Relationship between Current Temperament Measures and Physiological Responses to Handling of Feedlot Cattle

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IMPACT STATEMENT

In the current study, simple objective measures of plasma lactate as measured by a hand-held meter (Lactate Pro ® meter) and body temperature taken chute-side can be incorporated into temperament studies to help classify and animal's temperament. Currently, in production subjective scoring systems are used to identify and record and animal's temperament. These systems have been questioned for their reliability and consistency among observers. Exit velocity is recognized as the most reliable measure however it is expensive and difficult to use. The use of simple, inexpensive, and easy to use objective measures would help producers correctly assign a temperament score. Incorporating body temperature via a rectal thermometer and using a hand-held meter similar to diabetic meters, would help the beef industry select and remove variability in temperament which has direct impacts to average daily gains (ADG), meat quality, and consistency of product.

SUMMARY

The purpose of this study was to compare chute scores and exit velocities to physiological responses of body temperature, metabolites and hormones, to potentially find a biomarker which could improve objective temperament classifications. Body temperature, serum and plasma lactate, serum glucose, and salivary and serum cortisol concentrations were measured on mixed breed and sex feedlot cattle (n = 197). The data reported within indicates that in combination with exit velocity simple objective chute side measures of body temperature and plasma lactate measured using a simple digital thermometer and a hand-held meter (Lactate Pro ® meter) respectively, can potentially increase accuracy of temperament identification.

INTRODUCTION

Renewed interest in the temperament of beef cattle has occurred in response to concerns for animal welfare by consumers within the United States (Lyles and Calvo-Lorenzo, 2014). Additionally, temperament has a direct impact on feedlot performance, carcass quality, and meat quality (Voisinet et al., 1997a; Voisinet et al., 1997b; Ferguson et al., 2006; Cafe et al., 2011; Boles et al., 2015).Temperament has been defined as how an individual reacts to a novel or challenging situation (Fordyce et al., 1988; Grandin, 1998; Curley et al., 2006; Ferguson et al., 2006; Cafe et al., 2011). Temperament of beef cattle has been evaluated using a variety of subjective and objective methods that evaluates the animal's response to human interaction. Currently, exit velocity, defined as the speed at which an animal exits a chute, is recognized as the most practical objective measure for assessing temperament (Cafe et al., 2011). Subjective chute scoring systems have also been used by many researchers and breed associations (Fordyce et al., 1988; Voisinet et al., 1997b; Fell et al., 1999; Francisco et al., 2012). Due to the subjectivity and associated variability among observers, chute scores have been questioned for repeatability and consistency.

Table 1. Least square means for body weight (WT), chute scores (CS), body temperature (TEMP), blood lactate as measured by the handheld meter (PLAC), exit velocity (EV), serum glucose (GLUC), serum lactate (SLAC), and salivary cortisol (SCORT) or serum cortisol (BCORT) classed by sex for feedlot steers and heifers.

Item	STEERS	SEM	HEIFERS	SEM	*P*-Value
n	87		109		
WT (kg)	426.85	9.04	425.33	7.84	n.s.
CS[1]	2.94	2.9	3.24	3.2	***
EV (m/s)	2.24	0.14	2.80	0.12	**
TEMP (ºC)	39.78	0.05	39.93	0.05	*
GLUC (mg/dL)	104.72	3.74	112.04	3.30	n.s.
PLAC[2] (mM)	3.45	0.31	4.35	0.26	*
SLAC (mM)	5.43	0.44	6.05	0.39	n.s.
SCORT (µg/dL)	0.18	0.02	0.26	0.01	***
BCORT (µg/dL)	1.64	0.11	2.13	0.09	***

Significance = *$P < 0.05$ **$P \leq 0.01$, ***$P \leq 0.001$, **** $P \leq 0.0001$.
Values are Least Square Means. Significantly different $P < 0.05$.
[1]Chute Scores – 1 = Docile, 2 = Restless, 3 = Nervous, 4 = Flighty (Wild) 5= Aggressive, 6 = Very Aggressive.
[2]Lactate Pro® Meter.

Temperament influences the amplitude of response from the hypothalamic-pituitary-adrenal axis (HPA) to a stressor. The perception of a stress initiates a cascade of endocrine reactions, in an attempt to maintain homeostasis (Curley et al., 2008). The concomitant response of cortisol, epinephrine, and associated increase in heart rate, body temperature, and metabolic processes could provide biomarkers that could aid in defining an individual animal's temperament (Tsigos and Chrousos, 2002, Burdick et al., 2011b). The purpose of this study was to compare chute scores and exit velocities to physiological responses of, body temperature, metabolites and hormones, to find a biomarker which could improve objective temperament classifications.

PROCEDURES

Research was conducted under animal care protocol (MSU 2014-AA09) approved by the Montana State University Agricultural Animal Care and Use committee. One-hundred and ninety-seven (n = 197) feedlot cattle were sampled from a commercial, certified Beef Quality Assurance feedlot in Chappell Nebraska. Animals were fed a standard concentrate feedlot diet. Diets fed to mixed sex pens included melengestrol acetate (MGA), 0.5 mg/day, to suppress estrus. A Polaris timer system (Farmtek Inc., Wylie Texas) was used to measure exit velocity. The first "eye" was placed 6 feet in front of the chute too prevent premature activation by workers and the second "eye" was placed 6 feet from the first. Chute scores were assigned by the same individual for each sampling and were based on the chute scoring system recommended by Beef Improvement Federation.

While the animals were restrained in a hydraulic squeeze chute, body temperature, blood samples for cortisol, glucose and serum lactate and two saliva samples were collected. Blood lactate was measured chute side in < 2 µL of blood with a Lactate Pro® meter (Akray Inc. Minami-ku, Kyoto Japan). The Lactate Pro meter has a similar set up to an insulin meter used by diabetics. There is a test strip that is placed into the meter and a drop of blood is placed on the test strip

The General Linear Model and Least Square Means procedure of SAS (SAS 9.4, 2014) were used to analyze differences and calculate means between temperament classifications and physiological measures. Because of the significant ($P \leq 0.04$) sex effect, Pearson

Table 2. Classification of animals by exit velocity for body weight (WT), chute scores (CS), body temperature (TEMP), blood lactate as measured by the handheld meter (PLAC), exit velocity (EV), serum glucose (GLUC), serum lactate (SLAC), and salivary (SCORT) or serum (BCORT) cortisol.

	Exit velocity class				
Item	FAST[1]	MEDIUM	SLOW	SEM	*P*-value[2]
n = 197					
WT (kg)	452.8[a]	402.9[b]	374.7[c]	10.8	****
CS[3]	3.4[a]	3.1[b]	2.8[c]	0.07	****
TEMP (ºC)	40.15[a]	39.78[b]	39.64[b]	0.06	****
EV (m/s)	4.10[a]	2.56[b]	1.06[c]	0.07	****
GLUC (mg/dL)	129.68[a]	101.32[b]	94.63[b]	4.3	****
PLAC[4] (mM)	6.4[a]	3.2[b]	2.4[c]	0.3	****
SLAC (mM)	9.28[a]	4.76[b]	3.86[b]	0.48	****
SCORT (µg/dL)	0.27[a]	0.21[b]	0.17[b]	0.02	****
BCORT (µg/dL)	2.25[a]	1.74[b]	1.69[b]	0.14	**

[1]Exit velocities were separated by thirds with fastest exit velocities being classified as fast, slowest exit velocities as slow and the middle one-third classed as medium.

[2]Significance = *$P < 0.05$ **$P \leq 0.01$, ***$P \leq 0.001$, **** $P \leq 0.0001$.

[a,b,c] Means within a row that have a different superscript letter differ ($P < 0.05$).

[3]Chute Scores – 1 = Docile, 2 = Restless, 3 = Nervous, 4 = Flighty (Wild) 5= Aggressive, 6 = Very Aggressive.

[4]Lactate Pro® Meter.

correlations were calculated by sex. Linear models were analyzed (R-Studio version 2.15.1) where exit velocity was compared to the variables and combination of variables of plasma lactate, body temperature, glucose, salivary and serum cortisol to determine which measure or measures could possibly be used as an objective measure similar to exit velocity. An Akaike information criterion (AIC) was used to analyze the quality of the models. The lowest AIC values are reported here for steers and heifers indicating the best candidate linear models to predict exit velocity. A discriminate function analysis was used to analyze (SAS 9.4, 2014) the top candidate model from the AIC. All data were considered significant when the P-value was less than 0.05.

RESULTS AND DISCUSSION

The purpose of this study was to compare chute scores and exit velocities to physiological responses of body temperature, metabolites and hormones, to potentially find a biomarker which could improve objective temperament classifications. Sex had a significant effect on chute score, exit velocity, body temperature, plasma lactate and cortisol measures (Table 1). Data indicated heifers were more excitable than steers. Comparable results for sex differences in exit velocities have been reported (Voisinet et al., 1997b; Hoppe et al., 2010). Furthermore, body temperatures were significantly higher in heifers ($P < 0.05$) compared to steers. Burdick et al. (2011b) evaluated body temperatures of bulls prior to and during a lipopolysaccharide (LPS) challenge. The peak in serum epinephrine in calm bulls coincided with a rise in body temperature suggesting that it was a strong indicator of a stress response. Our data in combination with Burdick et al. (2011b) supports body temperature rises as an indicator of stress due to handling. Lastly, salivary and serum cortisol concentrations were significantly ($P \leq 0.001$) higher in heifers than steers.

In summary, animals with faster exit velocities or classified as fast, had a higher physiological response to handling than did animals classed as medium or slow. Furthermore, plasma lactate also sorted animals

Table 3. Pearson correlation coefficients among body temperature (TEMP), blood lactate as measured by the handheld meter (PLAC), exit velocity (EV), serum lactate (SLAC), serum glucose (GLUC), cortisol (SCORT) or serum (BCORT) salivary for steers and heifers

	STEERS			HEIFERS		
	EV	PLAC	TEMP	EV	PLAC	TEMP
PLAC[1]	0.631 ****	1	0.498 ****	0.529 ****	1	0.398 ****
SLAC	0.591 ****	0.781 ****	0.477 ****	0.534 ****	0.828 ****	0.387 ****
SCORT	0.162	0.127	0.445 ****	0.362 ****	0.375 ****	0.568 ****
BCORT	0.159	0.344 **	0.445 ****	0.218 *	0.330 ***	0.417 ****
GLUC	0.322 ***	0.517 ***	0.540 ****	0.537 ****	0.644 ****	0.419 ****

Significance = *$P < 0.05$ **$P \leq 0.01$, ***$P \leq 0.001$, **** $P \leq 0.0001$.
[1] Lactate Pro ® Meter

into three distinct classifications making it a candidate for an objective measure of temperament similar to exit velocity.

Selected Pearson correlations are reported for heifers and steers (Table 3). Body temperature was moderately correlated to blood lactate in both heifers and steers however the correlation was stronger in steers than in heifers. Additionally, body temperature was correlated to metabolites and exit velocity (Table 3). Gruber (2010) also found a positive correlation between body temperature and serum lactate concentrations. Additionally, they reported a positive correlation between body temperature and serum cortisol. In this study plasma lactate was also significantly correlated to metabolites and hormone measures. Importantly, plasma lactate as measured by the Lactate Pro® meter

was highly correlated to serum lactate in both heifers and steers. This agrees with the validation study of Burfeind and Heuwieser (2012), indicating that the hand-held meter can be as effective at measuring lactate as a detailed microplate assay. The data presented indicated that as exit velocity increased both lactate measures increased. These findings combined with the finding from Gruber (2010) and Coombes et al. (2014) demonstrated that excitable animals mobilized glucose through glycogenolysis due to increased energy demand in response to stress in the muscle, resulting in elevated lactate and glucose being transported into the blood.

Due to the differences found between steers and heifers in chute side measures and exit velocity separate tests for the models were done. The AIC data is presented in Table 4. In steers, the combination of plasma lactate and rectal temperature had the strongest AIC weight and therefore represented the best fit model to predict exit velocity. However, in heifers, the prediction using plasma lactate and rectal temperature did not have the same strength as in steers. The discriminate function analysis (Table 5) of the top candidate model of plasma lactate and body temperature was effective at placing animals correctly in fast and slow classifications 69.23% and 61.54% respectively

CONCLUSION

Temperament has a direct impact on efficiency and perception of beef cattle production in the United States. This study identified that steers and heifers react differently to handling stress as indicated by the significant differences in chute side measures, physiological measures, and exit velocity. The discriminate function analysis indicated plasma lactate and rectal temperature have the potential to become strong objective measures to augment

Table 4. AIC values for chute side measures: plasma lactate meter[1] (PLAC), body temperature (TEMP)[2], to predict exit velocity (EXIT) for steers and heifers

	Steers			
	AICc	Δ AICc	AICcWt	Cum.WT
BLM + TEMP	187.30	0.00	0.84	0.84
BLM	190.64	3.34	0.16	1.00
TEMP	200.26	12.95	0.00	1.00
Null EXIT	212.93	25.63	0.00	1.00
	Heifers			
BLM + TEMP	243.20	0.00	0.65	0.65
BLM	244.43	1.23	0.35	1.00
TEMP	260.37	17.17	0.00	1.00
Null EXIT	272.70	29.50	0.00	1.00

[1]Plasma lactate was measured using a Lactate Pro® meter

[2]Body temperature was measured using a veterinary digital thermometer fitted with a rectal probe.

exit velocity to predict an animal's temperament.

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Table 5. Discriminate function analysis for exit classifications[1] using chute side objective measures of plasma lactate[2] and body temperature[3]

Class	Fast	Medium	Slow	Total
Fast	69.23 %	29.23%	1.54%	100%
n =	45	19	1	65
Medium	42.62%	39.34%	18.03%	100
n =	26	24	11	61
Slow	10.77%	27.69%	61.54%	100
n =	7	18	40	65
Total	40.84%	31.94%	27.23%	100%
n =	78	61	52	191
Priors	0.333	0.333	0.333	

[1]Exit velocity classifications were derived by sorting exit velocities highest to lowest and splitting into thirds, first third being fast, second third being medium, and last third being slow.

[2]Plasma lactate was measured using a Lactate Pro® meter.

[3]Body temperature was measured using a veterinary digital thermometer fitted with a rectal probe.