# USE OF BLOOD LACTATE AS AN INDICATOR OF RESPONSE TO HANDLING STRESS IN BEEF CATTLE

Jane A. Boles[1], Michael C. Meyers[2], Katharine A. Perz[1], Kathleen C. Davis[1] and Katelyn S. Kohlbeck[1]

[1]Department of Animal and Range Sciences, Montana State University, Bozeman, Montana, USA 59717; Department of Health and Human Development, Montana State University, USA 59717.

**Abstract – Variation in meat quality and tenderness impact continued consumption of beef. Some factors contributing to variability is rate of pH decline and temperature. Stress can affect the rate of pH decline by increasing lactic acid in muscle prior to harvest. Measurements of temperament have been used to evaluate effects of stress on growth and tenderness. The objective of the study was to determine if blood lactate can be used as an objective measure in lieu of chute scores or exit velocity to evaluate temperament. At weaning, revaccination, entry into the feedlot and after 90 days in the feedlot, chute score, exit velocity and blood lactate concentration measured on steers (n=156). Correlation coefficients were calculated. Correlations between chute score, exit velocity and blood lactate were small but highly significant (P<0.001). Correlation coefficients between objective measures, exit velocity and blood lactate were more similar when animals were handled more than between blood lactate and chute score. Highly significant though small correlations between chute score, blood lactate and exit velocity suggest more research is warranted to elucidate the possible use of blood lactate meters for identification of animals with excitable temperaments that might lead to development of selection indices.**

**Key Words – beef, stress, handling, temperament, lactate**

## I. INTRODUCTION

Variation in meat quality and tenderness is a challenge for the meat industry [1]. Contributing to this variation is changes in postmortem pH decline which affects tenderness and quality of meat [2]. Decline of pH postmortem is influenced by numerous factors including temperature, genetics and anti-mortem stress. Apple and co-workers [3] reported increased consumption of glycogen by muscle and altered pH decline postmortem in response to restraint resulting in elevated stress hormones. Stress response results in increased concentrations of epinephrine and cortisol which result in increased gluconeogenesis, proteolysis and increased sensitivity of lipids to lipolytic hormones [4]. This response generally leads to increased anaerobic metabolic processes in the muscle and, subsequently, excessive lactic acid in the blood. Curley et al [5] reported that exit velocity was related to cortisol levels and the first measurements were related to cortisol levels after multiple times handling the animals, suggesting the use of exit velocity as a measure of stress during handling. Furthermore, Holmes et al. [6] reported increased blood lactic acid concentration in response to exercise and animals with excitable temperament had an even greater increase in lactic acid concentration during exercise than animals of calmer disposition.

Cafe et al. [7] evaluated persistent assessments of temperament on productivity, carcass characteristics and meat quality traits (color and tenderness). They found in general, cattle with more excitable temperaments as measured by exit velocities and chute speeds had consistently lower feed intakes and slower growth rates, which resulted in smaller carcasses with less fat cover and poorer objective meat quality characteristics. Other researchers also reported decreased growth rates (average daily gain) in animals with more excitable temperaments [8, 9]. Along with decreased growth rates, researchers reported that meat from animals with more excitable temperament had higher shear force values [7, 9, 10] and were more likely to produce carcasses that were borderline dark cutters [11]. This relationship was seen to be stronger in bos indicus (Brahman based cattle) breeds than bos taurus breeds.

The link between temperament and changes in growth rate and meat quality suggest a need for an objective simple reliable method to measure temperament to help select animals with calmer temperaments to minimize the negative impact on meat quality. An objective biomarker that can be used without training could help with selection of animals with calmer temperaments. The objective of the study was to determine if blood lactate can be related to chute scores or exit velocity.

## II. MATERIALS AND METHODS

One hundred fifty six steers were evaluated for reaction to handling using chute exit velocity measurements, chute scores and blood lactate concentrations. The exit velocity was measured with a Farm Tek timer (Farm Tek. Inc., North Wylie, TX). Utilizing a start and stop eye system, two infrared beams were placed 1.83 meters apart. The start infrared beam was placed 2.4 meters from the front of the chute to allow working of the animals without people setting off the timer. Time was measured with the Farm Tek timer and recorded. The meters/sec speed was calculated from the recorded time and distance traveled (1.83 m /time, s). Chute scores were assigned by a single individual on a 1 – 6 scale: 1 – docile, 2 – restless, 3 – nervous, 4 – flighty, 5 – aggressive and 6 – very aggressive [12]. Blood lactate was analyzed with a Lactate Pro lactate meter (FaCT Canada Consulting, Quesnel, BC Canada). Blood for lactate measurements was extracted from the non-tagged ear. The ear vein was used to allow the animals to be handled quickly and with limited increase in stress. The ear vein was punctured with a 16 gauge needle and the resulting blood droplet was placed on the end of the lactate strip. Following a required 60 s processing time, lactate concentration was recorded in mmol/L. The exit velocity, chute score and blood measurement on each animal were conducted on four different occasions: weaning (first handling after rearing under range conditions), re-vaccination (18 days after weaning), processing into the feedlot (50 days after weaning) and once again during the feedlot phase (90 days after entry into the feedlot). The average daily gain of the steers was calculated by the following equation: (feedlot weight – weaning weight)/140). Pearson Product correlation coefficients were calculated to evaluate if a relationship existed between traditionally used temperament measurements (chute score and exit velocity) and blood lactate concentration. An experimental-wise Type I error rate of 0.05 was established *a priori*.

## III. RESULTS AND DISCUSSION

The average chute scores and exit velocities indicate the animals tended to be restless to nervous when handled with very few being wild with none of the animals evaluated being aggressive (Table 1). Lactate measurements generally ranged from below detectable limits (0.8 mmol/L) to 11.3 mmol/L. The average lactate measurements suggested the majority of the animals when handled had blood lactate levels between 2.5 mmol/L and 3.0 mmol/L (Table 1). Exit velocities reported here are slightly lower than those reported by Behrends et al. [8] and chute scores and exit velocity reported here are similar to numbers reported by Café [7] for Brahman cattle. Exit velocities generally were reduced as number of handling times increased, indicating some “learning” or increased comfort with the process. Café [7] also, saw slight reduction in exit velocity and chute score as the number of handling experiences increased.

Table 1 Mean values (± standard deviation) for handling response measurements

| Handling Time | Chute Score | Exit Velocity (m/s) | Lactate (mmol/L) |
|---|---|---|---|
| Weaning | 2.45±0.88 | 3.25±0.87 | 2.61±1.51 |
| Re-vaccination | 2.66±0.80 | 3.34±0.99 | 3.06±1.64 |
| Processed into Feedlot | 2.25±0.85 | 2.80±1.06 | 2.92±1.73 |
| Midway Feedlot | 2.65±0.64 | 2.30±0.88 | 2.59±1.77 |

Correlation coefficients between chute score, exit velocity, blood lactate concentration and ADG at the for handling times are displayed in Tables 2-5. Correlations between temperament measurements and lactate were low but significant at all measurement times. Correlations between Average daily gain and measurements of temperament or blood lactate were low. This disagrees with data reported by other researchers [7, 8, 9] who found a reduction in average daily gain with more excitable animals.

Table 2 Simple correlation coefficients (P-value) between chute scores, exit velocity and lactate values measured at weaning and average daily gain (ADG) over the period between weaning and mid feedlot measurement.

| | Chute Score | Exit Velocity | Lactate | ADG |
|---|---|---|---|---|
| Chute Score | 1.0 | | | |
| Exit Velocity | 0.47 (<0.0001) | 1.0 | | |
| Lactate | 0.32 (0.0002) | 0.31 (0.0007) | 1.0 | |
| ADG[a] | -0.06 (0.43) | -0.01 (0.88) | -0.11 (0.21) | 1.0 |

[a]ADG = (feedlot weight – weaning weight)/140 days)

Table 3 Simple correlation coefficients (P-value) between chute scores, exit velocity and lactate values measured at re-vaccination and average daily gain (ADG) over the period between weaning and mid feedlot measurement.

| | Chute Score | Exit Velocity | Lactate | ADG |
|---|---|---|---|---|
| Chute Score | 1.0 | | | |
| Exit Velocity | 0.31 (0.0002) | 1.0 | | |
| Lactate | 0.14 (0.08) | 0.27 (0.001) | 1.0 | |
| ADG | -0.002 (0.97) | -0.03 (0.73) | -0.04 (0.63) | 1.0 |

[a]ADG = (feedlot weight – weaning weight)/140 days)

The level of significance was reduced at the later measurement times. Café et al. [7] also observed a reduction in the correlation coeeficients with multiple measurements. The low correlation coefficients between exit velocity and chute score reported here (Table 2 and 3) for measurements made at weaning and re-vaccination are similar to those reported by Café et al. [7]. Correlation coefficients between lactate and chute score are low but significant (P=0.0002) at weaning but the relationship between chute score and blood lactate concentration is reduced the more times the animals are handled. This could suggest two different avenues of interpretation. One would be that the increased exposures to handling makes the animal more comfortable with the environment resulting in less stress response. The second option is the steers learn to fight the head chute less resulting in lower subjective scores that are not sensitive enough to reveal the anaerobic stress and concomitant increase in lactic acid the animal is actually experiencing. The latter option would be supported by the higher correlation between exit velocity and lactate levels at the later measurement times.

Table 4 Simple correlation coefficients (P-value) between chute scores, exit velocity and lactate values measured at processing into the feedlot and average daily gain (ADG) over the period between weaning and mid feedlot measurement.

| | Chute Score | Exit Velocity | Lactate | ADG |
|---|---|---|---|---|
| Chute Score | 1.0 | | | |
| Exit Velocity | 0.65 (<0.0001) | 1.0 | | |
| Lactate | 0.17 (0.04) | 0.26 (0.0014) | 1.0 | |
| ADG[a] | 0.04 (0.63) | 0.08 (0.35) | -0.04 (0.62) | 1.0 |

[a]ADG = (feedlot weight – weaning weight)/140 days)

Table 5 Simple correlation coefficients (P-value) between chute scores, exit velocity and lactate values measured midway through the feedlot and average daily gain (ADG) over the period between weaning and mid feedlot measurement.

| | Chute Score | Exit Velocity | Lactate | ADG |
|---|---|---|---|---|
| Chute Score | 1.0 | | | |
| Exit Velocity | 0.05 (0.50) | 1.0 | | |
| Lactate | 0.15 (0.05) | 0.26 (0.0014) | 1.0 | |
| ADG | -0.04 (0.63) | 0.04 (0.60) | -0.15 (0.06) | 1.0 |

[a]ADG = (feedlot weight – weaning weight)/140 days)

## IV. CONCLUSION

The relationship between the different accepted measures of temperament and blood lactate were significant but not high. The relationship would suggest that the measures are related but other factors are contributing to the differences. The ability to identify animals that react negatively to handling at breeding or early in the growth period could allow removal of these animals from the breeding population or lead to altered handling practices to reduce stress impact on tenderness and meat quality. The altered handling procedures and breeding could lead to some reduction in meat tenderness variation seen in the market place. Significant correlations between chute score, blood lactate and exit velocity suggest more research is warranted to elucidate the possible use of blood lactate meters as an objective biomarker for identification of animals with excitable temperament and lessen the impact of stress on meat quality characteristics.

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