

Meat Science and Muscle Biology: Beef Quality

458 National Market Cow and Bull Beef Quality Audit-2007: A survey of producer-related defects. J. D. W. Nicholson¹, R. J. Maddock², R. J. Delmore³, T. E. Lawrence⁴, W. R. Henning⁵, T. D. Pringle⁶, D. D. Johnson⁷, J. C. Paschal¹, R. J. Gill¹, J. J. Cleere¹, B. B. Carpenter¹, R. V. Machen¹, J. P. Banta¹, J. W. Savell¹, D. S. Hale^{*1}, and D. B. Griffin¹, ¹Texas A&M University, College Station, ²North Dakota State University, Fargo, ³California Poly Technical University, San Luis Obispo, ⁴West Texas A&M University, Canyon, ⁵Pennsylvania State University, University Park, ⁶University of Georgia, Athens, ⁷University of Florida, Gainesville.

Packing plants (n = 23) were audited for producer-related defects found in cull cows and bulls. Interviews, live animal and carcass evaluations, and subprimal evaluations were conducted during audits at each plant. Similar audits were conducted in 1994 and 1999. A drastic reduction in downer (non-ambulatory) incidence was found between 1999 and 2007. Fewer cattle had horns, brands, and mud/manure contamination on hides than in 1999. Predominant hide color for beef cows was black (44%). Fewer cattle displayed evidence of bovine ocular neoplasia than in 1994 and 1999. The frequency of injection site knots on live cattle was less in the round and more in the shoulder region than in 1999. Dairy cows were more frequently lame in 2007 than 1999, while beef cows were less lame. Carcass bruising was less evident during the 2007 audit than in previous audits. An increase in liver, tripe, heart, head, and tongue condemnation was found in 2007 than in 1999. Carcasses weighed more in 2007 (305 kg) than in 1999 (246 kg), as well as had less fat. The overall maturity score for cow and bull carcasses was D⁵⁴. The average fat color score was more yellow for beef cows (3.14) than dairy cows (2.42). The majority of all cattle (64%) were able to be traced back to their original owner. End-user audits revealed a higher incidence of injection site lesions in dairy rounds (48%) than in beef rounds (12%).

459 Expression of myosin heavy chain mRNA in skeletal muscle of zilpaterol-HCl fed steers. R. J. Rathmann^{*1}, T. J. Baxa², J. T. Vasconcelos¹, M. L. Galyean¹, B. J. Johnson², and M. F. Miller¹, ¹Texas Tech University, Lubbock, ²Kansas State University, Manhattan.

The objective of this experiment was to determine whether zilpaterol-HCl (ZH) influences protein turnover through the alteration of skeletal muscle gene expression. A 4 x 4 factorial arrangement of treatments in a completely random design was used with the feeding of ZH (8.33 mg/kg, DM basis) to 560 crossbred beef feedlot steers (112 pens; 7 pens/treatment) for durations of 0, 20, 30, and 40 d before slaughter with a 3-d withdrawal. The ZH duration treatments were applied to 4 slaughter groups (136, 157, 177 and 198 d on feed). Feedlot performance, carcass measurements, and the mRNA abundance of β -adrenergic receptors (β -AR), calpastatin (CAL), myosin heavy chain (MHC) isoform 2a, and insulin-like growth factor I (IGF-I) were determined. Within 10 min postmortem, samples were collected from the semimembranosus muscle for RNA isolation from 4 randomly selected steers from each treatment within the 157, 177, and 198 d slaughter groups. No ZH duration x slaughter group interactions were detected ($P > 0.10$) for feedlot or carcass data. Feeding ZH increased ADG, G:F, HCW, dressing percent, and LM area ($P < 0.01$); and decreased fat at the 12th rib, YG, marbling score ($P < 0.01$), and KPH ($P = 0.03$). Feeding ZH did not alter $\beta 1$ -AR, $\beta 2$ -AR, CAL, or IGF-I mRNA abundance ($P > 0.10$). There was ZH

duration x slaughter group interaction ($P < 0.01$) for the expression of MHC-2a, in which feeding ZH decreased MHC-2a mRNA abundance for every ZH duration within the 177 and 198 d slaughter groups ($P < 0.02$), but not for the 157 d group ($P > 0.10$). There was a tendency for a linear decrease in CAL mRNA abundance as ZH duration increased ($P = 0.07$), and there was a linear increase in $\beta 2$ -AR ($P = 0.03$) and CAL ($P < 0.01$) mRNA abundance as days on feed increased. Collectively, the data indicate that ZH may influence net protein turnover by decreasing MHC-2a mRNA expression; however, further research is needed to confirm these results.

Key Words: Myosin, Skeletal Muscle, Zilpaterol

460 Zilpaterol-HCl feeding reduces myosin heavy chain mRNA abundance in skeletal muscle of finishing steers. T. J. Baxa^{*1}, J. P. Hutcheson², M. F. Miller³, W. T. Nichols², M. N. Streeter², D. A. Yates², and B. J. Johnson¹, ¹Kansas State University, Manhattan, ²Intervet Inc., Millsboro, DE, ³Texas Tech University, Lubbock.

This experiment investigated the effects of zilpaterol-HCl with and without the steroidal implant Revalor-S (Rev-S) on feedlot performance and mRNA expression of β -adrenergic receptors (β -AR), insulin-like growth factor I (IGF-I), and myosin heavy chain (MHC) isoforms 1, 2a, and 2x. A total of 2279 (426.2 kg) feedlot steers were administered Rev-S (0 vs. 120 mg trenbolone acetate and 24 mg estradiol) on day 0, and fed zilpaterol (0 vs. 8.3 mg/kg on a dry matter basis) during the last 30 days with a 3 day withdrawal. Treatments were randomly assigned to 24 pens. At slaughter, semimembranosus muscle tissue was excised for RNA isolation from four carcasses per pen. Zilpaterol administration increased ($P < 0.01$) ADG, G:F, HCW, and LM area; decreased ($P < 0.01$) 12th rib fat depth, and marbling; and improved ($P < 0.01$) yield grade. There was no effect ($P > 0.10$) for zilpaterol feeding on the expression of $\beta 1$ -AR mRNA concentrations; however there was a tendency ($P = 0.09$) for Rev-S administration to decrease $\beta 1$ -AR mRNA levels. All treatments had no effect ($P > 0.10$) on $\beta 2$ -AR mRNA. Administration of Rev-S decreased ($P = 0.03$) $\beta 3$ -AR mRNA, and zilpaterol feeding had a tendency ($P = 0.07$) to decrease $\beta 3$ -AR mRNA. There was no effect ($P > 0.10$) on the expression of IGF-I mRNA for all treatments. For MHC-1 mRNA, there was a tendency ($P = 0.09$) for zilpaterol by implant interaction, with zilpaterol decreasing ($P = 0.03$) MHC-1 mRNA levels. We also observed a zilpaterol by Rev-S interaction ($P = 0.05$) for MHC-2x abundance. Zilpaterol administration decreased ($P = 0.01$) MHC-2a, and numerically decreased MHC-2x. These data indicate the combined use of zilpaterol and Rev-S additively contributes to total lean tissue accumulation in finishing feedlot steers. In addition, zilpaterol feeding reduced the abundance of myosin heavy chain mRNA in skeletal muscle which could be a consequence of altered protein synthesis and degradation.

Key Words: β -Adrenergic Receptors, Skeletal Muscle, Zilpaterol

461 Effects of ractopamine hydrochloride and zilpaterol hydrochloride fed to beef steers for the final 33 days of the finishing period on growth performance, carcass traits and Warner Bratzler shear force. W. J. Platter¹, R. A. Gomez¹, W. T. Choat^{*1}, S. M. Scramlin²,

and F. K. McKeith², ¹Elanco Animal Health, Greenfield, IN, ²University of Illinois, Urbana.

This study was conducted to evaluate the effects of ractopamine hydrochloride, (Optaflexx[®]) [RAC] and zilpaterol hydrochloride, (Zilmax[®]) [ZH] on performance, carcass characteristics and Warner Bratzler shear force (WBSF). Three hundred beef steers (516 ± 8 kg) were blocked by re-implant (Component TES[®] plus Tylan[®]) BW, breed make-up and condition score and randomly assigned to one of three treatments (10 steers per pen; 10 pens per treatment). Treatments were; control [C], RAC (200 mg RAC•hd⁻¹•day⁻¹ for 33 days), and ZH (7.5 ppm, ~75 mg•hd⁻¹•day⁻¹ ZH for 30 days plus a 3 day withdrawal). Both RAC and ZH improved (P < 0.05) daily gain (ADG), feed efficiency (FE), final BW and carcass wt (HCW) compared with C. Compared to RAC, ZH had (P < 0.05) lower ADG, feed intakes and final BW along with greater (P < 0.05) HCW and dressing percentages. RAC had no effect on carcass quality or yield in this experiment. However, ZH decreased (P < 0.05) backfat and KPH fat, increased (P < 0.05) ribeye area and improved (P < 0.05) yield grade when compared with C. Marbling score was not different between treatments. RAC steaks had higher (P < 0.05) WBSF values than C after 7 days of aging and did not differ from C after 14 days of aging. ZH steaks were tougher (P < 0.05) than C and RAC steaks even after 21 days of aging. This study indicates that both RAC and ZH are effective at improving feedlot performance during the final 33 days of the finishing period. Feeding ZH significantly increased WBSF, even with extended aging periods.

Table 1. Least squares means

Trait	Treatment			SEM
	Control	RAC	ZH	
Initial weight, kg	516	514	516	8.7
End weight, kg	547 ^c	555 ^a	550 ^b	1.5
ADG, kg	0.95 ^c	1.18 ^a	1.05 ^b	0.05
ADFI, kg•hd ⁻¹ •day ⁻¹	8.99 ^a	9.08 ^a	8.22 ^b	0.26
Feed:gain	9.6 ^a	7.8 ^b	8.0 ^b	0.38
HCW, kg	358 ^c	363 ^b	371 ^a	1.4
DP, %	65.49 ^b	65.52 ^b	67.42 ^a	0.18
Yield Grade	2.9 ^a	2.9 ^a	2.34 ^b	0.06
Marbling Score	SM ⁴⁵	SM ³³	SM ²⁴	8.66
14 d shear force, kg	3.55 ^a	3.78 ^a	5.28 ^b	0.20

^{a,b,c}Means lacking common superscripts differ (P < 0.05)

Key Words: Ractopamine Hydrochloride, Zilpaterol Hydrochloride, Shear Force

462 Sensory attributes of beef from steers finished with corn or high-tannin sorghum. R. E. Larrain^{*1,2}, D. M. Schaefer¹, and J. D. Reed¹, ¹University of Wisconsin, Madison, ²Pontificia Universidad Católica de Chile, Santiago, RM, Chile.

The objective of this study was to test if finishing steers with diets containing high-tannin sorghum (HTS) affects sensory attributes of beef. Steers (n = 31) were randomly allocated to 3 diets containing: 132 g/kg supplement, 100 g/kg corn silage and 768 g/kg grain. Grains were corn (control), HTS and a 1:1 mix of both. Animals were individually penned and harvested in 2 groups after 102 and 123 d. Strip loins were removed from each carcass 48 h post-mortem. Samples were aged in vacuum packages at 2°C for 14 d. Steaks (2.54 cm thick) were cooked in

an electric broiler to an internal temperature of 71°C. A seven-member trained panel evaluated samples from all animals. Loins were evaluated for juiciness, tenderness, beef flavor intensity, grass-fed beef flavor intensity, off-flavor intensity and degree of cooking-doneness. A continuous 15 cm line scale with anchors at both sides was used. The model used for analysis was a completely randomized design with diet as variable, harvest group and panelist as blocks and degree of cooking-doneness as covariate. There was no difference among treatments in juiciness and intensity of beef flavor, grass-fed beef flavor and off flavors (Table 1). Main effect of diet in tenderness tended to be significant but none of the treatments was different from the control (Table 1). We concluded that replacement of corn by HTS in finishing diets for steers did not affect beef sensory attributes when evaluated by a trained panel.

Table 1. Trained-panel sensory attributes of beef from steers finished with corn (C) or high-tannin sorghum (HTS)

	C	HTS	1:1 mix C:HTS	P diet effect
Juiciness	7.27 ± 0.24	6.57 ± 0.24	7.12 ± 0.22	0.094
Tenderness	7.84 ± 0.25	7.22 ± 0.26	8.06 ± 0.24	0.055
Beef flavor intensity	8.37 ± 0.19	8.07 ± 0.19	7.99 ± 0.18	0.307
Grass-fed beef flavor intensity	2.86 ± 0.17	3.00 ± 0.17	2.78 ± 0.16	0.646
Off flavor intensity	1.88 ± 0.17	1.78 ± 0.17	1.63 ± 0.16	0.548

Scale of attributes: 0 = absent, 15 = present strongly or at high degree

Key Words: Sensory Attributes, Sorghum, Beef

463 Development of a natural beef production and marketing program for Holstein bull calves. M. J. Baker^{*1}, D. G. Fox¹, W. R. Henning², L. O. Tedeschi³, and D. J. Ketchen¹, ¹Cornell University, Ithaca, NY, ²Pennsylvania State University, University Park, ³Texas A&M University, College Station.

The effects of diet and sex condition on feedlot performance, carcass quality, and taste panel acceptability were evaluated for Holstein bulls (n=36), implanted steers (n=36), and non-implanted steers (n=36). During Phase 1 (84 d), cattle were fed a high grain (HG) or high forage (HF) diets, and then fed a common high grain diet (Phase 2) until they reached the USDA low Choice quality grade. During Phase 1, bulls and implanted steers were not different (P > 0.05) in ADG, DMI, or F:G. The HG cattle gained faster, consumed more DM, and were more efficient than HF (P < 0.01). During Phase 2 there was no difference (P > 0.01) between bulls and implanted steers in days on feed (DOF), ADG, or DMI. For steers, implants decreased DOF (P < 0.05) and increased (P < 0.01) ADG and DMI. There was no difference (P > 0.05) in F:G due to sex or implant. Cattle that had previously been on the HF diet had a higher ADG (P < 0.05), but were not different (P > 0.05) in all other performance traits. Over the entire feeding period there was no difference (P > 0.05) between bulls and implanted steers in ADG, DMI, or F:G. In steers, implants increased ADG and DMI (P > 0.05). Compared to implanted steers, bulls tended to have less backfat (P = 0.05) and marbling (P = 0.06) but were similar in ribeye area (REA; P = 0.15), and had numerically lower yield grades, darker lean and lower USDA quality grade. No differences were found in carcass traits due to previous diet, other than HG increased REA. The consumer taste panel favored bull beef over that from implanted steers in juiciness

and tenderness but found both sources of beef to be equally acceptable. Juiciness and tenderness were improved in HF treatment ($P > 0.05$). We conclude that young Holstein bulls grow and convert feed to weight gain as efficiently as implanted steers and produce beef that is of equal or better eating quality.

Key Words: Holstein Beef, Implants, Natural Market

464 Fatty acid composition of beef finished on various forage species or concentrates. S. K. Duckett^{*1}, J. P. S. Neel², J. P. Fontenot³, W. Clapham², and W. S. Swecker, Jr.³, ¹Clemson University, Clemson, SC, ²USDA-ARS, Beaver, WV, ³Virginia Tech University, Blacksburg.

Angus-crossbred steers ($n = 128$) were used to determine the effects of forage species grazed in the last 41 d or high concentrate finishing on the fatty acid composition of beef. Steers grazed mixed pastures (bluegrass/white clover) for 93 d and then grazed alfalfa (AL; $n = 36$), pearl millet (PM; $n = 24$), or mixed (MP; $n = 36$) pastures for the final 44 d of finishing. Due to drought conditions in year 3, steers did not graze PM pastures. Steers were also finished on traditional high concentrate diets (C; $n = 32$) for 134 d. Total lipid content of LM was 60% lower ($P < 0.01$) for forage-finished than C with no differences among forage species. Saturated fatty acid percentage was higher ($P < 0.05$) for AL, PM, and MP than C due to greater ($P < 0.05$) concentrations of stearic acid. Monounsaturated fatty acid (MUFA) percentage was higher ($P < 0.05$) for C than all forage-finished treatments. MUFA was also higher ($P < 0.05$) in PM than AL. Omega-6 fatty acid concentration was higher ($P < 0.05$) for AL than PM and C with MP intermediate. Linolenic acid and total omega-3 fatty acid concentrations were higher ($P < 0.05$) for AL than MP and PM, which were also greater ($P < 0.05$) than C. The ratio of omega-6 to omega-3 fatty acids was lower ($P < 0.05$), hence more desirable from a human health standpoint, for forage-finished (1.3) than C (6.1). Trans-11 vaccenic acid (TVA) concentration was greater ($P < 0.05$) for forage-finished than C; whereas, trans-10 octadecenoic acid concentration was greater ($P < 0.05$) for C than forage-finished. The cis-9 trans-11 isomer of conjugated linoleic acid (CLA) concentration was greater ($P < 0.05$) for PM than AL and MP. CLA percentages were higher ($P < 0.05$) for all forage species compared to C. Forage species grazed during the final 44 d of finishing altered the concentrations of CLA, MUFA, omega-6 and omega-3 fatty acids. Forage finished beef

was leaner and contained greater concentrations of CLA, TVA, and omega-3 fatty acids than concentrate finished.

Key Words: Beef, Forages, Fatty Acids

465 Effect of finishing steers on different forages or high concentrate diet on rib composition, color, and palatability. S. K. Duckett^{*1}, J. P. S. Neel², J. P. Fontenot³, W. Clapham², and W. S. Swecker, Jr.³, ¹Clemson University, Clemson, SC, ²USDA-ARS, Beaver, WV, ³Virginia Tech University, Blacksburg.

Angus-crossbred steers ($n = 128$) were used to determine the effects of forage species grazed in the last 41 d or high concentrate finishing on rib composition, color, and palatability of beef. Steers grazed mixed pastures (bluegrass/white clover) for 93 d and then grazed alfalfa (AL; $n = 36$), pearl millet (PM; $n = 24$), or mixed (MP; $n = 36$) pastures for the final 44 d of finishing. Due to drought conditions in year 3, steers did not graze PM pastures. Steers were also finished on traditional high concentrate diets (C; $n = 32$) for 134 d. Hot carcass weight (HCW) was on average 97 kg heavier ($P < 0.01$) for C than MP, AL, and PM for the three year period. Percentage total fat was 45% greater ($P < 0.05$) and percent fat-free lean was 27% lower for C than forage-finished in the 9-10-11th rib section. No differences were detected in lean, fat and bone composition among forage species. Lightness (L^*) of LM was higher ($P < 0.01$) for C than AL, MP and PM. Lightness values were also higher ($P < 0.05$) for AL than MP. Redness (a^*) of LM was higher ($P < 0.05$) for C than MP and PM in year 1 and higher ($P < 0.05$) than all forage-finished treatments in year 2. In year 3, redness of LM did not differ ($P > 0.05$) among treatments. Yellowness (b^*) of s.c. fat was higher ($P < 0.01$) for AL, MP, and PM than C in all three years. Ultimate LM pH was lower ($P < 0.05$) for C than PM, MP, or AL. Warner-Bratzler shear force did not differ ($P = 0.90$) among finishing treatments and averaged 2.6 kg. Descriptive flavor panel evaluation found that C had higher ($P < 0.05$) beef flavor identification and less ($P < 0.05$) off-notes than AL or MP. Steaks from MP had higher ($P < 0.05$) organ meat (livery) flavor than AL, C, or MP. Finishing steers on forages versus concentrates to an equal animal age endpoint lowered carcass weight and fat content with no change in tenderness. Forage species utilized during the final 44 d of finishing did not alter rib composition or tenderness and had only minor influences on color and palatability.

Key Words: Beef, Forages, Tenderness