# EXIT VELOCITY EFFECTS ON GROWTH, CARCASS CHARACTERISTICS, AND TENDERNESS IN HALF-BLOOD BONSMARA STEERS

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## Introduction

One of the goals of the beef industry has been to produce a more palatable, uniform, tender and cost efficient product. Live animal stress has been shown to impact live animal growth, carcass characteristics and tenderness. It has been hypothesized, that flighty or stressed cattle have undesirable performance and carcass characteristics. One method of classifying cattle, proposed by Burrow et al. (1988), is to classify cattle by exit velocity leaving the chute. Curley (2004) reported a relationship between stress and exit velocity. Steers expressing flighty behaviors in response to handling stress had lower average daily gains, higher feed to gain ratios, lower USDA Quality and Yield grades and higher Warner-Bratzler shear force values (WBS) (Brown et al., 2002, Vann et al., 2004).

By evaluating animal behavior and temperament during stressful periods these measurements may be used as a method to classify and sort cattle. Not only could it help to identify cattle that produce more desirable carcasses containing more tender meat, but it could also help producers make production decisions. Producers could select animals that either respond more positively or adapt to stress.

The Bonsmara breed developed in the late 1930’s and early 1940’s in South Africa, is a composite of 5/8 Afrikaner (tropically adapted breed), and 3/8 Hereford /Shorthorn. The breed was developed with the goal of adaptability, tenderness, and productivity in the subtropical region. Bonsmara-influenced cattle have been shown to produce comparable carcasses to British cattle that are considered tender under US production systems (Holloway et al., 2000, Miller et al., 2005). Research in South Africa has suggested that carcass characteristics and WBS values were similar to those of British cattle breeds produced under the same production conditions (Strydom, 1994). Bonsmara germplasm was first imported into the United States in 1996 to Amarillo, TX. Bonsmara-influenced cattle are being produced in the southwest and Colorado. These cattle provide a unique population to evaluate the relationship between stress adaptation and temperament traits with average daily gain in the feedlot, carcass characteristics and cooked beef tenderness.

## Objectives

The objective was to examine the relationship between exit velocity as a measurement of temperament and stress at weaning, entering the feedlot, and leaving the feedlot on live animal growth, carcass characteristics and beef tenderness in half-blood Bonsmara steers.

## Methodology

### *Experiment 1*

Bonsmara X Beefmaster (BM) steers (n=139) from Dos Amigos Ranch near Roswell, NM were used to evaluate exit velocities (EV) at weaning and entering the feedlot and the effect it had on growth and carcass performance and WBS. At weaning, steers were evaluated for EV and live animal weight (BW). Exit velocity was an adapted procedure described by Burrow et al. (1988). Exit velocity was measured electronically as the time (m/sec) between two sets of timers placed 1.83 m apart and .9 m in front of a squeeze chute. Twenty-two weaned Bonsmara cross (BONX) steers from the Harris Ranch (Cline, TX) were also used in this study. Sixty-two BM steers and 22 BONX steers were randomly assigned to Uvalde (semi-arid) and 77 BM steers assigned to Overton (humid), TX for winter grazing (Table 1). Prior to the initiation of grazing, Uvalde steers were fed hay *ad libitum* and 0.9 kg/head/d of a 20% protein range cube. Steers in Uvalde were allowed to graze irrigated 'TAM 90' annual ryegrass pasture. Steers assigned to Overton remained in a dry lot and were allowed *ad libitum* Coastal bermudagrass hay and 0.9 kg/hd/d of a 4:1 (corn:SBM) ration until initiation of a winter pasture ('Maton rye' + 'TAM 90' ryegrass) experiment. The experiment at Overton used a 2x2x2 factorial arrangement to examine the effects of stocking rate, stocking method, and stocking strategy on grazing performance.. Upon completion of the winter grazing, all steers entered the Liveoak Feedlot on May 13, 2002. One week after entering the feedlot, EV and BW were measured during routine feedlot processing (defined as EV and BW entering the feedlot). Exit velocity was determined as described earlier. Approximately 50 d after entering the feedlot, an estimate of subcutaneous fat was taken using ultrasound. Animals were harvested in five groups on 23, 68, 90, 126, and 153 d on feed as steers were targeted to be harvested at 7 mm subcutaneous fat thickness based on visual and ultrasound measurements. The BW was recorded prior to leaving the feedlot to calculate ADG. Average daily gain was calculated by subtracting the weight taken when the cattle left the feedlot minus the weight taken during processing or when the cattle entered the feedlot, divided by the number of days on feed. The animals were harvested at Sam Kane Packing Plant in Corpus Christi, TX when a group reached approximately 7 mm of backfat. At approximately 36 h post-harvest, hot carcass weight, $12^{th}$ rib fat thickness, estimated percentage of kidney, pelvic and heart fat, ribeye area, and marbling score were determined as defined by USDA (1989). The USDA Yield and Quality grades were calculated according to USDA (1989) using these factors. A 2.5 cm steak was removed from the $13^{th}$ rib for Warner-Bratzler shear force determination at 14 d post-harvest. For WBS, steaks were removed from the -80$^{O}$C freezer and allowed to thaw at 2$^{O}$C for 48 h. The steaks were cooked on Faberware Open-Hearth broilers (Faberware

Co., Bronx, NY) to an internal temperature of 70$^{O}$C (monitored by copper constantan thermocouples and a recording potentiometer). When the desired internal temperature was reached, steaks were removed and cooled at room temperature (20$^{O}$C) before testing. Six, 1.27 cm diameter cores were removed parallel to the longitudinal orientation of the muscle fibers. Each core was sheared using an Instron Universal Testing Instrument (Instron, Canton, MA) equipped with Warner-Bratzler shearing device. The average force (kg) required to segment the six cores was reported as the WBS for each steak.

*Experiment 2*

Bonsmara X Angus spring born steers (n=207) from near Dalhart, TX were weaned and grazed on winter ryegrass pasture. The animals were evaluated for EV and BW were measured after 27 d on feed (DOF), to provide measurements near entry in the feedlot. The cattle were evaluated after either 93 or 119 d of high concentrate feeding in the feedlot for exit velocity and live animal weight. Exit velocity and ADG was determined as described in Experiment 1. Steers were harvested at 2 times so that steers had approximately 7 mm of visually assessed subcutaneous fat. Steers were harvested (97 and 126 d, respectively) at Excel Corporation in Plainview, TX. At approximately 48 h post-harvest USDA Yield and Quality grades (1=Prime; 2=Choice; 3=Select; 9=Standard) were obtained and carcass characteristics of hot carcass weight, 12$^{th}$ rib fat thickness and ribeye area were determined as defined by USDA (1989). A 2.5 cm steak was removed from the 12$^{th}$ rib, aged at 2$^{O}$C for 21 d and placed in a -80$^{O}$C freezer until used for WBS evaluation as described in Experiment 1.

*Statistical Analysis*

To determine the effect of pre-finishing background treatments on carcass characteristics, data were analyzed by Analysis of Variance using the general linear model (GLM) procedure of SAS (Version 6.12, Cary, NC, 1998) with a predetermined significance level of $P \leq 0.05$. Pre-finishing background treatment was defined as a main effect. For carcass characteristics that were affected by pre-finishing background treatment, least squares means were calculated and differences between means were determined using the standard error pdiff function (Table 1). Descriptive statistics were calculated for Experiment 1 and 2 (Table 2). Simple correlation coefficients were determined between exit velocity measures from Experiments 1 and 2 and live animal and carcass characteristics (Table 3). Partial regression coefficients were calculated using the manova function of GLM where the effect of pre-finishing background treatment was defined as a fixed effect (Table 4). Exit velocity data were converted to discrete data that was defined as exit velocity groups of slow, medium and fast based on <0.5 SD, ± 0.5 SD, and >0.5 SD, respectively, from the mean. Weaning EV categories from Experiment 1 and in feedlot EV categories from Experiment 2 were analyzed by Analysis of Variance as previously described using pre-finishing background treatment as a block and the EV category as a main effect. Least squares means were calculated and if differences in EV category were reported ($P<0.05$) then least squares means were separated using the standard error pdiff function.

## Results & Discussion

### *Experiment 1*

Pre-finishing background treatments affected feedlot average daily gain (ADG) and hot carcass weight (HCW) measurements (Table 1). Steers that were fed at a low stocking rate had lower ADG compared to steers fed on other pre-finishing treatments. Pre-finishing treatments have been shown to impact live animal growth and carcass characteristics of steers fed high concentrate diets (Miller et al., 1987). As steers in our study were fed from 23 to 153 days to a projected fat constant endpoint of 7 mm during finishing, nutritional and management practices for steers prior to entering the finishing phase would expectantly impact ADG and HCW. While understanding the effect of pre-finishing treatments on live animal growth and carcass characteristics is important, cattle will vary in nutritional management and pre-finishing treatments prior to entering the finishing phase of beef production. Therefore, variation in pre-finishing management of steers provided necessary variation to understand the relationship between EV on live animal growth, carcass characteristics, and beef tenderness. Although ADG and hot carcass weight were influenced by pre-finishing treatments, EV at weaning was correlated with ADG, Yield Grade (YG), and WBS ($P<0.05$), but EV for cattle entering the feedlot was not correlated (Table 3). When pre-finishing treatment was used as a fixed effect, ADG and WBS were still correlated with weaning EV, and correlations were not found with EV for animals entering the feedlot (Table 4). To help discover the differences between the EV groups, pre-finishing treatment was used as a block and weaning EV category was defined as a main effect (Table 5). Steers with fast weaning EV had higher YG than steers from the other weaning EV groups.

### *Experiment 2*

Experiment 2 was a second set of cattle used to further examine the relationship between EV, growth, carcass characteristics and tenderness. This group of cattle was not evaluated at weaning, but cattle were evaluated entering and exiting the feedlot. Experiment 2 did not follow the same trends as Experiment 1. When cattle entered the feedlot, backfat and QG were correlated with EV ($P<0.05$) (Table 3). Although EV and backfat were found to be significant entering the feedlot, the fast EV group had more backfat when compared to the slow EV group (Table 5).

## Conclusions

Exit velocity at weaning had the highest relationship, even though the relationships were not always significant, between live animal growth, carcass characteristics, and tenderness. It appears that as cattle are either fed in production systems that incorporate more exposure to humans or as they get older, exit velocity is not as good of a predictor of average daily gain, carcass characteristics or tenderness.

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Table 1. Effects of grazing treatment on average daily gain in the feedlot (p=0.051) and hot carcass weight (p=0.024) due to stocking treatment.

| Stocking treatment[a] | | | Average daily gain, kg/d | | Hot Carcass weight, kg | |
|---|---|---|---|---|---|---|
| Method[b] | Strategy[c] | Level[d] | LSMean | SE | LSMean | SE |
| Continuous | Fixed | Low | 1.13[e] | 0.101 | 333.1[e] | 10.55 |
| Continuous | Variable | Low | 1.33[efg] | 0.096 | 333.7[ef] | 14.92 |
| Rotational | Fixed | Low | 1.26[efg] | 0.107 | 321.6[ef] | 9.77 |
| Rotational | Variable | Low | 1.26[ef] | 0.096 | 310.3[e] | 11.56 |
| Continuous | Fixed | Medium | 1.35[efg] | 0.083 | 331.8[ef] | 9.77 |
| Continuous | Variable | Medium | 1.46[fg] | 0.107 | 337.1[ef] | 11.56 |
| Rotational | Fixed | Medium | 1.47[fg] | 0.114 | 348.3[f] | 12.92 |
| Rotational | Variable | Medium | 1.55[g] | 0.107 | 332.5[ef] | 11.56 |
| Continuous | Fixed | Medium | 1.44[fg] | 0.034 | 310.4[e] | 3.81 |

[a]The first 8 treatments were stocking treatments applied at the Texas Agricultural Research and Extension Center in Overton, TX and last treatment was the stocking treatment at the Texas Agricultural Research and Extension Center in Uvalde, TX.

[b]Continuous: steers were continual access to grass on the same pasture during the stocking treatment; Rotational: 8-paddock rotation with an approximate 2-day residence and 14-day rest.

[c]Fixed: the stocking rate was not changed the entire grazing period; Variable: stocking rate at intitiation (both 0.9 and 1.7 hd/ac) were fixed until March 4, 2003, and then both low and medium stocking rates, respectively, were increased to approximately 3 hd/ac for the duration of the grazing period.

[d]Low: approximately 0.9 steer/ac at initiation of grazing; Medium: approximately 1.7 steers/ac at initiation of grazing.

[efg]Least squares means with different superscripts within a column differ, $P<0.05$.

Table 2. Exit velocity characteristics, average daily gain, carcass characteristics and Warner-Bratzler shear force descriptive statistics.

| Variable | Experiment 1 | | | Experiment 2 | | |
|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD |
| Weaning exit velocity, m/sec | 138 | 3.53 | 0.79 | - | - | - |
| In feedlot exit velocity, m/sec | 156 | 2.91 | 0.94 | 205 | 2.85 | 0.90 |
| End feedlot exit velocity, m/sec | - | - | - | 207 | 2.38 | 0.92 |
| Average daily gain, kg/d | 152 | 1.39 | 0.310 | 207 | 1.42 | 0.311 |
| Hot carcass weight, kg | 88 | 319.8 | 27.43 | 207 | 328.6 | 28.66 |
| Backfat, mm | 88 | 6.99 | 0.247 | 207 | 9.83 | 0.347 |
| Quality grade[a] | 88 | 692.56 | 31.14 | 207 | 2.91 | 1.53 |
| Yield grade | 88 | 2.16 | 0.40 | 196 | 2.07 | 0.37 |
| Warner-Bratzler shear force, N | 146 | 26.46 | 6.251 | 204 | 27.84 | 5.517 |

[a]600 = Select.

Table 3. Simple correlations coefficients for average daily gain, carcass characteristics and Warner-Bratzler shear force and exit velocity measurements.

| | Experiment 1 | | Experiment 2 | |
|---|---|---|---|---|
| Trait | Weaning Exit Velocity | In Feedlot Exit Velocity | In Feedlot Exit Velocity | Out Feedlot Exit Velocity |
| Average daily gain, kg/d | -0.25[a] | 0.05 | 0.09 | -0.07 |
| Hot carcass weight, kg | -0.17 | -0.08 | -0.05 | -0.13 |
| Backfat, mm | 0.02 | -0.03 | 0.14[a] | -0.05 |
| Quality grade[c] | 0.03 | -0.02 | 0.18[a] | 0.03 |
| Yield grade | 0.29[a] | -0.03 | -0.08 | -0.15[a] |
| Warner-Bratzler shear force, N | 0.23[a] | 0.02 | 0.10 | 0.02 |

[a]P<0.05

Table 4. Partial correlations coefficients for average daily gain, carcass characteristics and Warner-Bratzler shear force and exit velocity measurements adjusted for the effect of prefinishing background treatment.

| | Experiment 1 | | |
|---|---|---|---|
| Trait | Weaning | In Feedlot Exit Velocity | Exit Velocity |
| Average daily gain, kg/d | -0.28[a] | 0.06 | |
| Hot carcass weight, kg | -0.22 | -0.22 | |
| Backfat, mm | -0.07 | -0.03 | |
| Quality grade[c] | -0.19 | 0.09 | |
| Yield grade | 0.20 | -0.05 | |
| Warner-Bratzler shear force, N | 0.29[a] | 0.13 | |

[a]P<0.05

Table 5. Least squares means, standard errors and p-values for average daily gain, carcass characteristics and Warner-Bratzler shear force as effected by exit velocity groups at weaning and entering the feedlot for Experiment 1.

| | Experiment 1 Weaning exit velocity group | | | | | Experiment 2 In feedlot exit velocity group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Slow | Medium | Fast | P-value | RMSE[d] | Slow | Medium | Fast | P-value | RMSE[d] |
| Average daily gain, kg/d | 1.47 | 1.36 | 1.30 | 0.058 | 0.297 | 1.40 | 1.40 | 1.47 | 0.36 | 0.309 |
| Hot carcass weight, kg | 341.6 | 326.8 | 325.9 | 0.11 | 25.74 | 329.8 | 329.6 | 327.6 | 0.89 | 28.56 |
| Backfat, mm | 8.8[b] | 6.5[a] | 8.1[b] | 0.002 | 2.14 | 9.4[a] | 9.4[a] | 10.9[b] | 0.019 | 3.44 |
| Quality grade[c] | 692.7 | 681.2 | 690.5 | 0.39 | 30.15 | 2.61 | 3.03 | 3.13 | 0.109 | 1.52 |
| Yield grade | 2.20[ab] | 2.06[a] | 2.38[b] | 0.015 | 0.354 | 2.08 | 2.04 | 2.07 | 0.80 | 0.369 |
| Warner-Bratzler shear force, N | 25.04 | 27.52 | 28.07 | 0.108 | 6.113 | 27.15 | 28.00 | 28.65 | 0.30 | 5.519 |

[ab]Least squares means with different superscripts within a row and velocity group differ, P<0.05.

[c]USDA Beef Quality Grade for Experiment 1: 600=Select; USDA Beef Quality Grade for Experiment 2: 1=Prime; 2=Choice; 3=Select; 9=Standard

[d]RMSE: Root Mean Square Error from Analysis of Variance table.