High forage versus high concentrate heifer diets during gestation on progeny carcass traits

Charles A. Bunker[1], Samat Amat[1], Christy Finck[1], Shelby L. Sullivan[1], Kiersten M. Gundersen[1], Roberta Dahlen[1], Carl Dahlen[1], Pauliane Pucetti[1], Kendall C. Swanson[1], Godson Aryee[1], Kell Helmuth[1] and Kasey Maddock Carlin[1]

Maternal diets during gestation may influence progeny carcass characteristics, as steers from the high-forage dams have displayed heavier cold carcass weights and primal chuck weights, while no significant differences were observed in marbling, ribeye area and 12th rib backfat.

Summary

Limited research has examined the effects of maternal nutrition throughout the whole of gestation in heifers on progeny carcass characteristics and meat quality. This study evaluated the impact of high-forage (HF, 75% forage, 25% concentrate, n = 11) or high-concentrate (HC, 75% concentrate, 25% forage, n = 11) diets fed to crossbred Angus heifers from 15 days prebreeding through calving on offspring carcass traits and meat quality. Progeny were all fed a typical finishing diet and harvested at approximately 14 months of age over a one-month period. The carcasses were evaluated for ribeye area, yield grade, marbling score and 12th rib backfat. Blade, ribeye, sirloin and round steaks were collected upon carcass fabrication for drip loss, shelf-life, thaw loss, cook loss and Warner-Bratzler shear force (14- and 21-day-aged). Cold carcass weights and primal chuck weights were heavier ($P < 0.002$), and hot carcass weights tended ($P < 0.075$) to be heavier for HF compared to HC progeny. Live weight, dressing percentage, yield grade, ribeye area, 12th rib backfat and round weights did not differ between treatments. Kidney, pelvic and heart fat percentage tended to be lower ($P < 0.09$) in HF carcasses. Shear force values did not differ at 14 days of aging; however, at 21 days, HC shear force values were lower ($P < 0.019$). The HF blade steaks had less water loss ($P < 0.008$) during thawing. During shelf-life evaluation, HF blade steaks were less ($P < 0.05$) red (a^*) on days 5-7, and there was a tendency ($P < 0.06$) for lower lightness (L^*) in HF round steaks on day 7. Results suggest maternal heifer diets may influence progeny carcass weight as well as affect meat tenderness, thaw loss and color stability in carcass forequarter. The novelty of our findings regarding the chuck indicates a need for all aspects of the carcass parts to be evaluated.

Introduction

High forage-based diets for pregnant heifers may not always be feasible, particularly during times of drought or seasonal changes in the quality of available forages-grasses where nutritional requirements may not be met. Therefore, alternative diets should be considered, as the nutritional needs of heifers are greater than in cows and change throughout the entire length of gestation. There is limited research on the effects of feeding different sources of dietary energy during the whole of gestation on heifers and on progeny outcomes, particularly the quality and yield of the meat they produce. Previous research has evaluated maternal diets and the effects on progeny carcass characteristics, but the focus has been on mature cows and targets specific times of gestation, usually mid- to late-gestation. Radunz et al. (2012) found that progeny that were harvested from cows fed a low-starch diet during late gestation had higher marbling scores, but USDA Low Choice, Upper ⅔ and Prime did not differ between treatments (low-starch [grass hay and dried corn distillers grains with solubles] vs. high-starch [corn]). Ewes fed a diet containing high inclusion of dried corn distillers grains with solubles during mid- to late-gestation had lower dressing percentages and boneless, closely trimmed retail cuts of the DDGS diet (Radunz et al. 2011). Given the limited research conducted in this area, it is important to understand which carcass traits can be affected by the diet fed to cows and heifers during gestation. Therefore, the objective was to evaluate the effect of feeding high-forage or high-concentrate diets from 15 days prebreeding through calving on progeny carcass characteristics and meat quality traits.

[1]Department of Animal Scieces, NDSU

Procedures

Forty-six crossbred Angus heifers from 15 days prebreeding through calving were fed two different diets to achieve similar average daily gains consisting of either 75% forage and 25% concentrate (n = 24; HF) or 75% concentrate and 25% forage (n = 22; HC). The heifers conceived and calved at the NDSU Beef Cattle Research Complex. For this study, a subset (n = 11; HF, n = 11; HC) of progeny steers were managed similarly throughout growing and finishing. During finishing, all steers were fed the same high-concentrate diet (90% concentrate, DM basis). Steers were fed out at the NDSU Animal Nutrition and Physiology Center and were harvested at approximately 14 months of age over one month, with treatment stratified across harvest days. The steers were harvested at the NDSU Meat Lab under USDA inspection. Carcasses were weighed, and kidney fat was removed and weighed prior to entrance into the carcass cooler. Carcass measurements were recorded, including weight, marbling, ribeye area and 12th rib fat depth. Carcasses were stored in the cooler for 14 days prior to fabrication. Upon fabrication, primal weights and circumference were recorded for round (IMPS 158) and chuck (IMPS 113). Steaks (1 in) from the round (top), sirloin (top), ribeye and blade were cut during carcass fabrication for shelf-life and Warner-Bratzler shear force (WBSF). Smaller samples (1.7 oz) from each cut were used to evaluate drip loss for 48 hours. Steaks for shelf-life were placed on polystyrene trays, overwrapped with PVC film and stored in an upright refrigerator at 34 degrees Fahrenheit for seven days, with L^* (black to white), a^* (red to green) and b^* (yellow to blue) values recorded every 24 hours using a HunterLab spectrophotometer for the evaluation of fresh meat color. Steaks for WBSF were weighed, vacuum packaged and either frozen at minus 3 degrees Fahrenheit (aged 14 days) or stored at 34 degrees Fahrenheit for an additional seven days (aged 21 days) then frozen until evaluation. Steaks were thawed at 34 degrees Fahrenheit and weighed to measure thaw water loss. Steaks were cooked on a clam-shell grill to 152-154 degrees Fahrenheit, removed and rested on a metal tray until a peak temperature of 165-170 degrees Fahrenheit was reached and recorded. Cooked steaks were weighed to determine cook loss percentage. Steaks were stored at 34 degrees Fahrenheit overnight. For WBSF, a minimum of three cores were removed parallel with muscle fiber, and shear force was determined by measuring the amount of force needed in kilograms to shear through each core using a Warner-Bratzler shear force machine.

Results and Discussion

Steers from the heifers given the HF diet during gestation had a tendency ($P < 0.08$) for higher hot carcass weights (766.1 lb vs. 741.6 lbs.; SE = 9.3 lb). The left side cold carcass weight was heavier for the high forage than the high concentrate diet (364.9 lb vs. 342.4 lb, respectively; SE = 4.4 lb; $P < 0.002$). Additionally, the primal chuck weight for the HF diet was heavier (129.9 lb vs. 121.7 lb; SE= 1.5 lb; $P < 0.002$). There weren't any differences ($P > 0.1$) of maternal diets on steer progeny final live weights,

Table 1. Least square means for carcass measurements from steers whose dams were fed either a high concentrate (HC) or high forage (HF) diet throughout gestation.

	Treatment			
Variable	Concentrate (HC)	Forage (HF)	SEM	*P*-value
Live Weight (lb.)	1,262.40	1,282.40	16.8	0.40
Hot Carcass Weight (lb.)	741.6	766.1	9.3	0.08
Dressing Percentage (%)	58.8	59.7	0.4	0.14
12th Rib Backfat (in.)	0.63	0.69	0.06	0.53
Kidney, Pelvic, and Heart Fat (%)	2.32	2.14	0.07	0.10
Ribeye Area (in.^{2})	12	12.17	0.9	0.67
Marbling Score	421	449	13	0.13
Total Kidney Fat (lb.)	7.44	6.85	1.07	0.70
Final Yield Grade	2.1	2.2	0.2	0.73

Marbeling Score = 400-499 = small; 500-599 = modest

Table 2. Least square means for cold carcass weight and primal chuck and round measurements from steers whose dams were fed either a high concentrate (HC) or high forage (HF) diet throughout gestation.

	Treatment			
Variable	Concentrate (HC)	Forage (HF)	SEM	*P*-value
Cold Carcass Weight - one side (lb.)	342.6	364.9	4.4	0.002
Primal Round Weight (lb.)	75.4	79.4	1.8	0.12
Primal Round Circumference (in.)	44.2	45	0.6	0.28
Primal Chuck Weight (lb.)	121.7	129.9	1.5	0.002
Primal Chuck Circumference (in.)	59.3	60.9	0.7	0.13

dressing percentages, 12th rib backfat and ribeye area, marbling score, total kidney fat and final yield. Water loss during thawing was greater for the HC diet in the blade steak (6.77% vs. 5.12% $P < 0.008$). Additionally, the blade steak also tended ($P < 0.05$) to have higher a* values (more red) for days 5, 6 and 7 of simulated retail display in the HC diet. There was also a tendency ($P < 0.06$) for lower L* values (lightness) in HF round steaks on day 7 of display. While no differences were observed in the 14-day aged steaks between the treatment diets, WBSF for the HC diet was lower compared to the high forage (2.37 kg vs. 2.58 kg; $P < 0.019$) in 21-day aged steaks, which is most likely driven by a large difference between blade steaks where the HC diet showed lower (more tender) WBSF values compared to the HF diet (2.5 kg vs. 2.94 kg; $P < 0.04$). Based on our observations, the primal chuck of offspring carcasses was influenced the most by heifer gestational diet. The HF steers had heavier primal chuck while the HC steers had a more red, lighter blade steaks that were more tender after 21 days of aging. However, the HC had greater thaw loss. Evaluation of the beef chuck has not often been evaluated in previous evaluations of maternal diet on progeny meat yield and quality. Based on the results of this study, evaluation of the primal chuck should be investigated further.

Acknowledgments

The authors would like to thank the meat lab managers Jason Bahls and Jacob Anztzen and their student employees for their help with harvest and fabrication. Funding for this project was provided by the North Dakota State Board of Agriculture Research and Education and USDA NIFA grant project #2022-67016-37092.

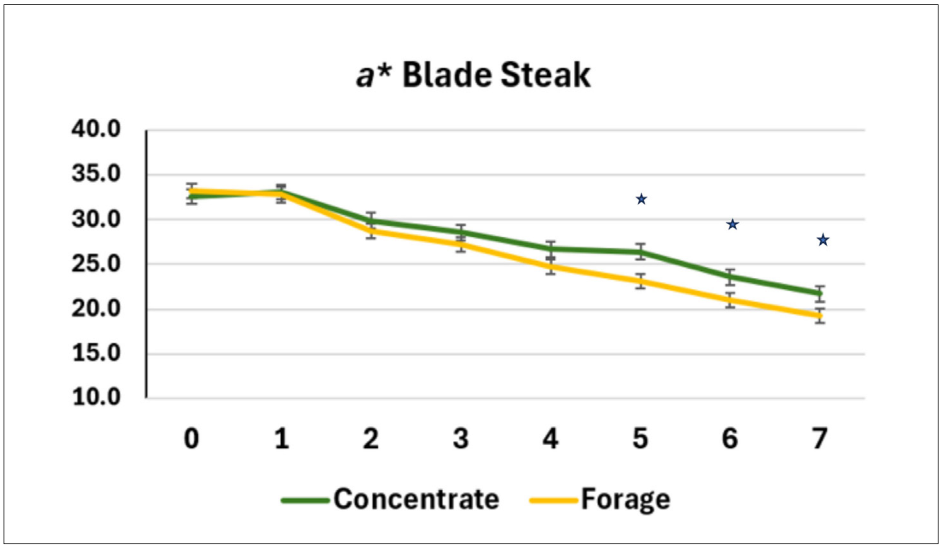

Figure 1. Instrumental *a values of concentrate and forage in the blade steaks**

* = Indicates days where HC diet was significant $P < .05$

Literature Cited

Finck, C. A., P. Pucetti, G. Aryee, K. Helmuth, C. R. Dahlen, K. K. Sedivec, S. Amat, and K. C. Swanson. 2025. Evaluating the impact of maternal diet during gestation on offspring energetic efficiency in finishing steers. North Dakota Livestock Research Report, pg. 9–11.

Kuzel, B. M., J. L. Hurlbert, K. R. M. Slavick, M. S. P. Carlis, C. R. Dahlen, S. Amat, K. K. Sedivec, K. C. Swanson, J. S. Caton, S. R. Underdahl, and G. D. Ramirez-Zamudio. 2025. High-forage vs. high-concentrate diets fed to beef heifers during pregnancy and the impacts on blood metabolite and hormone profiles in the dam and calf and growth of the male calves through 235 days of age. North Dakota Livestock Research Report, pg. 12–16.

Radunz, A. E., F. L. Fluharty, A. E. Relling, T. L. Felix, L. M. Shoup, H. N. Zerby, and S. C. Loerch. 2012. Prepartum dietary energy source fed to beef cows: II. effects on progeny postnatal growth, glucose tolerance, and carcass composition. J. Anim. Sci. 90:4962–4974.

Radunz, A. E., F. L. Fluharty, I. Susin, T. L. Felix, H. N. Zerby, and S. C. Loerch. 2011. Winter-feeding systems for gestating sheep II. effects on feedlot performance, glucose tolerance, and carcass composition of Lamb progeny. J. Anim. Sci. 89:478–488.