0016	0.22
Gain Efficiency[3]	3.50	3.45	0.070	0.54
NEm, Mcal/cwt[4]	88.43	88.34	0.916	0.93
NEg, Mcal/cwt[5]	58.96	58.88	0.803	0.92
O/E Nem[6]	0.95	0.95	0.011	1.00
O/E Neg[7]	0.96	0.96	0.013	0.93
O/E Dry Matter Intake[8]	1.05	1.05	0.013	0.86
Health outcomes, % (n)				
Digestive 1×	4.7 (3)	7.8 (5)	-	0.44
Digestive 2×	0.0 (0)	3.1 (2)	-	0.97
Digestive 3×	0.0 (0)	1.6 (1)	-	0.97
Removal	4.7 (3)	10.9 (7)	-	0.18
Dead	4.7 (3)	7.8 (5)	-	0.44

[1] A 4% pencil shrink was applied to all BW measures to account for digestive tract fill.
[2]Standard Deviation Average Daily Gain
[3] Calculated as ADG at the same DMI.
[4]Net energy for Maintenance (Mcal/cwt)
[5]Net energy for gain (Mcal/cwt)
[6]Observed/Expected Net energy for maintenance
[7]Observed/Expected Net energy for gain
[8]Observed/Expected Dry Matter Intake

Table 2. Carcass traits for finishing cattle fed an oregano-based essential oil (By-O-Reg+ Beef) or a control diet containing no essential oil.

	Treatment			
Carcass Traits	**Control**	**By-O-Reg**	**SEM**	***P*-value**
Steers, n	61	56		
Hot carcass weight, lbs	789	788	7.9	0.88
Dressing percentage, %	62.64	62.86	0.278	0.45
Ribeye area, in sq.	11.90	12.04	0.195	0.48
Rib fat thickness, in	0.34	0.35	0.013	0.43
Marbling score[1]	551	568	15.8	0.30
Yield grade	3.03	3.01	0.052	0.69
Retail yield, %	49.94	50.00	0.108	0.62
Empty body fat, %[2]	28.86	29.06	0.276	0.49
AFBW[3]	1216	1207	11.7	0.47
Quality Grade, %				
Select	3.3	3.6	-	0.79
Low Choice	27.9	23.2	-	
Average Choice	41.0	41.0	-	
High Choice	23.0	19.6	-	
Prime	4.8	12.6	-	
Yield Grade, %				
1	4.9	5.3	-	0.94
2	59.0	58.9	-	
3	36.1	35.8		
4	0.0	0.0		
5	0.0	0.0		

[1]Small 00=400,
[2]Calculated from Guiroy et al. (2001)
[3]Final BW at 28% estimated empty body fatness calculated from Guiroy et al (2001)

Animal Science Research Report 2024

Manger space restriction does not negatively influence growth efficiency in program fed feedlot heifers.

Erin DeHaan, Warren Rusche, Zachary Smith

Rationale and Approach

A main goal of a backgrounding program is to suppress fat or lipid deposition and promote growth of bones and lean tissue through achieving less-than-maximal growth (Block et al., 2001). Controlling or managing feed intake relative to the *ad libitum* amount is not a new concept to the cattle feeding industry. Feed intake can be managed via restricted feeding or programmed feeding (Galyean et al., 1999). Program feeding uses net energy (NE) equations to calculate the quantity of feed required for bodily maintenance at a desired rate of gain. The objective of this research was to determine the influence manger space restriction had on program-fed feedlot heifers during the growing phase. Charolais × Angus heifers [initial body weight (BW) = 725 ± 1.3 lb] were used in a 109-d backgrounding study. Heifers were received approximately 60 d prior to study initiation. Initial processing (53 d before study initiation) included individual BW, application of an identification tag, vaccination against viral respiratory pathogens and clostridial species, and administration of doramectin pour-on for control of internal and external parasites. All heifers were administered 36 mg of zeranol at study initiation and were assigned to 1 of 10 pens (*n* = 5 pens/treatment with 10 heifers/pen) in a randomized complete block design (blocked by location) and offered a common diet (Table 1). Each pen was randomly assigned to 1 of 2 treatments: 8 inches (8IN) or 16 inches (16IN) of linear bunk space/heifer. Heifers were individually weighed on days 1, 14, 35, 63, 84, and 109. Heifers were programmed to gain 3 lb daily based on predictive equations set forth by the California Net Energy System. To calculate predictive values, a final BW of 1268 lb was assumed to be the mature BW of the heifers and tabular net energy values of 93.0 NEm (Mcal/cwt) and 62.0 NEg (Mcal/cwt) from days 1 to 22, 91.0 NEm and 61.0 NEg from days 23 to 82, and 89.0 NEm and 60.0 NEg from days 83 to 109 were used. Data were analyzed using the GLIMMIX procedure of SAS 9.4 with manger space allocation as the fixed effect and block as the random effect.

Findings

No differences (*P* > 0.35) were observed between 8IN or 16IN heifers for initial BW, final BW, average daily gain, dry matter intake, feed efficiency, variation in daily weight gain within each pen or applied energetic measures (Table 2). No differences (*P* > 0.35) were observed between treatments for morbidity. Although not statistically analyzed, 8IN heifers appeared to have looser stools during the first 2 weeks compared to the 16IN heifers.

Implications

These data suggest restricting manger space allocation from 16 to 8 in. did not negatively influence gain efficiency or the efficiency of dietary net energy utilization in heifers programmed fed a concentrate-based diet to gain 3 lb daily. The use of tabular net energy values and required net energy of maintenance and retained energy equations are effective means to program cattle to a desired rate of daily gain during the growing phase.

Acknowledgements

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Table 1. Actual dietary formulation and tabular nutrient content for heifers offered a limit fed diet and 8 (8IN) or 16 (16IN) in of linear bunk space per heifer through the 109 d feeding experiment.[1]

Item	d 1 to 22	d 23 to 82	d 83 to 109
Dry-rolled corn[2], %	20.80	16.42	48.04
High-moisture corn, %	43.23	33.40	-
Dried distillers grains plus solubles, %	14.71	15.28	15.01
Oat hay, %	15.36	-	-
Corn silage, %	-	29.82	32.03
Liquid supplement[3], %	5.89	5.08	4.92
Dietary information			
Diet dry matter, %	79.65	57.04	54.68
Crude protein, %	13.31	12.94	12.80
Neutral detergent fiber, %	21.02	24.16	24.91
Acid detergent fiber, %	11.13	13.21	13.69
Ash, %	6.46	6.05	6.03
Organic matter, %	93.54	93.95	93.97
Ether extract, %	3.59	3.59	3.58
Tabular net energy for maintenance, Mcal/cwt	93.0	91.0	89.0
Tabular net energy for gain, Mcal/cwt	62.0	61.0	60.0

[1]All values except DM on a DM basis.

[2]Melengestrol acetate (MGS, Zoetis) was included at 0.50 mg/heifer daily in a premix that replaced a portion of the dry-rolled corn.

[3]From d 1 to 22 (dry-matter basis): 36.27% crude protein, 28.00% non-protein nitrogen, 0.74 Mcal/lb net energy for maintenance, 0.50 Mcal/lb net energy for gain, 1.62% crude fat, 4.62% Ca, 0.43% P, 2.28% K, 0.47% Mg, 5.00% salt, 3.38% Na, 0.54% S, 4.00 ppm Co, 200.00 ppm Cu, 20 ppm I, 11.41 mg/lb EDDI, 150.29 ppm Fe, 400.00 ppm Mn, 3.08 ppm Se, 700.00 ppm Zn, 20,000.00 IU/lb Vitamin A, 200.00 IU/lb Vitamin E, Monensin 500 g/907-kg. From d 23 to 109 (dry-matter basis): 41.86% crude protein, 38.38% non-protein nitrogen, 0.43 Mcal/lb net energy for maintenance, 0.30 Mcal/lb net energy for gain, 0.91% crude fat, 10.89% Ca, 0.32% P, 7.00% K, 0.22% Mg, 6.03% salt, 3.07% Na, 0.33% S, 4.23 ppm Co, 199.88 ppm Cu, 11.99 ppm I, 6.84 mg/lb EDDI, 83.16 ppm Fe, 304.81 ppm Mn, 2.90 ppm Se, 664.59 ppm Zn, 19,987.55 IU/lb Vitamin A, 199.88 IU/lb Vitamin E, Monensin 579.35 g/ton

Table 2. Cumulative growth performance responses for heifers offered a limit fed diet and 8 (8IN) or 16 (16IN) in. of linear bunk space per heifer through the 109-d feeding experiment.[1]

	Treatments			
Item	**8IN**	**16IN**	**SEM**	***P* - value**
Pens, n	5	5	-	-
Heifers, n	50	49	-	-
Cumulative growth				
Initial Body Weight, lb	725	726	1.3	0.77
Final Body Weight, lb	1038	1044	6.5	0.43
Average Daily Gain, lb/d	2.87	2.92	0.060	0.46
Dry Matter Intake, lb	17.73	17.73	0.002	0.35
Feed:Gain (DMI/ADG)	6.18	6.07	0.033	0.46
S.D. ADG	0.40	0.36	0.039	0.39
Applied energetics measures[2]				
Observed Net Energy for Maintenance (NEm), Mcal/cwt	90.34	91.33	1.222	0.44
Observed Net Energy for Gain (NEg), Mcal/cwt	60.63	61.50	1.071	0.44
Observed to expected NEm	1.00	1.01	0.013	0.47
Observed to expected NEg	0.98	0.99	0.016	0.42

[1]A 4% shrink was applied to the initial BW measure to account for digestive tract fill and all subsequent BW measures were pencil shrunk 2% to account for digestive tract fill.
[2]Calculated from observed cumulative growth performance assuming a mature BW of 1268 lb and a tabular NEm and NEg of 90.7 Mcal/cwt and 60.7 Mcal/cwt of NEm and NEg, respectively.

Animal Science Research Report 2024

Influence of source of origin and region of finishing on growth performance and carcass characteristics of feedlot heifers fed in the United States.

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Rationale and Approach

Beef cattle are procured from all regions of the U.S., and most are finished in a feedlot for harvest. Transportation of cattle can cause stress and lead to heightened immune responses, especially when cattle are transported for long periods of time (Arthington et al., 2003; Deters and Hansen, 2020). Information regarding the relationship of movement of cattle between regions from different production systems with differing ambient temperature, and the degree to which these factors can influence performance is novel and requires further consideration. The objective was to evaluate growth performance and carcass traits of finishing beef heifers sourced and finished in different geographical regions in the U.S. Yearling heifers [n=190; initial body weight (BW) 1064 and 937 ± 2.5 lb for SD and TX sourced, respectively] were used in a 2×2 factorial arrangement of origin state (SD vs. TX) and finishing state (SD vs. TX). Heifers were allotted on d -1 into four treatments: sourced from SD and finished in SD (SD-SD), sourced from SD and finished in TX (SD-TX), sourced from TX and finished in SD (TX-SD), and sourced from TX and finished in TX (TX-TX). Heifers were weighed on d -1, 3, 15, 28, 56, 78 (TX-TX and SD-TX) and 90 (SD-SD and TX-SD). On d 0, SD-TX and TX-SD heifers were shipped to the finishing location. The following morning (d 1), SD-TX and TX-SD heifers were weighed to determine transportation shrink. To monitor transportation stress effects, vaginal temperature probes were inserted into all SD-TX and TX-SD heifers and a portion of SD-SD and TX-TX heifers on d -1 and removed on d 3. Clinical attitude scores (CAS) were recorded on d -1, 0, 1, 2 and 3 for bovine respiratory disease symptoms.

Findings

Transported heifers had decreased temperatures ($P < 0.01$) during transit and post-transit, but had increased ($P < 0.01$) during loading and unloading compared to non-transported heifers. On d 0, 1 and 3 there was a shift in the distribution of heifers that had a CAS score greater than 0 for TX-TX, SD-TX and TX-SD. Cattle endured elevated ambient temperatures (temperature humidity index value > 75) for 54% and 18% of the feeding period for TX and SD finished heifers, respectively. All cumulative growth performance measures (Table 1) and carcass trait (Table 2) interactions were statistically significant ($P < 0.05$) except for initial BW, percent shrink during transit, average daily gain, dressing percent, ribeye area and liver abscess severity, which did not differ ($P > 0.23$). There was a shift in the distribution ($P <$

0.02) towards a greater proportion of Yield Grade 1 and Select carcasses for heifers fed in TX than fed in SD.

Implications

Overall, heifers transported to higher ambient temperatures had improved overall yield grades, but reduced dry matter intake, quality grades (QG) and limited growth recovery (100 lb lighter) compared to non-transported heifers. Heifers transported to lower ambient temperatures recovered growth and had improved QG at the same level of rib fat compared to non-transported heifers but had reduced overall yields and yield grades.

Acknowledgements

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Table 1. Effect of source of origin (SD vs. TX) and finishing location (SD vs. TX) on cumulative growth performance responses[1].

	Treatments[2]					P-Value		
Item	SD-SD	TX-SD	SD-TX	TX-TX	SEM	Origin	Finish	Org × Fin
Pens, n	6	6	5	5	-	-	-	-
Heifers, n	48	46	50	46	-	-	-	-
Initial Body Weight (d -14), lb	1065	939	1064	938	2.5	-	-	-
d -1 Body Weight, lb	1059	965	1053	947	9.1	0.01	0.08	0.34
d 1 Body Weight, lb	-	907[a]	989[b]	-	7.9	-	-	0.01
Transit shrink, %	-	-6.28	-6.51	-	0.419	-	-	0.60
d 3 Body Weight, lb	1058[d]	912[a]	454[c]	437[b]	3.6	0.01	0.57	0.01
Final[3]								
Body Weight, lb	1372[b]	1294[a]	1272[a]	1290[a]	13.2	0.01	0.33	0.01
Average Daily Gain, lb/d	3.60	4.39	3.63	4.35	0.120	0.01	0.96	0.71
Dry Matter Intake, lb	23.72[b]	23.90[b]	20.89[a]	25.02[b]	0.534	0.01	0.20	0.01
Feed:Gain (DMI/ADG)	6.59[b]	5.45[a]	5.76[a]	5.76[a]	0.139	0.01	0.25	0.01
DMI % of BW	1.73[b]	1.85[c]	1.69[a]	1.94[d]	0.032	0.01	0.17	0.01

[abcd] Means within a row without a common superscript differ ($P < 0.05$).
[1] A 4% pencil shrink was applied to all BW measures to account for gastrointestinal tract fill.
[2] SD-SD = heifers that originated from South Dakota and were finished in a feedlot in South Dakota SD-TX = heifers that originated from South Dakota and were finished in a feedlot in Texas; TX-SD = heifers that originated from Texas and were finished in a feedlot in South Dakota; TX-TX = heifers that originated from Texas and were finished in Texas.
[3] Final body weights measured either at d 79 for SD-TX and TX-TX and at a d 90 for TX-SD and SD-SD because of packing plant availability.

Table 2. Effect of source of origin (SD vs. TX) and finishing location (SD vs. TX) on heifer carcass trait responses[1].

	Treatments[2]					*P*-value		
Item	**SD-SD**	**TX-SD**	**SD-TX**	**TX-TX**	**SEM**	**Origin**	**Finish**	**Org × Fin**
Hot Carcass Weight, lb	891[b]	808[a]	813[a]	803[a]	10.61	0.01	0.01	0.01
Dressing Percent[3], %	64.9	62.4	63.9	62.2	0.44	0.01	0.07	0.23
Ribeye Area, in sq	14.39	13.97	15.38	15.27	0.295	0.20	0.01	0.45
12th Rib Fat, in	0.70[b]	0.53[a]	0.51[a]	0.51[a]	0.027	0.01	0.01	0.01
Marbling[4]	621[c]	458[b]	417[a,b]	385[a]	18.3	0.01	0.01	0.01
Calculated Yield Grade[5]	3.53[c]	2.93[b]	2.40[a]	2.36[a]	0.123	0.01	0.01	0.01
Retail Yield[6], %	48.50[a]	49.94[b]	51.16[c]	51.26[c]	0.300	0.01	0.01	0.01
Empty Body Fat[7], %	33.59[c]	29.68[b]	28.55[a]	28.27[a]	0.460	0.01	0.01	0.01
Adjusted Final Body Weight[7], lb	1262[b]	1203[a]	1229[a]	1217[a]	17.8	0.01	0.27	0.01
Yield Grade Distribution, %								
1	0.0	6.5	28.0	23.9		0.03	0.01	0.01
2	29.8	60.9	58.0	56.5				
3	55.3	30.4	14.0	19.6				
4	14.9	2.2	0.0	0.0				
Quality Grade Distribution, %								
Select	2.1	23.9	36.0	63.0		0.61	0.01	0.02
Low Choice	19.2	47.8	58.0	37.0				
Premium Choice	46.8	26.1	6.0	0.0				
Prime	31.9	2.2	0.0	0.0				
Liver Abscess Severity and Prevalence[8], %								
Normal	91.5	84.8	88.0	78.3		0.10	0.33	0.94
A-	6.4	8.7	8.0	10.9				
A+	2.1	6.5	4.0	10.8				

[1]Heifers finished in SD were on feed for 90 d and heifers finished in TX were on feed for 78 d. [2]SD-SD = heifers that originated from South Dakota and were finished in a feedlot in South Dakota SD-TX = heifers that originated from South Dakota and were finished in a feedlot in Texas; TX-SD = heifers that originated from Texas and were finished in a feedlot in South Dakota; TX-TX = heifers that originated from Texas and were finished in Texas. [3]DP = (HCW/final BW shrunk 4%) × 100.[4]300 = slight00, 400 = small00, 500 = Modest00, 600 = Moderate00. [5]According to the regression equation described by USDA (1997). [6]As a percentage of HCW according to Murphey et al. (1960). [7]Calculated according the equations described by Guiroy et al. (2002). [8]According to the Elanco Liver Scoring System: Normal (no abscesses), A- (1 or 2 small abscesses or abscess scars), A (2 to 4 well organized abscesses less than 1 in. diameter), or A+ (1 or more large active abscesses greater than 1 in. diameter with inflammation of surrounding tissue).

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Prevalence of *Salmonella* and *Escherichia coli* O157:H7 in finishing beef heifers sourced and finished in two different regions of the United States.

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Rationale and Approach

During harvest, pathogens may be transferred onto beef products directly from material on beef hides and cross-contamination during harvest or through lymph node harborage (Brichta-Harhay et al., 2008; Elder et al., 2000; Wilkerson et al., 2020). Topical interventions have effectively decreased *Escherichia coli* O157:H7 to less than 0.25% in ground beef samples (Wheeler et al., 2014). However, *Salmonella* in lymph nodes is not susceptible to topical post-harvest interventions (Gragg et al., 2013a). Pre-harvest interventions are critical to minimize the risk of pathogen transfer in beef products. Therefore, the objective of this study was to investigate the influence of source of origin and region of finishing on *Salmonella* and *E. coli* O157:H7 prevalence in finishing beef heifers. Yearling heifers [n = 185; initial body weight (BW) 1064 and 937 ± 2.5 lb for SD and TX sourced, respectively] were used in a 2 × 2 factorial arrangement of origin state (SD vs. TX) and finishing state (SD vs. TX). Initial *Salmonella* prevalence was determined by taking individual fecal samples from all heifers. After determining initial fecal *Salmonella* prevalence on d -14, heifers were sorted into one of four treatments: heifers originating from South Dakota and finished in South Dakota (SD-SD), heifers originating from South Dakota and finished in Texas (SD-TX), heifers originating from Texas and finished in South Dakota (TX-SD), and heifers originating from Texas and finished in Texas (TX-TX). Individual fecal samples from heifers in all treatments were collected throughout the study to determine *Salmonella* and *E. coli* O157:H7 prevalence. Hide swab and subiliac lymph node (SLN) samples were collected at study end to determine prevalence of *Salmonella*.

Findings

A treatment by time interaction was observed ($P < 0.01$) for fecal *Salmonella* prevalence, with prevalence being greatest for TX-TX and TX-SD heifers before transport (Figure 1). From d 14 through study end, prevalence was greatest for TX-TX and SD-TX heifers compared with SD-SD and TX-SD heifers. *Salmonella* prevalence on hides were greater ($P < 0.01$) for heifers finished in TX compared with SD (Table 1). *Salmonella* prevalence in SLN tended ($P = 0.06$) to be greater in TX-TX and SD-TX heifers compared with TX-SD and SD-SD. Fecal *E. coli* O157:H7 prevalence had a treatment by time interaction (P = 0.04), with SD-TX prevalence being greater than TX-SD on d 56 and SD-SD and TX-TX being intermediate.

Implications

These data suggest that the region and environmental variations between regions influence *Salmonella* and *E. coli* O157:H7 prevalence and shedding patterns. The initial 14 d following feedlot arrival are critical for transmission of pathogenic bacteria and appear to present a potential timeframe for pathogen carriage.

Acknowledgments

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Table 1. Effects of source of origin and feedlot location on *Salmonella* on hides and in subiliac lymph nodes (SLN) at harvest and *Escherichia coli* O157: H7 prevalence in fecal samples of finishing beef heifers.

	Treatments[1]					
Item	**SD-SD**	**SD-TX**	**TX-SD**	**TX-TX**	**SEM**	***P*-value**
Heifers, n	47	49	45	44		
Salmonella Hide prevalence[2], %	2.1[c]	66.0[b]	4.4[c]	87.0[a]	4.83	<0.01
Salmonella SLN prevalence[2], %	0.0[z]	8.2[y]	0.0[z]	6.8[y]	2.84	0.06
E. coli O157:H7 prevalence, %						
d -1	4.2	0.0	6.5	4.4	1.27	0.04
d 1[3]	---	0.0	4.8	---		
d 3	0.0	4.1	2.2	5.0		
d 56	2.1[c]	16.3[a]	4.3[bc]	11.7[ab]		
End	0.0	4.0	2.2	0.0		

[abc] Means bearing different superscripts in same row differ *P* ≤ 0.05.
[yx] Means bearing different superscripts in same row tended to differ (0.05 < *P* ≤ 0.10).
[1] SD-SD = heifers that originated from South Dakota and were finished in a feedlot in South Dakota SD-TX = heifers that originated from South Dakota and were finished in a feedlot in Texas; TX-SD = heifers that originated from Texas and were finished in a feedlot in South Dakota; TX-TX = heifers that originated from Texas and were finished in Texas.
[2]Sampled at study end.
[3]SD-SD and TX-TX heifers were not sampled on d 1.

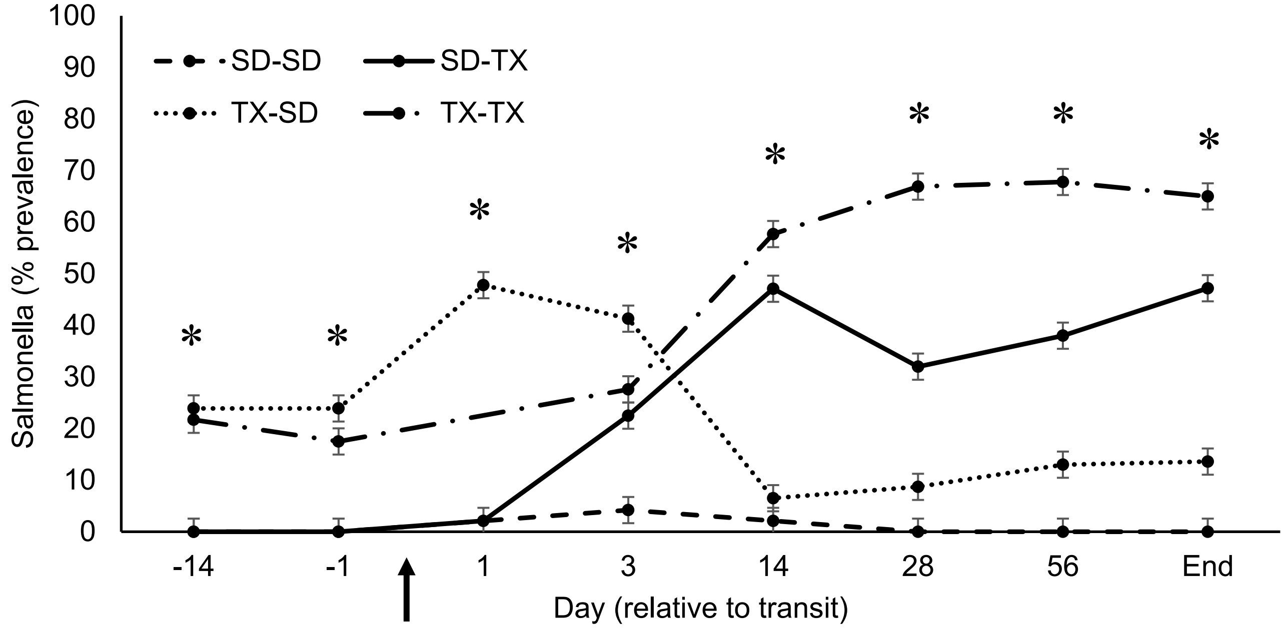

Figure 1. Effect of origin and feedlot location on *Salmonella* prevalence in fecal samples of finishing beef heifers. Treatments included heifers that originated from South Dakota and were finished in a feedlot in South Dakota (SD-SD), heifers that originated from South Dakota and were finished in a feedlot in Texas (SD-TX), heifers that originated from Texas and were finished in a feedlot in South Dakota (TX-SD), and heifers that originated from Texas and were finished in Texas (TX-TX). Transit occurred on d 0 (denoted with an arrow) for SD-TX and TX-SD treatments; SD-SD and TX-TX treatments were not sampled on d 1. Study end was on d 77 for TX-TX and SD-TX heifers and d 90 for TX-SD and SD-SD heifers. Error bars represent standard error of the mean. Fecal prevalence of *Salmonella* had a treatment ($P \leq 0.01$), day ($P \leq 0.01$), and a treatment × day effect ($P \leq 0.01$). If a treatment × day effect was observed, the pairwise treatment differences were sliced by day and indicated by * when $P \leq 0.05$.

Evaluation of phytogenic feed additive with essential oils and plant extracts on growth performance and in newly-received beef steers

Justin Delver, Warren Rusche, Zachary Smith

Rationale and Approach

The period when calves are newly received following being transported to the feedlot is a critical time in the beef production system. This period is arguably the most stressful event in beef cattle production as cattle are transported, deprived of feed and water, and introduced to an unfamiliar feed source. Specifically, this period of reduced feed intake and transit stress can lead to respiratory distress such as bovine respiratory disease complex. Furthermore, antimicrobial resistance is a large concern to animal producers. Continued and unwarranted use of antimicrobials in livestock production results in increased pools of antimicrobial resistant genes among bacteria. Essential oils and phytomolecule compounds have been shown to reduce inflammation and modulate immune function. Combining these products with commonly used treatments such as antimicrobials might aid in controlling systemic inflammation and reduce the overall need for antimicrobials. The objective of this research was to determine if a phytogenic feed additive (PFA) influences measures of growth or growth efficiency during the feedlot receiving phase. Two treatments were used: 1) no phytogenic feed additive (Control) and 2) PFA fed at a rate of 0.25 g/cwt (PFA). This study used 10 pens per treatment and each pen contained 8 steers (n = 80 steers/treatment), steers were allocated to study pens within 24 hours of arrival to the feedlot. The diet was based upon (DM basis): corn silage (74%), dried distillers grains plus solubles (21%), a liquid supplement (5%), and was fortified with vitamins and minerals to exceed nutrient requirements.

Findings

No steers were removed from the study, one steer from the control treatment was treated for respiratory disease. No mortality was noted in the present experiment. Growth performance data is presented in Table 1. No appreciable differences were noted for BW, ADG, variation in ADG, DMI, or feed conversion efficiency during the 53-d receiving period ($P \geq 0.11$). Performance based NEm and NEg was not influenced by dietary treatment ($P \geq 0.79$). The ratio of observed-to-expected dietary net energy was not impacted by dietary treatment ($P \geq 0.71$).

Implications

These were healthy, high-growth potential Northern Plains steers. There was minimal morbidity (0.63%) and no mortality noted during the 53-d receiving study. Steers performed well and met growth performance expectations (the ratio of observed-to-expected NEm = 1.00), hence, it was not anticipated that the PFA would appreciably influence growth or health outcomes under the conditions of this experiment.

Table 1. Growth performance responses for Control and PFA during the 53-d receiving period.

Item	Treatment		SEM	*P* - value
	Control	PFA		
Steers, n	80	80	-	-
Pens, n	10	10	-	-
Body weight				
Initial BW[1], lbs	668	667	-	-
d 53 BW[2], lbs	847	841	5.2	0.25
Growth performance				
ADG, lbs	3.38	3.29	0.099	0.40
S.D. ADG	0.441	0.537	0.0542	0.11
DMI, lbs	19.22	18.90	0.193	0.12
G:F	0.176	0.174	0.0041	0.68
F:G[3]	5.68	5.75	-	-
Applied Energetics[4]				
NEm, Mcal/cwt	80.22	79.93	1.054	0.79
NEg, Mcal/cwt	51.75	51.51	0.925	0.79
O/E Nem[5]	1.00	1.00	0.013	0.89
O/E Neg[6]	0.99	0.98	0.014	0.71

[1] No shrink was applied to initial BW.
[2] A 4% shrink was applied to account for digestive tract fill.
[3] Calculated as: 1/G:F.
[4] Calculated assuming a mature BW of 1325 lbs.
[5] Observed to Expected net energy for maintenance
[6] Observed to Expected net energy for gain

Effects of substitution of DDGS with soybean meal in finishing diets: Dietary protein degradability and ruminal parameters

Grace H. Jardon, Natasha L. Macholan, Katherine M. Moening, Elissa R. Colombo, Zachary K. Smith, Warren R. Rusche, Ana Clara B. Menezes

Rationale and Approach

The demand for oil used in renewable fuel has led to increased availability and reduced cost of oilseed meal. Among protein sources used in beef cattle diets, dried distillers grains plus solubles (DDGS) is the most common. However, there is limited data regarding the use of soybean meal (SBM), a potentially cost-effective alternative protein source. Objectives were to evaluate the effects of substitution of DDGS with SBM on ruminal degradability of protein and volatile fatty acid (VFA) and ammonia concentrations. Red Angus steers (n = 4; BW = 792 ± 19.8 lbs) with ruminal, duodenal, and ileal cannulas, were used in a 4 × 4 Latin square. Diets, fed as totally mixed rations (TMR), contained dry-rolled corn (70%), hay (10%), liquid supplement (5%), and test ingredients (15%). Treatments were (DM basis): 1) 15.0% DDGS (CON); 2) SBM in replacement of 50% of DDGS (SBM50); 3) SBM in replacement of 75% of DDGS (SBM75), and 4) SBM in replacement of 100% of DDGS (SBM100). Each period lasted 18-d, with a 7-d diet adaptation followed by an 11-d collection period. An in situ ruminal incubation of each TMR was performed from d 8 to 11. Ingredients were weighed separately, maintaining their proportion in the TMR. Six grams of air-dried TMR sample (2 mm grind) were ruminally incubated in a nylon bag (10 × 20 cm; Ankom) using the same steer from the in vivo study. Samples were incubated for 0, 2, 4, 8, 16, 24, 48, and 72h. The number of bags varied as a function of the incubation time to allow enough residual samples after incubation, where more bags per sample were incubated for the longer incubation times relative to the shorter incubation times (72 and 48h, n=5; 24h, n =4; 16h, n = 3; 8h and 4h, n = 2; 2h and 0h, n =1). To determine VFA and ammonia concentrations, 15 mL aliquots of rumen fluid were collected at -2, 0, 2, 4, 6, 8, 10, and 12 h post-feeding on d 16 and stored at −4 °F, prior to analysis.

Findings

There were no differences ($P \geq 0.47$) on fractions a (readily soluble fraction), b (potentially degradable fraction), and k_d (rate of degradation of fraction b) or rumen degradable protein (RDP = 55% CP) between treatments (Figure 1). The 75% SBM inclusion resulted in greater concentrations of ammonia, acetate, propionate, butyrate, isobutyrate, and valerate compared to CON ($P \leq 0.01$; Table 1).

Implications

Thirteen hours of incubation is necessary to accurately estimate the RDP content of the diets in this study. The NASEM (2016) uses 35% and 75% RDP for DDGS and SBM, respectively, based on fixed incubation time of 16 h. In this study, the diet degradation profiles suggest that RDP of complete diets differs compared to individually assayed ingredients. This data indicates that SBM can be used in replacement to DDGS in feedlot finishing diets without compromising ruminal degradability. Further, our results indicate that 75% substitution of DDGS with SBM has the potential to optimize microbial fermentation.

Acknowledgements

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Table 1. Effects of substitution of DDGS by SBM on ammonia (NH_3) and volatile fatty acids concentration.

	Treatments[1]					*P*-value		
Item	**CON**	**SBM50**	**SBM75**	**SBM100**	**SEM**	**TRT**	**Time**	**TRT × Time**
NH_3, mmol/l	3.03[b]	5.09[ab]	7.02[a]	3.34[b]		< 0.01	< 0.01	0.96
Acetate, mM	65.00[b]	62.67[b]	75.86[a]	74.27[a]	3.45	< 0.01	0.53	0.99
Propionate, mM	32.71[c]	39.26[bc]	43.93[ab]	48.92[a]	7.73	< 0.01	< 0.01	0.99
Isobutyrate, mM	1.29[b]	1.54[a]	1.66[a]	1.55[a]	0.13	< 0.01	< 0.01	0.84
Butyrate, mM	18.55[b]	17.28[b]	21.62[a]	16.80[b]	3.12	< 0.01	< 0.01	0.99
Isovalerate, mM	4.74[a]	3.73[bc]	3.15[c]	3.94[b]	1.06	< 0.01	0.58	0.99
Valerate, mM	1.66[c]	2.11[b]	2.45[a]	2.55[a]	0.28	< 0.01	0.12	0.86
Acetate:propionate	2.59[a]	1.87[b]	1.85[b]	1.62[b]	0.43	< 0.01	< 0.01	0.88

[1] CON: DDGS at 15.0% (DM basis) inclusion (13.42 % CP; 43.06% RDP [%CP]; 62.00 Mcal/cwt NEg); SBM50: SBM in replacement of 50% of DDGS (13.61 % CP; 56.65% RDP [%CP]; 62.23 Mcal/cwt NEg); SBM75: SBM in replacement of 75% DDGS (14.18 % CP; 60.68% RDP [%CP]; 62.23 Mcal/cwt NEg); SBM100: SBM in replacement of 100% of DDGS (13.81 % CP; 66.81 RDP [%CP]; 62.45 Mcal/cwt NEg).

[abc] Means within a row lacking common superscript differ ($P \le 0.05$)

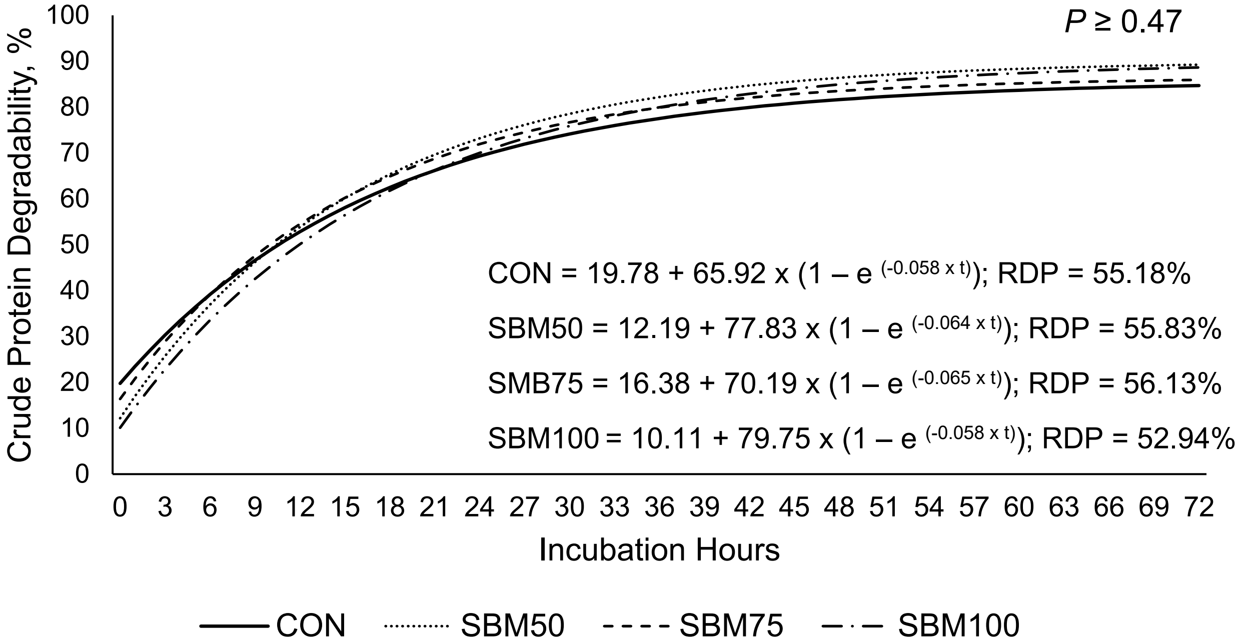

Figure 1. Ruminal degradation of crude protein.

CON: DDGS at 15.0% (DM basis) inclusion (13.42 % CP; 43.06% RDP [%CP]; 62.00 Mcal/cwt NEg); SBM50: SBM in replacement of 50% of DDGS (13.61 % CP; 56.65% RDP [%CP]; 62.23 Mcal/cwt NEg); SBM75: SBM in replacement of 75% DDGS (14.18 % CP; 60.68% RDP [%CP]; 62.23 Mcal/cwt NEg); SBM100: SBM in replacement of 100% of DDGS (13.81 % CP; 66.81 RDP [%CP]; 62.45 Mcal/cwt NEg).

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Effects of partial or total replacement of dried distillers plus solubles with soybean meal on growth performance, carcass characteristics, and dietary net energy utilization in finishing beef steers

Cassidy Ross, Warren Rusche, Zachary Smith

Rationale and Approach

The average inclusion of distillers in American feedlot diets is 19.9% dietary DM (Asem-Hiablie et al., 2016) with 86.7% of nutritionists choosing to use wet distillers grains with solubles (WDGS) or dried distillers grains with solubles (DDGS) as their primary grain by-product (Samuelson et al., 2016). Recent expansion in oilseed crush capacity should increase supplies of soybean meal (SBM) with potentially lower prices. The objective of this study was to determine if partial or complete substitution of DDGS with SBM influences growth performance, efficiency, or carcass characteristics in finishing beef steers.

Continental × British crossbred steers (*n* = 189; 7 or 8 steers/pen; 8 pens per treatment) were utilized in a 139-d finishing experiment at the South Dakota State University Ruminant Nutrition Center (RNC) in Brookings, SD using three treatments (Table 1): DDGS fed at 20% DM (15.4% CP, 8% RDP, and 1.90% NPN; DDGS), SBM replacing 50% of DDGS (16.4% CP, 9% RDP, and 0.96% NPN; SBM50), and SBM replacing 100% of DDGS (17.4% CP, 10% RDP, and 0.05% NPN; SBM100).

Findings

In the first 35 d of the study, ADG linearly increased with greater inclusions of SBM (Table 2; *P* = 0.01), but treatment did not affect DMI (*P* = 0.39). Feeding SBM as a replacement of DDGS linearly increased G:F in the first 35 d (*P* = 0.01). For the entire feeding period, steers fed SBM had greater final body weight (*P* = 0.03), ADG (*P* = 0.05), and G:F (*P* = 0.01). Dry matter intake was unaffected by soybean meal substitution (*P* = 0.60). Dietary treatment did not influence carcass-adjusted final BW (*P* = 0.32), ADG (*P* = 0.77), or DMI (*P* = 0.38). We noted a tendency for improved G:F (Quadratic; *P* = 0.10) for SBM50.

Feeding SBM in replacement of DDGS linearly decreased dressing percentage (*P* = 0.03), but linearly increased ribeye area (*P* = 0.02). Treatment did not affect hot carcass weight, ribfat, marbling score, or USDA Yield or Quality grade distribution (*P* ≥ 0.22). Replacing DDGS with SBM altered the distribution of liver scores (*P* = 0.05). Steers from SBM100 had fewer livers classified as normal and a greater proportion of severely abscessed livers. However, steers fed SBM50 had the fewest severe abscesses and greatest proportion of normal livers.

Feeding SBM quadratically increased apparent dietary net energy values (*P* = 0.03) and the ratio of observed to expected dietary energy (*P* ≤ 0.04). The total and partial substitution NEg values for SBM were 17.0 and 27.5% greater than DDGS respectively.

Implications

The use of SBM as a partial or complete replacement of DDGS resulted in greater daily gain and gain efficiency compared to DDGS when measured on a live basis. Feeding soybean meal altered the distribution of liver scores, increased REA, and decreased DP, with no other differences observed in carcass characteristics.

Acknowledgements

The authors wish to thank the Minnesota Soybean Research and Promotion Council for providing financial support for this study.

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Table 1. Diet Composition (DM basis)[a].

Item[b]	d 1 to 16			d 17 to 21			d 22 to 103			d 104 to 139		
	DDGS	SBM50	SBM100	DDGS	SBM50	SBM100	DDGS	SBM50	SBM100	DDGS	SBM50	SBM100
Ingredient Composition, %												
HMEC	65.40	65.51	65.61	74.90	74.88	74.85	14.47	14.48	14.49	13.93	13.95	13.97
LS 1[c]	4.96	2.48	0.00	5.08	2.54	0.00	4.80	2.40	0.00	4.80	2.40	0.00
LS 2[d]	0.00	2.48	4.97	0.00	2.54	5.07	0.00	2.40	4.81	0.00	2.40	4.81
SBM	0.00	9.77	19.57	0.00	10.04	20.08	0.00	9.55	19.12	0.00	9.64	19.31
DDGS	19.82	9.93	0.00	20.02	10.00	0.00	19.25	9.63	0.00	19.54	9.78	0.00
DRC	0.00	0.00	0.00	0.00	0.00	0.00	16.31	16.32	16.34	55.95	56.03	56.11
HMC	0.00	0.00	0.00	0.00	0.00	0.00	39.28	39.31	39.34	0.00	0.00	0.00
GH	9.81	9.83	9.85	0.00	0.00	0.00	5.88	5.89	5.89	5.79	5.79	5.80
Nutrient Composition[e]												
DM, %	74.52	74.40	74.28	71.01	71.04	71.07	79.90	79.83	79.77	84.35	84.23	84.11
CP, %	15.08	16.08	17.07	15.16	16.22	17.28	15.45	16.48	17.51	15.37	16.36	17.35
RDP, %	8.34	9.37	10.41	8.11	9.35	10.47	8.00	9.03	10.06	7.96	9.00	10.05
NDF, %	25.24	22.81	20.38	20.53	18.06	15.58	19.72	17.29	14.86	17.73	15.36	12.99
ADF, %	12.94	11.96	10.98	10.01	9.01	8.02	8.71	8.01	7.31	7.33	6.73	6.12
Ash, %	5.98	6.16	6.34	5.33	5.52	5.70	5.68	5.82	5.97	5.50	5.63	5.77
EE, %	4.15	3.57	2.98	4.22	3.63	3.04	3.77	3.22	2.68	3.82	3.25	2.69
NEm, Mcal/lbs[f]	1.97	1.90	1.89	1.97	1.96	1.96	2.07	2.06	2.06	2.06	2.05	2.04
NEg, Mcal/lbs[g]	1.26	1.25	1.24	1.34	1.33	1.32	1.40	1.39	1.38	1.38	1.37	1.36

[a] All values except dry matter are on a DM basis
[b] HMEC = high moisture ear corn; LS = molasses-based liquid supplement; SBM = soybean meal; DDGS = dried distillers grains plus solubles; DRC = dry rolled corn; HMC = high-moisture corn; GH = grass hay; DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; EE = ether extract; NEm = net energy for maintenance; NEg = net energy for gain.
[c] Liquid supplement 1 contained (DM basis): 44.46% CP, 38.78% non-protein nitrogen, 41 Mcal/cwt of NEm, 26 Mcal/cwt of NEg, 0.90% ether extract, 16.52% total sugars, 50.77% ash, 11.00% calcium, 0.38% P, 7.07% K, 0.13% Mg, 6.00% NaCl, 3.54% Na, 0.41% S, 4.30 ppm Co, 200.00 ppm Cu, 12.11 ppm I, 6.91 mg/lb EDDI, 525.35 ppm Fe, 404.93 ppm Mn, 2.93 ppm Se, 1,800 ppm Zn, 20,195.12 IU/lb Vitamin A, 201.95 IU/lb Vitamin E, and 585.37 g/ton monensin sodium.
[d] Liquid supplement 2 contained (DM basis): 7.32% CP, 1.03% non-protein nitrogen, 54 Mcal/cwt of NEm, 35 Mcal/cwt of NEg, 1.36% ether extract, 27.18% total sugars, 50.77% ash, 11.00% calcium, 0.38% P, 7.07% K, 0.12% Mg, 6.00% NaCl, 2.94% Na, 0.46% S, 4.38 ppm Co, 200.00 ppm Cu, 12.11 ppm I, 6.91 mg/lb EDDI, 436.14 ppm Fe, 409.87 ppm Mn, 2.93 ppm Se, 1,800 ppm Zn, 20,195.12 IU/lb Vitamin A, 201.95 IU/lb Vitamin E, and 585.37 g/ton monensin sodium
[e] Tabular NE from Preston (2016) and actual nutrient compositions
[f] Net energy for maintenance
[g] Net energy for gain

Table 2. Influence of dietary treatment on growth performance and carcass trait responses deads and removals excluded.

Item	Treatments[a]			SEM[c]	F-test	*P*-value	
	DDGS	SBM50	SBM100			Linear	Quadratic
Pens, n	63	61	63				
Steers, n	8	8	8				
Initial BW[b], lbs	842	844	844	2.2	0.84	0.57	0.91
d 1 to d 35							
BW d35[b], lbs	983	992	1008	2.9	0.01	0.01	0.33
ADG, lbs	4.01	4.21	4.63	0.079	0.01	0.01	0.35
DMI, lbs	21.8	21.7	22.0	0.13	0.31	0.39	0.21
G:F	0.185	0.196	0.211	0.0033	0.01	0.01	0.61
F:G[c]	5.41	5.10	4.74	-	-	-	-
d 36 to d 77							
BW d77[b], lbs	1193	1197	1206	4.2	0.08	0.03	0.81
ADG, lbs	4.96	4.89	4.74	0.097	0.33	0.16	0.63
DMI, lbs	24.2	23.8	23.4	0.24	0.08	0.03	0.85
G:F	0.205	0.207	0.204	0.0032	0.77	0.69	0.55
F:G[c]	4.88	4.83	4.90	-	-	-	-
d 78 to d 105							
BW d105[b], lbs	1276	1283	1287	4.2	0.19	0.07	0.98
ADG, lbs	3.00	3.00	2.91	0.090	0.66	0.43	0.67
DMI, lbs	24.3	24.1	24.1	0.29	0.88	0.65	0.83
G:F	0.124	0.125	0.121	0.0038	0.71	0.58	0.55
F:G[c]	8.06	8.00	8.26	-	-	-	-
d 106 to d 139							
BW d139[b], lbs	1369	1391	1391	6.6	0.04	0.03	0.14
ADG, lbs	2.69	3.24	3.04	0.165	0.10	0.18	0.09
DMI, lbs	25.5	25.4	25.2	0.22	0.60	0.33	0.87
G:F	0.106	0.128	0.120	0.0059	0.05	0.10	0.06
F:G[c]	9.43	7.81	8.33	-	-	-	-
Cumulative (live-basis)							
ADG, lbs	3.77	3.95	3.92	0.051	0.06	0.05	0.15
DMI, lbs	23.9	23.7	23.6	0.17	0.38	0.18	0.72
G:F	0.158	0.167	0.167	0.0173	0.01	0.01	0.05
F:G[c]	6.33	5.99	5.99	-	-	-	-
Cumulative (HCW/0.625)							
Final BW, lbs	1413	1429	1420	6.6	0.32	0.60	0.16
ADG, lbs	4.10	4.21	4.12	0.053	0.42	0.77	0.21
G:F	0.172	0.178	0.175	0.0020	0.14	0.26	0.10
F:G[c]	5.81	5.62	5.71	-	-	-	-
Applied Energetics[e]							
NEm[f], Mcal/cwt	91.2	95.3	95.3	0.73	0.01	0.01	0.03

NEg[g], Mcal/cwt	61.2	64.9	64.9	0.64	0.01	0.01	0.03
O/E[h] NEm	0.98	1.03	1.03	0.008	0.01	0.01	0.03
O/E[h] NEg	0.99	1.04	1.04	0.011	0.01	0.01	0.04
Carcass Traits[i]							
HCW, lbs	884	893	886	4.2	0.32	0.60	0.16
DP[j], %	64.60	64.10	63.75	0.251	0.09	0.03	0.80
REA, in^2	14.0	14.3	14.4	0.12	0.05	0.02	0.54
RF, in	0.55	0.59	0.57	0.018	0.22	0.28	0.17
Marbling[k]	519	531	524	14.9	0.85	0.83	0.60
Calculated YG	3.25	3.30	3.19	0.078	0.63	0.60	0.42
EBF[j], %	31.02	31.61	31.23	0.349	0.49	0.68	0.27
AFBW[l], lbs	1279	1272	1276	11.9	0.91	0.87	0.69
Quality Grade Distribution, %							
Select	6.3	5.0	6.5	-	0.92		
Low Choice	39.7	40.7	38.7				
Average Choice	33.3	30.5	33.9				
High Choice	17.5	17.0	16.1				
Prime	3.2	6.8	4.8				
Yield Grade Distribution, %							
1	0.0	3.3	3.2	-	0.36		
2	41.2	30.1	46.0				
3	55.6	63.3	44.4				
4	3.2	3.3	4.8				
5	0.0	0.0	1.6				
Liver Abscess Prevalence, %							
Normal	74.6	81.7	63.5	-	0.05		
A-	4.8	8.3	9.5				
A	3.2	5.0	0.0				
A+ or greater	17.4	5.0	27.0				

[a] DDGS = 100% DDGS; SBM50 = 50 % DDGS, 50% SBM; SBM100 = 100% SBM
[b] A 4% pencil shrink was applied to BW measures to account for gastrointestinal tract fill.
[c] Calculated as; 1/G:F
[d] Pooled SEM
[e] Calculated from live BW shrunk 4%
[f] Net energy for maintenance
[g] Net energy for gain
[h] Observed to Expected ratio (calculated net energy value/tabular net energy estimate)
[i] HCW = hot carcass weight; DP = dressing percent; REA = ribeye area; RF = rib fat; EBF = empty body fat; AFBW = adjusted final body weight
[j] Calculated as: (HCW/Final BW shrunk 4%) × 100.
[k] Small00 = 400
[l] Calculated according to Guiroy et al. (2002).

Substitution of modified distillers grains with soybean meal with or without hulls had negligible effects on growth performance, efficiency, and carcass traits in yearling steers.

Cassidy Ross, Scott Bird, Zachary Smith, Warren Rusche

Rationale and Approach

Traditionally, corn dry-milling co-products are used as a standard feed ingredient in American feedlots for at least 20 years, whereas oilseed meals are rarely used. However, recent increases in the demand for biodiesel may result in changes to long-held supplemental protein price relationships in the United States, influencing protein source decisions of feedyard operators. The objective of this research was to examine the effects of soybean meal (SBM) with or without additional soybean hulls (SBH) in replacement of modified corn distillers grains plus solubles (MDGS) on growth performance, efficiency of dietary net energy utilization, and carcass trait responses in finishing beef steers.

Steers (*n* = 240) were allotted to one of 24 pens (*n* = 10 steers per pen; 8 pens per treatment) and assigned to one of three treatments: MDGS fed at 15% diet DM (MDGS) replaced by either soybean meal and corn (9 and 6% of DM, respectively; SBM), or soybean meal and soyhull pellets (9 and 6% of DM, respectively; SBM-SBH). Dietary concentrations of crude protein and neutral detergent fiber based on tabular values and weekly batching records were 12.3 and 17.6%, 12.8 and 14.5%, and 12.8 and 17.8% for MDGS, SBM, and SBM-SBH, respectively (Table 1).

Findings

Growth performance and carcass trait data are in Table 2. In the first 21 d the soybean meal showed advantages over MDGS. Day 21 BW was greater ($P = 0.01$) in the SBM and SBM-SBH compared to MDGS, reflected by 41 and 38 % greater ADG ($P = 0.01$) observed in the SBM and SBM-SBH treatments, respectively. Soybean meal also increased DMI ($P = 0.01$) and improved feed efficiency ($P = 0.01$) compared to MDGS. However, differences between MDGS and SBM were reversed between d 21 and d 49, with MDGS increasing ADG ($P = 0.03$) and gain to feed ratio (G:F; $P = 0.01$) during this period.

Cumulatively, there were no differences amongst treatments for carcass-adjusted final BW, DMI, ADG, or feed efficiency ($P \geq 0.11$). Dietary treatment had no effect on hot carcass weight, dressing percentage, ribeye area rib fat marbling score, USDA Yield Grade, percent empty body fat (EBF), or final body weight adjusted to 28% EBF ($P \geq 0.11$). Also, distribution of USDA Quality or Yield grades were unaffected by treatment and dietary treatment did not affect liver abscess incidence and severity ($P \geq 0.11$).

Implications

Feeding supplemental protein sources with enhanced diet conditioning attributed and greater concentrations of ruminally undegradable protein sources (MDGS) provided no advantage to cattle performance. Therefore, protein source decisions can be based upon price per delivered crude protein and impact on diet costs.

Acknowledgements

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Table 1. Diet Composition (DM basis)[a].

	Treatment[b]		
Item	**MDGS**	**SBM**	**SBM-SBH**
Ingredient Composition, %			
Dry-rolled Corn	69.78	75.17	69.48
MDGS	14.74	0	0
Soybean Meal	0	9.26	8.97
Soybean Hull Pellets	0	0	5.91
Roughage[c]	11.48	11.58	11.62
Liquid Supplement[d]	4.02	3.99	4.01
Nutrient Composition[e]			
Dry Matter, %	65.41	72.24	72.17
Crude Protein, %	12.23	12.45	12.68
Neutral Detergent Fiber, %	16.62	13.59	16.75
Fat, %	4.67	4.05	4.01
Nem[f], Mcal/cwt	93.03	92.56	90.76
NEg[g], Mcal/cwt	62.99	62.57	61.00

[a]All values except dry matter are on a DM basis.
[b]MDGS – modified distillers grains as CP source; SBM- soybean meal and corn replacing MDGS; SBM-SBH – soybean meal and soyhulls replacing MDGS
[c]Roughage source was ryelage from d 1 to 44, corn silage from d 45 to 105, & sorghum silage from d 106 to 118
[d]Liquid supplement contained (DM basis): 27.0% CP, 20.154% non-protein nitrogen, 38.765 Mcal/cwt of NEm, 26.265 Mcal/cwt of NEg, 0.316% ether extract, 20.273% total sugars, 58.823% ash, 16.923% calcium, 0.40% P, 1.538% K, 0.255% Mg, 7.935% NaCl, 3.415% Na, 0.493% S, 4.615 ppm Co, 250.00 ppm Cu, 40.0 ppm I, 50.0 ppm EDDI, 243.067 ppm Fe, 500.00 ppm Mn, 4.00 ppm Se, 2,253.846 ppm Zn, 36,000.00 IU/lb Vitamin A, 250.00 IU/lb Vitamin E, and 750.769 g/ton monensin sodium
[e]Tabular net energy from Preston (2016) and tabular nutrient compositions from NASEM (2016)
[f]Net energy for maintenance
[g]Net energy for gain

Table 2. Influence of dietary treatment on growth performance and carcass trait responses (deads and removals excluded).

Item	Treatments[a]			SEM	P-value		
	MDGS (1)	SBM (2)	SBM-SBH (3)		Overall	SBM effect (1 vs 2,3)	Starch effect (2 vs 3)
Steers, n	79	79	80				
Pens, n	8	8	8				
Initial BW[b], lbs	963	956	957				
d 1 to 21							
d 21 BW[b], lbs	1038	1082	1077	4.4	0.01	0.01	0.01
ADG, lbs	3.57	5.96	5.73	0.206	0.01	0.01	0.01
DMI, lbs	22.15	24.22	23.34	0.148	0.01	0.01	0.01
G:F	0.161	0.246	0.245	0.0080	0.01	0.01	0.01
F:G[c]	6.39	4.10	4.10				
d 22 to 49							
d 49 BW[b], lbs	1202	1224	1220	5.2	0.02	0.01	0.05
ADG, lbs	5.84	5.10	5.11	0.199	0.03	0.01	0.15
DMI, lbs	27.24	27.21	27.69	0.220	0.26	0.46	0.36
G:F	0.214	0.187	0.185	0.007	0.01	0.01	0.16
F:G[c]	4.72	5.44	5.44				
d 50 to d 77							
d 77 BW[b], lbs	1365	1393	1384	8.9	0.12	0.06	0.12
ADG, lbs	5.87	6.03	5.86	0.254	0.87	0.80	0.60
DMI, lbs	31.31	31.73	32.15	0.365	0.30	0.18	0.99
G:F	0.190	0.190	0.182	0.0068	0.71	0.88	0.53
F:G[c]	5.26	5.26	5.49				
d 78 to d 118							
d 118 BW[b], lbs	1521	1533	1515	8.3	0.33	0.80	0.17
ADG, lbs	3.79	3.41	3.18	0.188	0.11	0.05	0.74
DMI, lbs	32.35	31.76	31.45	0.383	0.27	0.13	0.76
G:F	0.117	0.108	0.101	0.0054	0.15	0.07	0.80
F:G[c]	8.55	9.26	9.90				
Cumulative (live-basis)							
ADG, lbs	4.73	4.89	4.73	0.070	0.22	0.37	0.09
DMI, lbs	29.08	29.33	29.28	0.212	0.68	0.39	0.57
G:F	0.117	0.108	0.101	0.0054	0.15	0.54	0.07
F:G[c]	6.13	5.99	6.17				
Cumulative (HCW/0.625)							
Final BW[d], lbs	1508	1497	1481	8.5	0.11	0.09	0.81
ADG, lbs	4.61	4.58	4.44	0.071	0.22	0.25	0.56
DMI, lbs	29.08	29.33	29.28	0.212	0.68	0.39	0.57
G:F	0.159	0.156	0.152	0.0023	0.13	0.11	0.73
F:G[c]	6.29	6.41	6.58				

Item	Treatments[a] MDGS (1)	SBM (2)	SBM-SBH (3)	SEM	*P*-value Overall	SBM effect (1 vs 2,3)	Starch effect (2 vs 3)
Carcass Trait Responses							
Hot carcass wt., lbs	942	936	926	5.3	0.11	0.09	0.81
Dressing percentage[e]	61.96	61.14	61.23	0.291	0.13	0.05	0.22
Ribfat, in	0.61	0.62	0.62	0.016	0.90	0.69	0.99
Ribeye area, in sq.	13.95	13.70	13.66	0.110	0.17	0.07	0.42
Marbling[f]	535	549	531	10.9	0.51	0.74	0.27
Calculated YG	3.65	6.72	6.69	0.062	0.74	0.47	0.57
Quality Grade Distribution, %							
Select	6.4	3.9	8.8		0.70		
Low Choice	26.9	26.0	28.8				
Average Choice	42.3	42.9	40.0				
High Choice	18.0	23.4	18.8				
Prime	6.4	3.9	3.8				
Yield Grade Distribution, %							
1	1.3	1.3	0.0		0.70		
2	24.4	15.2	18.3				
3	52.6	62.0	53.7				
4	21.8	20.3	26.8				
5	0.0	1.3	1.2				
Liver Abscess Prevalence, %[g]							
Normal	76.9	73.4	64.6		0.11		
A-	11.5	13.9	11.0				
A	5.1	1.3	6.1				
A+	6.4	11.4	18.3				

[a]MDGS – modified distillers grains as CP source; SBM- soybean meal and corn replacing MDGS; SBM-SBH – soybean meal and soyhulls replacing MDGS
[b]A 4% pencil shrink was applied to BW measures to account for gastrointestinal tract fill.
[c] Calculated as: 1/G:F
[d] Determined from carcass-adjusted growth performance.
[e] Calculated as: (HCW/Final BW shrunk 4%) × 100.
[f]Small^{00} = 400
[g]Elanco scoring system: Normal (no abscesses), A- (1 or 2 small abscesses), A (2 to 4 small abscesses), A+ (1 or more abscesses greater than 1 inch in diameter)

Animal Science Research Report 2024

Effects of phase feeding hybrid rye on growth performance and carcass characteristics of backgrounded steers

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Rationale and Approach

Previous studies we have conducted at the Southeast Research Farm have consistently demonstrated that hybrid rye can replace approximately one-third of dry-rolled corn in finishing beef cattle diets without negatively impacting growth performance or carcass value. Including rye in greater proportions resulted in reduced final performance but there were no differences for the first 56 days. That observation led us to ask whether we could feed dry-rolled rye as the sole grain source initially, then switch to dry-rolled corn as the sole grain source. This flexibility would allow cattle feeders to take advantage of temporary price differences between rye and corn to reduce the cost of gain.

We conducted an experiment to compare feeding rye grain as the sole grain source for the first 46 days after which they were switched to a dry-rolled based diet. Diets are shown in Table 1. We fed 110 primarily Angus steers with an initial weight of 861 pounds which were allotted into 14 pens (seven pens per treatment). For the first 46 days half of the pens were fed the dry-rolled corn based diet (DRC) while the other seven pens were fed a diet where dry-rolled rye replaced all the corn (RYE). All cattle were fed the DRC diet from day 47 until trial completion.

Findings

During the initial 46 days, feeding rye as the sole grain source resulted in a 13% reduction in ADG compared to DRC (3.51 vs. 4.04, respectively; P = 0.01) and an 18% reduction in DMI (18.6 vs. 22.7; P = 0.01) as shown in Table 2. The RYE steers did recapture some of the lost performance when switched to DRC resulting in no significant differences in ADG or feed efficiency when measured over the cumulative feeding period. Steers fed RYE tended to eat 1.1 pound less over the entire feeding period (P = 0.08). There were no significant differences between treatments for carcass characteristics, grade distributions, or liver scores, but feeding rye did result in an eight-pound reduction in hot carcass weight (HCW).

Implications

Rolled rye can be fed as the sole grain source for a portion of the feeding period without significant carryover losses in performance. In this experiment, steers displayed an aversion to rye grain, resulting in reduced performance during the rye feeding phase. Cattle feeders would need to consider the impacts of temporarily reduced performance when evaluating phase feeding rye compared to inclusion at a reduced amount over the entire feeding period.

Acknowledgements

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Table 1. Composition of experimental finishing diets fed to steers during rye feeding period (d1 to d 46).[1]

Item	DRC[2]	RYE[2]
Dry-rolled corn, %	66.0	0.0
Hybrid rye, %	0.0	66.0
Modified distillers grains plus solubles, %	20.0	20.0
Sorghum silage, %	4.0	4.0
Grass hay, %	6.0	6.0
Liquid Supplement, %[3]	4.0	4.0
Nutrient Composition[4]		
Crude protein, %	14.9	16.7
Neutral detergent fiber, %	17.9	24.5
NEm, Mcal/cwt	93.79	84.55
NEg, Mcal/cwt	62.61	54.69

[1] From d1 to d46, pens were fed either DRC or RYE diet based on treatment assignment. After d 46, all pens were fed common DRC diet.
[2] DRC = control diet; RYE = dry-rolled rye grain fed from d 1 to d 46 at 66% of diet DM.
[3] Provided 30 g/ton of monensin as well as vitamins and minerals to exceed requirements (NASEM, 2016)
[4] Based on tabular estimates

Table 2. Growth performance of finishing steers fed either dry-rolled corn (DRC/DRC) or dry-rolled rye for the first 46 days, followed by a dry-rolled corn diet (RYE).[1]

	Treatments			
Item	**DRC/DRC**[2]	**RYE**[2]	**SEM**[3]	***P* - value**
Pens, n	7	7	-	-
Steers, n	55	54	-	-
Initial BW, lbs.	861	861	-	-
Rye feeding period				
ADG, lbs.	4.04	3.51	0.071	0.01
DMI, lbs.	22.7	18.6	0.36	0.01
G:F	0.178	0.189	0.0049	0.15
Feed to gain[4]	5.62	5.29	-	-
Cumulative performance				
Final BW[5]	1396	1383	13.1	0.37
ADG, lbs.	3.72	3.63	0.091	0.34
DMI, lbs.	24.5	23.4	0.36	0.08
G:F	0.152	0.155	0.0025	0.30
Feed to gain	6.58	6.45		
Carcass traits				
HCW, lbs.	873	865	8.2	0.37
Dressing percent	63.6	63.9	0.51	0.49
Ribeye area, sq in	14.0	14.0	0.32	0.98
Rib fat, in	0.55	0.55	0.027	0.84
Marbling[6]	467	452	13.1	0.29
Yield Grade	3.2	3.2	0.16	0.91
Quality Grade, %				
Standard	1.8	0.0		0.40
Select	23.6	34.0		
Low Choice	43.6	46.0		
Upper 2/3rd Choice	25.5	20.0		
Prime	5.5	0.0		
Liver outcomes, %[7]				
Normal	58.2	65.4		0.51
A-	10.9	9.6		
A	9.1	3.8		
A+	21.8	21.2		

[1]A 4% shrink was applied to all body weights.
[2]Pens were fed either dry-rolled corn (DRC) or dry-rolled rye (DRR) for the first 46 days, after which all pens were fed a DRC based diet.
[3]Standard error of the mean
[4]Calculated as 1/G:F.
[5]Final BW calculated using hot carcass weight (HCW) adjusted to a common dressing percentage (62.5%).
[6]400 = Small^{00}; Low Choice.
[7]Determined according to the Elanco Liver Scoring System: Normal (no abscesses), A- (1 or 2 small abscesses), A (2 to 4 small abscesses), A+ (1 or more abscesses greater than 1 inch in diameter)

SOUTH DAKOTA STATE UNIVERSITY
Department of Animal Science

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Non-ruminant Research

Photo courtesy of National Pork Board

Effects of dietary manganese supplementation on growth performance in growing-finishing pigs

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Rationale and Approach

Manganese (Mn) plays a critical role in metabolism, bone development and antioxidant activity. Mn is usually supplemented in swine diets as part of the trace mineral premix in the form of manganese sulphate because of the unknown bioavailability of Mn in feed ingredients. The source of Mn may differently influence growth performance of pigs. Therefore, the objective of this study was to evaluate the effects of dietary Mn source on growth performance in growing-finishing pigs.

A total of 450 growing pigs (initial body weight (BW) = 73.4 ± 13.7 lbs) were housed in 30 pens with 15 pigs per pen and 10 replicates per treatment. Pigs were fed three dietary treatments over four feeding phases in a randomized complete block design (Phase 1: 55 – 110 lbs, Phase 2: 110 – 165 lbs, Phase 3: 165 – 220 lbs, and Phase 4: 220 – 287 lbs). The three dietary treatments were: 1) corn-soybean meal-based basal diet with mineral premix (copper: 4 ppm, zinc: 60 ppm, and selenium 0.2 ppm of diet; CON); 2) CON diet with SAM Nutrition Mn supplementation at 25 ppm (SAM-Mn; Mn hydroxychloride, SAM Nutrition); 3) CON diet with Intellibond® Mn supplementation at 25 ppm (ITB-Mn; Mn hydroxychloride, Micronutrients). Growth performance of the pigs was assessed at the end of each diet phase.

Findings

The Mn-supplemented diets had 20 ppm (analyzed value) greater Mn concentration than the CON diets and both Mn-supplemented diets had similar Mn concentrations. At the end of Phase 3, the SAM-Mn treatment had greater ($P < 0.05$) BW than CON and ITB-Mn treatments. The SAM-Mn treatment had BW similar to the CON treatment and greater ($P < 0.05$) than ITB-Mn treatment (265.0 vs. 260.1 lbs) at the end of Phase 4. The average daily gain (ADG) for SAM-Mn treatment was greater (P < 0.05) than ITB-Mn treatment (2.38 vs. 2.25 lbs) in Phase 2, whereas it was greater ($P < 0.05$) than CON treatment (2.51 vs. 2.36 lbs) in Phase 3. In Phase 3, the average daily feed intake for SAM-Mn treatment was greater ($P < 0.05$) than CON treatment (7.10 vs. 6.77 lbs) but did not differ from ITB-Mn treatment. Dietary treatments did not affect feed efficiency during the whole experimental period.

Implications

Additional Mn supplementation with SAM-Mn product (25 ppm) improved growth performance of growing-finishing pigs when compared to CON (0 ppm) and ITB-Mn (25 ppm) treatments.

Acknowledgements

The authors thank the swine group at South Dakota State University and SAM Nutrition for their contributions and support for this study.

Impact of feed delivery in the first days after farrowing on piglet performance and survivability

A. Bardales Castellanos, C.L. Bradley, and C.L. Levesque

Rationale and Approach

Preweaning mortality in commercial pig herds ranges from 10% to 20% with the greatest occurrence within 72 hours of birth. Piglet mortality is the result of several interactions between the sow, the piglet, and the environment. Piglets are more prone to be crushed in the first 5 days after birth. In some feeding systems, sows are provided feed in 6 feedings daily rather than 2. It has been speculated that feeding sows more times daily, particularly in the first week after weaning, may increase sow crushing of piglets. Thus, the impact of the sow feeding schedule after farrowing on sow reproductive performance, piglet survivability, and growth from birth to weaning were investigated.

A total of 252 sows (parity 1 to 8) were used in a randomized incomplete block design and assigned to one of three feeding schedules: 1) FEED-6 (6 feeding times daily), 2) FEED-2 (2 feeding times daily), 3) FEED-2/6 (2 feeding times daily for first 5 days, then 6 times daily for the remainder of lactation). At farrowing and weaning, the sow's reproductive performance which includes litter size, piglet weights, weaning age, and body condition score was assessed. Weight of the litter both at birth and at weaning was measured. Piglet mortality/removal was documented, including day, time, pig and litter, pig body weight, and reason for death/removal. A feed bowl score (scale of 1 = empty, to 5 = full) was assigned daily as an indirect measure of feed 'wastage'.

Findings

The feeding program did not impact born alive piglets (15 ± 0.4 piglets), piglet survivability in the first 5 days (2.2 ± 0.3 piglets dead/litter), overall preweaning mortality (2.8 ± 0.3 piglets), or overall piglet body weight gain (4.8 ± 0.6 lb). Sows fed twice daily had greater ($P < 0.05$) daily feed delivered (19.5 lb) than sows on the FEED-6 (18.2 lb) or FEED2/6 (18.4 lb). Bowl scores tended to be lowest ($P < 0.09$) in FEED-2 on day 6 compared to FEED-2 and FEED-2/6. The bowl score was highest for FEED-2/6 ($P < 0.01$) on days 12 and 19 versus FEED-2 and FEED-6. Piglets born alive was unaffected by sow parity and daily feed delivered increased with sow parity ($P \leq 0.05$). Parity 4+ sows had the highest ($P \leq 0.05$) preweaning mortality at 3.0 piglets per litter (equivalent to 20%) compared to piglet mortality rate for all the herd of 14.6%.

Implications

Preweaning mortality was not deemed related to the number of feeding events in a single day; however, the increase in preweaning mortality suggests a need to understand what factors other than sow daily feeding times impact the piglet's likelihood of survival.

Acknowledgements

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Effect of dietary isoacids supplementation on nutrient digestibility of growing pigs fed corn-soybean meal diets

A.P. Benavides-Infante, M.T. Socha, L.A. Rodrigues, C.L. Levesque, and J.Y. Perez-Palencia

Rationale and Approach

Branched-chain fatty acids, which are collectively referred to as isoacids, are the product of branched-chain amino acid fermentation and have been associated with improvements in ruminants' productivity (i.e. milk production), primarily by positively modulating gut microbes. The objective of this study was to determine the optimal inclusion level of isoacid blend product in swine diets based on apparent ileal digestibility (AID) and apparent total tract digestibility (ATTD) of nutrients in growing pigs fed corn-soybean meal diets.

Twelve cannulated pigs (initial body weight (BW) = 46 ± 1.6 lbs) were used in a 5-period switch-back design with 6 diets and 2 replicate pigs in each period, which provided 10 observations per dietary treatment. Experimental diets consisted of increasing levels (0%, 0.5%, 0.75%, 1%, 1.25%, and 1.5%) of an isoacid blend (isobutyrate, isovalerate, and 2-methyl butyrate, 1:1:1) added to a corn-soybean meal basal diet containing titanium as an indigestible marker. Each experimental period consisted of 14 d, with 10 d for acclimatization to the diets, 2 d for fecal collection, and 2 d for digesta collection. Diets, fecal, and ileal digesta samples were analyzed for gross energy (GE), crude protein (CP), fiber composition, amino acids (AA), and titanium. Orthogonal polynomial contrasts were used to determine linear and quadratic effects of increasing levels of isoacids.

Findings

Dietary supplementation of isoacids improved ($P < 0.1$, linear and/or quadratic) AID of crude fiber and hemicellulose and most of the indispensable AA (except Met+Cys, Trp, and Val) as well as ATTD of CP, GE, neutral detergent fiber, and hemicellulose. In addition, ATTD of Arg, His, Ile, Leu, Met+Cys, Phe, Thr, Trp, and Val increased quadratically (P < 0.1). Collectively, 1% isoacid inclusion promoted the greatest responses in most measured variables (% increase: unsupplemented vs. 1%): AID of Lys (9.3%), Met (5.7%), Thr (17.8%), Leu (7.4%), Ile (9.2%), Phe (7.8%), His (5.9%), Arg (4.9%); ATTD of CP (2.1%), GE (1.3%), NDF (3.9%), hemicellulose (> 50%), overall indispensable AA (9.5%), overall dispensable AA (8.6%).

Implications

Overall, dietary supplementation of isoacids at 1% can improve dietary nutrient digestibility, particularly ileal AA digestibility. By increasing nutrient digestibility, this novel feed additive represents a promising opportunity to reduce feed cost and/or improve pig productivity.

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Animal Science Research Report 2024

Evaluating the inclusion of probiotic or postbiotic in the nursery period on pig performance through to market, gut health and microbial populations, and carcass value

J. Castillo Zuniga, R.S. Samuel, and C.L. Levesque

Rationale and Approach

Probiotics and postbiotics are proposed to be beneficial additives for swine diets, especially in the nursery phase, due to the numerous environmental and biological stressors that may affect the young pig. Beneficial gut microbiota can regulate and support the immune system by altering the digestive tract environment, regulating pH, and competing with pathogenic bacteria that could harm the animal. Probiotic and postbiotic inclusion can also reduce mortality and the need for antibiotics. Therefore, the objective of this study was to evaluate the inclusion of a Lactobacillus-based probiotic and Bifidobacteria-based postbiotic in nursery pig diets on pig performance to market, gut health, microbial populations, and carcass value.

The trial involved 1,040 pigs allocated to 40 pens of 26 pigs per pen, with a starting weight of 13 ± 0.5 lbs. Pens were assigned to one of 4 dietary treatments: 1) Control, 2) 0.1% inclusion of Lactobacillus-based probiotic (LacPro), 3) 0.2% inclusion of Lactobacillus-based probiotic, or 4) 0.2% inclusion of Bifidobacteria-based postbiotic (BifPos). Pens of pigs were weighed at barn entry, end of Phase 1 (from d 0 to d 10), end of Phase 2 (from d 10 to d 21), d 47, d 70, d 105, and d 135. Feed remaining on weigh days was calculated according to a prepared calibration curve and the distance from the top of the feeder to the top of the feed. To evaluate microbial populations, fecal samples were collected on d 10, d 21, and d 47. To measure gut health parameters, on d 10, 40 pigs were euthanized, providing 10 jejunal and ileal tissue samples per treatment that were then measured for villi height, crypt depth, and villi height to crypt depth ratio (Vh:Cd). Hot carcass weight was provided from the harvest facility.

Findings

On day 10, pigs fed the Control diet had lower daily feed intake (0.33 lbs/d vs. 0.84 lbs/d; P ≤ 0.05) than pigs fed with any other diet. A greater (P < 0.02) Vh:Cd in the ileal tissue from pigs fed 0.2% inclusion of LacPro (1.21 μm), 0.1% LacPro (1.04 μm), and for 0.2% BifPos (1.18 μm) indicates a greater surface area compared to 0.99 μm for Control in the ileum, suggesting increased nutrient absorptive surface. Pigs fed diets 0.2% BifPos, 0.1% LacPro, and Control had similar hot carcass weights (218.1 lbs), versus pigs fed 0.2% LacPro (214.7 lbs; *P* < 0.01), indicating that weight gain was similar throughout the trial for all treatments except for pigs fed with 0.2% LacPro. An increased abundance (*P* < 0.03) of Lactobacillaceae family in feces from 0.2% LacPro and 0.2% BifPos groups compared to Control group (10.38% and 10.78% vs. 3.53%) on d 10 may indicate a more beneficial microbiota to keep pigs healthy.

Implications

The microbiota with greater Lactobacillaceae may be more capable of degrading complex carbohydrates such as dietary fibers, helping pigs to adapt to diets during the weaning transition period.

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Animal Science Research Report 2024

Effect of dietary fatty acids composition on growth performance and fecal consistency of weaned pigs

A. Forero-Salamanca, J.Y. Perez-Palencia, and C.L. Levesque

Rationale and Approach

Lipids are an important source of energy and fatty acids (FA). Dietary FA play critical roles in mucosal immune responses, epithelial barrier functions, and overall intestinal development. Thus, the strategic inclusion of lipids in the diet to provide FA offers a significant opportunity to maximize growth performance and intestinal health of pigs after weaning. This study evaluated the effects of two different dietary fatty acid compositions derived from either conventional soybean oil (CSO) or high oleic soybean oil (HOSO) supplemented to growing pigs on growth performance and fecal consistency of weaned pigs.

A total of 208 weaned pigs (10.9 ± 1.8 lb) were used in a randomized complete block design and allotted to 16 pens of 13 pigs each. Experimental diets met NRC (2012) requirements and were provided in a 3-phase nursery feeding program: Phase 1 (d 0 – d 7), Phase 2 (d 8 – d 21), and Phase 3 (d 22 – d 42). Pens were assigned to one of two dietary treatments consisting of two dietary FA compositions derived from supplementation with either 1) CSO (20% Oleic acid; 50% Linoleic acid; 6% Linolenic acid) or 2) HOSO (44% Oleic acid; 30% Linoleic acid; 3% Linolenic acid) at 3% of the diet. Feed disappearance and body weight were measured at d 0, 21, and 42. Pen fecal score was assessed daily from d 0 to 21 and then 3 times per week until d 42. Performance data were analyzed using T-TEST and fecal score using PROC FREQ procedures of SAS.

Findings

From d 0 to 21, pigs fed CSO supplemented diets had a greater ($P \leq 0.05$) body weight (18.9 vs. 16.3 lb) and average daily gain (ADG; 0.37 vs. 0.26 lb per day). In addition, daily feed intake and feed efficiency tended to be 23% and 16% greater in CSO-fed pigs, respectively. From d 21 to d 42, there were no differences between dietary treatments for growth performance. In the overall nursery period, pigs fed CSO had greater ($P \leq 0.1$) ADG than HOSO pigs (0.75 vs 0.66 lb per day). There were no differences in fecal scores in weeks 1 and 2. However, pigs fed CSO had less incidence of soft and watery feces (x2 < 0.1) in weeks 3 to 6.

Implications

A greater dietary content of linoleic and linolenic FA promoted pig growth performance and reduced incidence of diarrhea after weaning compared to greater content of oleic FA.

Acknowledgements

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Animal Science Research Report 2024

Effects of dietary corn origin (U.S., Argentina, and Brazil) on pig growth performance

J.G. Halbur, A. Forero Salamanca, J.K. Jansen, J. Hong, J.Y. Perez-Palencia, C.L. Levesque, S.M. Mueller, R.C. Thaler, and E.M. Weaver

Rationale and Approach

Corn is an important global commodity. Understanding and practically utilizing different corn sources and varieties in swine diets is important to U.S. corn and swine production. Other countries rely on imported corn for their nutrient needs in swine and poultry diets. Globally, the U.S. "dent" corn variety is presumed to be of lesser quality when compared to "harder" flint-type corn (the preferred varieties in Argentina and Brazil) due to differences in whole kernel structure when shipped long distances. In fact, official work from the US Grains Council indicates that US corn produces more ethanol per bushel when compared to flint-type varieties of corn. This indicates a higher level of starch in US corn and increased starch content should mean a higher level of energy and nutrients. Therefore, swine producers globally benefit from understanding the feeding value of different varieties and origins of corn. The objective of this study was to assess the performance of pigs fed corn from three exporting countries: U.S., Argentina and Brazil.

Two similar studies were conducted comparing the effect of 3 corn sources on late nursery pig performance. Study 1 used 96 nursery pigs (19.4 ± 1.7 lb) split between 14 pens and study 2 used 114 nursery pigs (17.5 ± 2.9 lb) split between 14 pens. Three experimental diets were formulated with corn sources from: 1) U.S.; 2) Argentina; and, 3) Brazil. The U.S. corn diet was considered the control diet and was balanced to meet or exceed all nutrient requirements for the pigs. U.S. corn was replaced with Argentina corn and Brazil corn on a lb for lb basis in the diets. Pigs were assigned in a randomized block design based on initial body weights and sex. Feed and water were offered ad libitum over a 28-day period, pig weights and feed disappearance were measured each week. Average daily gain (ADG), average daily feed intake (ADFI), feed efficiency, and death loss were measured after weeks 1, 2, and 4.

Findings

Results and Discussion: There were no significant differences ($P < 0.05$) in ADFI, ADG, and feed efficiency between the three corn sources throughout all weeks and the overall 28 days. Overall performance values for the three treatments were: US corn ADG (1.44), ADFI (2.00), and F:G (3.09); Argentina corn, ADG (1.42), ADFI (2.03), and F:G (3.18); and Brazil corn, ADG (1.45), ADFI (2.04), and F:G (3.13). The use of US corn and flint-based corn resulted in equivalent performance in nursery pig diets.

Implications

No significant difference in performance across these corn sources is beneficial for U.S. corn and swine producers globally. The value of US corn is similar in nutrient content and nutritional quality as demonstrated by equivalent performance. The aesthetics of whole kernels are not indicative of feeding value to pigs.

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Animal Science Research Report 2024

An evaluation of soybean meal inclusion rate in pigs fed from wean-to-market

A. Kramer, J. Hong, R.S. Samuel, C.L. Levesque, R.C. Thaler, and E.M. Weaver

Rationale and Approach

An increase in soybean production, driven by renewable energy policies, may increase the Midwest soybean meal (SBM) supply. Therefore, two common diet formulation strategies, Corn-DDGS-SBM (DDGS) or Corn-SBM (SBM) with synthetic amino acid additions (0.5%, 0.25% or no added Lysine HCl) were investigated in wean-to-market pigs.

A total of 540 pigs (PIC X Terminal Duroc) weaned at 21 days of age were used in a wean-to-market (WTM) study conducted in two fully-slatted, environmentally-controlled rooms. Individual BW and pen feed disappearance were collected every two weeks for 18 weeks. Carcass weights were collected at marketing between 18 and 20 weeks. All diets were formulated to a SID lysine:NE target by phase using current NE estimates for SBM (NRC, 2012) and DDGS, 995 Kcal/lb, (typical analysis of the DDGS source). The six dietary treatments were allotted to the 90 pens (15 pens/diet) with 6 pigs per pen in a randomized complete block design. The treatments consisted of high, medium and low SBM levels altered with the utilization of 0.5%, 0.25% and no added lysine (AA) in either a corn-SBM or corn-DDGS based diet formulation.

Findings

Feed intake was unaffected by dietary treatment. Nursery Phase: SBM increased week 6 BW and ADG compared to DDGS ($P < 0.05$). Intact SBM and 0.25% AA additions increased week 6 BW weights and ADG vs 0.5% AA ($P < 0.05$). Growing Phase: SBM increased week 14 BW and ADG compared to DDGS ($P < 0.05$) except for 0.25% AA in DDGS diets, which were not different. Intact SBM and 0.25% AA additions increased week 14 BW weights and ADG vs 0.5% AA ($P < 0.05$). Finishing Phase: SBM increased week 18 BW and ADG compared to DDGS ($P < 0.05$). Intact SBM and 0.25% AA additions increased week 18 BW and ADG vs 0.5% AA ($P < 0.05$). Marketing: Carcass data (97% of pigs allocated) indicated SBM addition increased hot carcass weight by 4.2 lbs, loin depth, BF, and calculated lean weight, compared to DDGS ($P < 0.05$). AA additions of 0.5% resulted in greater BF, less loin depth and less lean weight compared to the use of 0.25% or no AA (i.e. higher levels of SBM).

Implications

Higher SBM levels and/or 0.25% amino acid addition resulted in improved growth, feed and caloric conversion, and increased carcass value in high-performance WTM pigs compared to the use of DDGS and 0.5% amino acid additions. While economic conditions for feed ingredients and carcass value vary, formulations for best economic outcome should consider that high-performing pigs benefit from the health and nutritional components contained in SBM.

Acknowledgements

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Evaluation of hemoglobin concentration in gilts and their offspring

K. McClellan, M.D. Lindemann, and C.L. Levesque

Rationale and Approach

Piglets are born with low iron levels which renders them susceptible to anemia. While the prevalence of anemia in sows has recently gained attention, a limited number of studies have explored the impact of factors such as parity and reproductive status (gestation vs lactation) on sow hemoglobin (Hb) status. It is also not readily understood how sow Hb status influences offspring Hb status at birth and weaning. Determining appropriate Hb concentration reference intervals could play a crucial role in identifying, diagnosing, and treating anemia in sows and developing new strategies for iron supplementation in piglets. The objective was to evaluate Hb status in gilts during gestation and lactation and to assess the occurrence of anemia in the offspring at birth and weaning.

Blood Hb concentration was measured from an ear vein using Hemocue Hb 201+ monitor in 19 gilts on day 30, 60, 90, and 112 in gestation and day 2 and 17 of lactation. Blood Hb concentration was similarly measured in all born alive piglets (n = 293) at 24h of birth (prior to iron injection) and the pigs that were remaining on day 17 of age (n = 263). Sows and piglets were categorized as anemic (Hb < 10 g/dL) for non-anemic (Hb > 10 g/dL). Piglets were provided a single injection of 200 mg iron dextran at day 2-4 of age. Sow daily iron (Fe) intake based on diet Fe analysis was 621 ± 6 mg during gestation and averaged 1790 ± 15 mg during lactation, which represents more than a two-fold greater Fe intake than NRC 2012 recommendations.

Findings

The blood Hb concentration was lowest (9.6 g/dL; $P < 0.04$) at day 90 with slight recovery by day 112 (10.7, 10.7, 9.9 g/dL at 30, 60, and 112 days of gestation, respectively). In lactation, blood Hb concentration was lower ($P < 0.01$) at day 17 than day 2 (8.7 vs 10.1 g/dL) and lowest at day 17 compared to all other time points. At birth, 55.5% of piglets were deemed anemic (8.3 ± 1.3 g/dL) with 35.6 % still remaining anemic (8.1 ± 1.5) g/dL) at day 17.

Implications

This work highlights the presence of anemia in half of the piglets born from gilts and that anemia remains present to near weaning in one-third of the piglets. There appears to be a need for targeted iron interventions to enhance overall health of piglets from gilt litters prior to weaning. Inadequate iron levels in the weaning phase may result in anemia and compromised immunity during the nursery period, rendering young pigs more susceptible to diseases and growth-related issues. In addition, lower blood Hb concentrations on day 17 of lactation in sows indicates a potential need for iron intervention in parity 1 sows to support adequate blood Hb concentrations for the subsequent pregnancy.

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Effects of higher levels of soy protein and methionine on periparturient health of sows

L.J. Olson, M. Dey, and E.M. Weaver

Rationale and Approach

Most of the nutrient recommendations for sows (NRC, 2012) are based on data from sows with much lower reproductive productivity (2008: 18-23 p/s/y) compared to current (2022: 25-27 p/s/y). Increasing corn and crystalline amino acids reduces the levels of the nutritional and potentially beneficial components of soy and may impact highly prolific sow health during pregnancy. In 2015, recommendations for SID methionine (MET) to SID lysine (LYS) ratio (MET:LYS) were increased for the prolific sows in Denmark to 32% of LYS while NRC recommends 27% of LYS. The primary objective of this research was to evaluate SBM and MET at higher levels, as a replacement for corn, the main carbohydrate source, and crystalline amino acids, for its effects on markers of health.

A total of 38 parity 1-3 females (PIC 1050) with a starting body weight (BW) of 492.6 ± 28.7 lbs were utilized. On d 85 of gestation, sows were allocated by BW and parity to one of four treatments: 1) 30% SBM (30% of diet) and 36% SID MET:LYS ratio; 2) 15% SBM, 36% MET:LYS; 3) 30% SBM, 27% MET:LYS; 4) 15% SBM, 27% MET:LYS. Sows were fed dietary treatments 28 d pre-farrow (NRC) and continued through lactation (ad lib). In addition to performance data, at d 0, 21, 2 d post-farrow, and weaning, BW, body condition score by caliper (BCS), and backfat (BF) were measured. Beginning 3 d pre-farrow through 3 d post-farrow, body temperature was taken twice daily. Sows were assigned a farrowing ease score (1 – 4) based on farrowing duration, restless activity, savaging, and farrowing assistance required. Continuous glucose monitors were placed on a subset of sows (n = 12) on d 113 of gestation to 3 d post-farrow.

Findings

The combined effect of high SBM and high MET produced an average lactation weight loss of only 0.7 lbs, while the low SBM and low MET treatment, similar to current NRC, lost an average of 40.0 lbs. Main effects: Sows fed the 30% SBM diets had less lactation weight loss than 15% SBM ($P < 0.10$). Sows fed 36% MET lost less weight than sows fed 27% MET ($P < 0.05$), lost less backfat during lactation, and had lower body temperatures than higher levels of MET ($P < 0.01$) and ($P < 0.05$), respectively. In the subset of sows with continuous glucose monitors, interstitial glucose was lower in sows supplemented with a higher level of soy protein ($P = 0.055$).

Implications

Peripartum health complications, including farrowing difficulty, contributes to the need for greater care of highly prolific sows. This study demonstrated the higher inclusion of SBM and MET to sow diets may improve sow condition and health outcomes. Additional research is necessary to establish the critical relationships between farrowing ease, nutritional state, and sow mortality.

Acknowledgements

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Animal Science Research Report 2024

An evaluation of sodium salicylate in the periparturient management of the sow

L.J. Olson and E.M. Weaver

Rationale and Approach

The main causes of mortality in highly prolific sows in the U.S. are non-specified, lameness, prolapse, and farrowing difficulty (Eckberg, 2021). Sodium salicylate (NaSal) is a nonsteroidal anti-inflammatory drug with similar mechanisms of action to aspirin which is used in the management of preeclampsia-related pregnancy complications in humans (Roberge et al. 2017). The objectives of this experiment were: 1) collect farrowing ease data for scoring; and 2) evaluate the impact of NaSal on farrowing ease and post-partum recovery and inflammation.

A total of 47 parity 1 and 2 females (PIC 1050) were used with a starting trial body weight (BW) of 470.3 ± 32.4 lb. Sows were randomly assigned to one of two treatment groups on d 105 of gestation blocked by BW and parity. The treatments were: control (CON) n = 23; or treatment (TRT) n = 24. TRT consisted of NaSal supplementation (Oral-Pro®, Aurora Pharmaceutical, Northfield, MN) administered by a water medicator. NaSal was provided beginning 3 d pre-farrow, and continuing to 5 d post-farrow, with a target dose of 22.7 mg/lb BW. All females were fed a corn-SBM-based lactation diet formulated to meet or exceed nutrient requirements (NRC, 2012) using an electronic feeding system (Gestal 3G). In addition to performance data, BW, backfat (BF), and body condition score (BCS) were measured. Sows were assigned a farrowing ease score (exceptionally easy = 1 to highly difficult = 4) based on farrowing duration, restless activity, savaging, and farrowing assistance. Beginning d 3 pre-farrow to d 3 post-farrow, body temperature, heart rate, and respiration rates were collected twice daily.

Findings

Averages for pigs born alive/litter, pigs weaned/litter, and pig weaning weights, were 14.2, 12.8, and 11 lbs, respectively. The average farrowing duration for both groups was 335.5 minutes with a range of 110 – 710 minutes. Farrowing ease score for all sows was assessed as a mean of 2.28 with 47% scored as generally difficult (Score 3 - 4). Treatment with NaSal improved farrowing ease score (TRT avg: 1.9; CON avg 2.7; $P < 0.01$) and reduced savaging severity and occurrence (TRT: 5 sows, 1 severely savaged; CON: 8 sows, 7 severely savaged; $P < 0.05$). TRT sows (24/24) successfully weaned litters compared to 20/23 CON sows. All sows assigned a 1 or 2 score (25/25) weaned litters compared to sows assigned 3 or 4 (19/22). There was no statistical difference in change in BF, BCS, feed intake, gestation duration, or body temperature due to treatment.

Implications

Farrowing difficulty contributes to the need for greater care of highly prolific sows. Supplementation of NaSal during the periparturient period may improve farrowing ease and outcomes. Additional research is necessary to establish the relationship between farrowing ease and peri-parturient sow mortality.

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Effect of dietary xylanase supplementation on growth performance, apparent ileal digestibility of nutrients, and digesta viscosity of weaned pigs fed wheat-soybean meal-based diets

S. Sheffield, K. Haydon, C.L. Levesque, and J.Y. Perez-Palencia

Rationale and Approach

Xylanase supplementation can improve nutrient digestibility in pig diets by degrading cell wall non-starch polysaccharides and reducing digesta viscosity as well as promoting intestinal health of pigs after weaning. This study looked at the effects of dietary xylanase supplementation on growth performance, apparent ileal digestibility (AID) and apparent total tract digestibility (ATTD) of nutrients, and digesta viscosity in different digestive sites of weaned pigs.

A total of 312 weaned pigs (initial body weight (BW) 11.2 ± 2 lb) were weaned into 48 pens and assigned to one of six dietary treatments, each treatment with 8 pens, 6 – 7 pigs per pen, and sex ratios maintained within BW blocks. Experimental diets were formulated in a 3-phase nursery feeding program: Phase 1 (d 0-d 7), Phase 2 (d 8-d 21), and Phase 3 (d 22-d 42). Experimental diets consisted of: 1) a wheat/soybean meal-based diet formulated to meet pig requirements (positive control, PC), 2) the PC diet with reduction of 100 kcal of ME (negative control, NC), and 3-6) the NC diet supplemented with either 900, 1800, 3600, or 7200 units of xylanase. Feed disappearance and body weight were measured at d 7, 14, 21, and 42. Pen fecal score was assessed daily during d 0 to 14 and three times a week during d 15 to 28. On d 21 to 24 of the experiment (12 pigs per day), one pig per pen was selected for sample collection: ileal, cecal, and mid-colon digesta for viscosity and ileal digesta and feces for nutrient digestibility. Orthogonal polynomial contrasts were used to determine the linear and quadratic effects of xylanase in NC diets. Contrast analysis was used to compare PC and NC groups with xylanase-supplemented groups. Fecal scores data were analyzed using the PROC FREQ procedure.

Findings

Supplementing xylanase to NC diets did not improve pig growth performance ($P > 0.05$) through the nursery period. In week 2 and week 3, pigs fed the PC and NC diets had a greater ($x^2 < 0.05$) incidence of fecal scores 3 & 4 (diarrhea) than the xylanase-supplemented pigs. The AID of dry matter and ATTD of crude protein, gross energy, and neutral detergent fiber were greater ($P < 0.05$) in the 900-xylanase supplemented diets than in NC diets (2.5%, 3.2%, 1.6%, and 14%, respectively). In addition, the ATTD of neutral detergent fiber and acid-detergent fiber increased linearly ($P < 0.1$) in response to xylanase supplementation. Xylanase supplementation (900 to 7200 U) decreased digesta viscosity in colon when compared to PC and NC diets.

Implications

Overall, xylanase supplementation can improve nutrient digestibility, particularly at total tract level, and reduce viscosity in the hindgut, which could be related with decreasing the occurrence of looseness. However, the effects on growth were not expressive when xylanase was supplemented to wheat-soybean meal-based diets with reduction of 100 kcal of ME.

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Yeast carbohydrates in lactating sow diets may improve lightweight suckling piglet performance

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Rationale and Approach

Supplementation of yeast carbohydrates (YC) lysed from the yeast cell wall in sow diets has been linked to essential functions related to immune modulation in both sows and piglets, positively impacting their health and performance. This study aimed to determine the optimal inclusion level of a novel YC product in sow diets based on the immunoglobulin content in colostrum, milk, and serum and the performance of sows and suckling piglets.

Forty-nine sows and gilts (parity 0 to 5; 477 ± 66 lb) were randomly assigned to one of three YC supplementation levels (0%, 0.1%, and 0.2% of diet) from d 105 through weaning that was top-dressed using corn as a carrier to achieve daily active ingredient intake of 3 and 6 g/d in gestation and 7 and 15 g/d in lactation at the 0730 and 0800 h feed time in gestation and lactation, respectively. Variables measured included: sow body weight (BW), backfat (BF), feed intake (ADFI), litter characteristics at birth, piglet BW, piglet weight distribution at birth and wean, and serum, colostrum, and milk immune status.

Findings

Sows supplemented with 0.2%YC had 0.95 fewer stillborn pigs and tended to wean 1.04 more pigs ($P = 0.09$) compared to 0%YC and 0.1%YC ($P = 0.04$). Total born, born alive, and farrowing duration did not differ among treatment groups. Colostral immunocrit ratio tended to be higher in 0.2%YC sows compared to 0%YC sows ($P = 0.09$; 0.66 vs 0.48). 0%YC litters had 14.9% greater proportion of pigs at birth < 2.6 lb and both 0.1%YC and 0.2%YC had 12.4% greater proportion of average weight pigs (2.6-3.6 lb; $P < 0.01$). Pig BW at weaning (13.1 vs 12.5 lb) and overall ADG (0.53 vs 0.48 lb/d) were greatest from sow fed 0%YC ($P \geq 0.05$). The 0.2%YC group had a 3.7% and 10.4% higher frequency ($x^2 < 0.01$) of weaning light weight (< 11 lb) and average weight (11 – 14 lb) pigs, respectively. The 0.1%YC and 0.2%YC groups both had higher frequency of pigs in lower weight categories between birth and weaning (27.3 vs 25.9% vs 2.9; $x^2 < 0.01$). There was a 15.6% lower pre-weaning mortality of light born pigs in 0.2%YC group compared to 0%YC and 0.1%YC groups ($x^2 = 0.03$). Suckling pigs from sows in the 0.2%YC group had a higher ($P = 0.03$) concentration of serum IgA at weaning (31.63 vs 23.47 vs 23.83 μg/ml in 0%YC and 0.1, respectively).

Implications

0.2% YC supplementation in sow diet benefited both sow and litter performance with the capacity to wean more light born pigs as well as a higher colostral immunocrit ratio and offspring IgA levels at weaning. Yeast supplementation in sow diets may provide a means to enhance performance of lightweight, higher risk piglets.

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