ENVIRONMENTAL AND NUTRITIONAL EFFECTS ON BEEF PALATABILITY AND CARCASS COMPOSITION

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Abstract

Half-blood *Bos indicus*-influenced steers (n=92), raised at the Agricultural Research Center, Texas Agriculture Experiment Station (McGregor, TX) (ARC), were used to understand the impact of environment (south, east and central Texas) and nutrition (low versus high) immediately post-weaning (treatments = 8) on the growth, composition and eating characteristics of beef after feedlot feeding. After treatments, steers were fed a high concentrate feedlot diet at the ARC to a visually assessed fat constant endpoint of 1.0 cm of external fat over the 12th rib within a pen. Steers were harvested and electrically stimulated at a commercial packing plant. Twenty-five g sample was removed 24-h postmortem from the longissimus muscle at the 5th lumbar vertebrae for calpastatin. Carcass yield and quality grades were determined 48-h postmortem. The 9-11th rib was removed into separable fat, lean and bone and then further processed to determine proximate analysis and sarcomere length. Strip loins were removed from each carcass for trained descriptive attribute sensory evaluation for juiciness, tenderness and flavor and Warner-Bratzler shear force (WBS). Steaks were aged for 1, 7, 14, 21, 28, and 35 d. Chemical measurements of collagen solubility, chemical lipid and moisture were determined on a 1 d-aged steak. Post-weaning treatments induced different rates of growth where steers fed limited nutrition had lower average daily gains (ADG) and lighter live weights (P<0.05). Steers having restricted grow post-weaning had higher feedlot ADGs (P<0.05). While carcass adjusted fat thickness did not differ due to treatment (P>0.05), adjusted fat thickness was used as a covariate in analysis for carcass chemical and sensory analysis. Ribeye area (cm^2), kidney, pelvic and heart fat (%), and hot carcass weight varied due to treatment (P<0.05); however, yield grade, marbling score, lean maturity, overall maturity or quality grade was not affected by treatment (P>0.05). Percentages of rib separable fat and lean, and chemical lipid, moisture and protein were not affected by treatment (P>0.05). Shear force values decreased with increased length of storage (P<0.05), but shear force values were not affected by treatment or the treatment by storage day interaction (P>0.05). Sensory attributes of muscle fiber tenderness, connective tissue amount, overall tenderness and flavor intensity were not affected by treatment (P>0.05); however, steaks from calf-fed steers were juicier (P<0.05). Chemical measures of sarcomere length, 24-h calpastatin, lipid and moisture were not affected by treatment (P>0.05). However, after characteristics and muscle to bone ratio feedlot feeding half-blood *bos indicus* steers to a constant fat endpoint, carcass sensory and fat composition was not affected by treatment (P>0.05). Data indicated environment and nutrition during the stocker phase impacted many of the important compositional and palatability components of beef production in Texas. Feedlot feeding of high concentrate diets removes much of the variation in beef yield and palatability induced by environment and nutrition during the stocker phase. Steers that are subjected either to hotter climates or low planes of nutrition tended to grow slower during the stocker phase and gain more rapidly during the feedlot phase to compensate for losses in the stocker phase. Management systems in Texas impact the variability of composition and palatability of Texas beef.

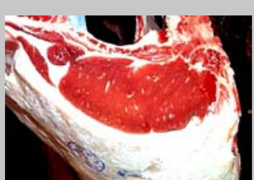
KEYWORDS: Beef, Nutrition, Palatability, Environment

Introduction

Numerous studies have been done on the effect of pre-slaughter nutrition on growth, production efficiency, carcass characteristics, carcass quality, and meat palatability. It has been hypothesized that while differences in environment and nutrition in the stocker phase induces differences in growth, that these differences are reduced or eliminated during the feedlot phase of production. Many of these studies have compared the effects of forage-based and grain-based feeding. Source of dietary energy, such as lower-energy forage diets as compared to higher-energy grain diets, has an effect on the quality of the meat. Early research suggested grain feeding produced more positive effects on meat quality and palatability than forage feeding; however, other results have been contradictory.

Objective

The objective of this project was to examine the effect of three different environments and their native or rye pasture forage systems on carcass characteristics, carcass composition, and meat palatability.



Materials and Methods

Steer Selection - Ninety two F2 Angus x Brahman steers were selected and randomly assigned to one of eight environment/nutritional treatments to evaluate carcass and tenderness traits.

- Overton-Low, Rotational (n=8)
- Overton-Low, Continuous (n=7)
- Overton-High, Rotational (n=6)
- Overton-High, Continuous (n=9)
- McGregor Calf Fed (n=18)
- McGregor-Low (n=18)
- Uvalde-Low (n=10)
- Uvalde-High (n=16)

After treatments, steers were fed a high concentrate feedlot diet.

Fabrication – Strip loins from both sides were fabricated into 6 sections, 8 cm thick. Sections were randomly assigned into aging periods (1, 7, 14, 21, 28, and 35 d). Two 2.53 cm steaks were cut for Warner-Bratzler Shear force determination and sensory evaluation. The 9-10-11th rib section was used for determination of carcass separable and chemical composition

Warner-Bratzler Shear Force – After each aging period, steaks were cooked, cored and sheared using an instron Universal Testing Machine (Model 4411, Instron Corp., Canton, MA) according to AMSA (1995) guidelines.

Sensory Evaluation - After each aging period steaks were broiled and presented to an eight-member trained sensory panel according to AMSA guidelines (1995).

Sarcomere Length – Sarcomere length of each animal was determined following the guidelines in Cross et al. (1980) using a Spectra Physics model 155SL helium-neon laser (0.95 mW) (Spectra-Physics, Inc., Eugene, OR).

24 Hr Calpastatin – Samples from the longissimus muscle tissue was taken to analyze calpastatin activity following the procedure of Wheeler and Koohmaraie (1991).

Chemical Analysis – A 5 gram powdered sample was used to determine chemical moisture, lipid and protein as described by AOAC (1995).

Statistical analysis - Data were analyzed by analysis of variance (ANOVA) using the general linear model (GLM) procedure. The significant level was predetermined at P<0.05. Least squares means were calculated and when significant effects were identiied in the Analysis of Variance table, the least squares means were separated using the standard error pdiff function of SAS (1991).

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Results

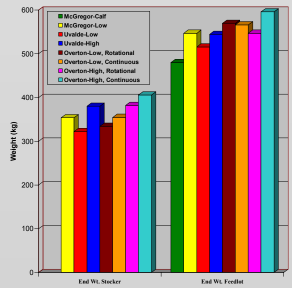

Figure 1: Treatment effects on Weight at the end of stocking and feedlot phases

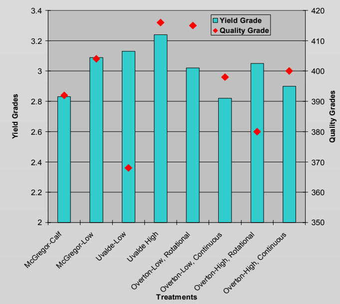

Figure 2: Treatment effects on yield and quality grades

- Treatments affected rates of gains during the stocker phase (Figure 1).
  - Rotating pastures during the stocker phase obviously affected live animal growth for the Overton-Low steers
  - At the end of the feedlot phase, steers differed in live weight due to treatment (Figure 1)
- Stocker treatments affected carcass yield grade characteristics, but had minimal affects on carcass quality grade characteristics.
- While yield grade differed across treatments, quality grade did not differ (Figure 2). This implies that treatments affected growth and composition of steers with minimal effects on carcass quality when steers are harvested at a constant fat endpoint.
- Meat palatability was impacted by environment and nutrition treatments (Table 1).
- Treatment and length of aging, affected Warner-Bratzler shear force.
  - Differences in Warner-Bratzler shear force values at 1 d of aging were negated after 14 d of aging.
  - There was a treatment by aging day interaction for Warner-Bratzler shear force (Figure 3).
- As expected differences in sarcomere length were not found.
- Chemical moisture and lipid percentages did not differ across treatments.

Table 1. Least squares means for sensory attributes of myofibrillar tenderness, juiciness, connective tissue, overall tenderness, and overall flavor intensity and cook loss.

Effect	Juiciness[c]	Muscle Fiber Tenderness[c]	Connective Tissue Amount[c]	Overall Tenderness[c]	Overall Flavor Intensity[c]	Cook Loss,%
Kill (Treat) a	.0001	.0001	.0003	.0001	.45	.0001
Fat Thickness[a]	.73	.54	.58	.57	.16	.77
Treatment[a]	.0001	.14	.10	.11	.17	.0001
McGregor-Calf	5.4 [fg]	6.1	6.8	6.2	5.0	11.61 [e]
McGregor-Low	4.7 [d]	5.8	6.5	5.8	5.1	14.19 [g]
Uvalde-Low	5.3 [fg]	6.3	6.9	6.3	5.3	11.82 [ef]
Uvalde-High	4.5 [g]	6.6	7.2	6.6	5.2	16.83 [h]
Overton-Low, Rotational	5.2 [efg]	6.2	6.7	6.2	5.1	11.30 [de]
Overton-Low, Continuous	5.0 [def]	5.9	6.7	5.9	5.1	13.52 [fg]
Overton-High, Rotational	4.9 [d]	6.4	7.0	6.4	5.3	10.50 [de]
Overton-High, Continuous	5.0 [de]	6.0	6.6	6.0	5.1	9.48 [d]
Storage Day[a]	.89	.87	.33	.86	.10	.80
1	5.1	6.1	6.2	6.2	5.2	13.23
7	5.2	6.2	6.2	6.2	5.4	12.15
14	5.1	6.2	6.2	6.2	5.0	11.92
21	5.1	6.0	6.0	6.0	5.0	12.19
28	5.1	6.2	6.2	6.2	5.0	12.03
35	5.0	6.3	6.3	6.3	5.2	12.92
Treatment x Storage Day[a]	.89	.99	.96	.99	.43	1.00
Root Mean Square Error[b]	.83	1.21	1.80	1.20	.65	4.394

[a] P-value from analysis of variance tables.
[b] From the Analysis of Variance table.
[c] Sample evaluated on an 8-point scale for myofibrillar tenderness (8=extremely tender, 1=extremely tough), juiciness (8=extremely juicy, 1=extremely tough), connective tissue amount (8=none, 1=abundant), overall tenderness (8=extremely tender, 1=extremely tough), and overall flavor intensity (8=extremely intense, 1=extremely bland).
[defg] Means within a column and followed by the same letter are not significantly different (P > 0.05).

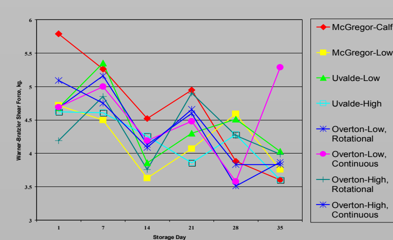

Figure 3. Least squares means for storage day by treatment interaction of Warner-Bratzler shear force (P = 0.16).

Conclusion

Data indicated environment and nutrition during the stocker phase impacted many of the important compositional and palatability components of beef production in Texas. Feedlot feeding of high concentrate diets removes much of the variation in beef yield and palatability induced by environment and nutrition during the stocker phase. Steers that are subjected either to hotter climates or low planes of nutrition tended to grow slower during the stocker phase and gain more rapidly during the feedlot phase to compensate for losses in the stocker phase. Management systems in Texas impact the variability of composition and palatability of Texas beef. It is clear that if the beef industry is going to utilize genetic markers to select beef animals that have the genetic potential to produce tender meat, we must begin to understand the nutritional, environmental and genetic interactions involved in producing beef with acceptable carcass characteristics and palatability in Texas.