An evaluation of the relationship between supplement intake behavior, performance, and grazing behavior by beef cattle grazing northern mixed-grass rangelands

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INTRODUCTION

Beef cattle temperament has become an increasingly important factor in herd management as it can directly affect average daily gain, feed conversion efficiency, and carcass quality characteristics of feedlot cattle, reflected in the overall economic return to the beef cattle producer (Voisinet et al., 1997; Cafe et al., 2011; Goodman et al., 2016). However, the same beef cattle temperaments that are negatively correlated to feedlot performance appear to be unrelated to grazing behavior and animal performance on rangelands (Fordyce et al., 1988; Bailey et al., 2010; Reeves and Derner, 2015). Thus, the effects of temperament on beef cattle performance is likely mediated by confinement and human interaction (Reeves and Derner, 2015; Goodman et al., 2016). In addition, recent research suggests that evaluating a single behavioral trait to determine an animal's overall temperament and/or evaluating temperament traits relevant to confinement when determining effects of temperament on grazing behavior may not produce meaningful results (Wesley et al., 2012; Goodman et al., 2016). Therefore, it has been proposed that animal behavioral traits consistent from animal to animal and across context and time (behavioral syndromes) be used when evaluating the effects of behavior and temperament on grazing cattle performance (Sih et al., 2004; Wesley et al., 2012; Goodman et al., 2016). From an ecological perspective, behavioral syndromes can limit an individual's ability to adapt to fluctuating environmental conditions, thereby affecting animal fitness (Bell, 2007; Smith and Blumstein, 2008). Thus, studying individual variation in correlated behavior syndromes could provide valuable means of explaining animal to animal productivity differences in rangeland settings (Wesley et al., 2012).

Seasonal deficiencies in rangeland forage quality often require supplementation in order to maintain animal performance and provide increased economic returns, however, the reported effectiveness of supplementation programs on grazing cattle performance has been inconsistent, likely due to variation in supplement intake behavior by individual cows (Bowman and Sowell, 1997; DelCurto et al., 2000). Recent research evaluating the correlation of behavioral traits to grazing beef cattle performance using the behavioral syndrome framework has demonstrated that cattle exhibiting rapid rates of supplement consumption have higher weight gains, heavier calf weaning weights, and travel farther than their counterparts with slow supplement consumption rates (Wesley et al., 2012). Although this study is unique in its adaptation of the behavioral syndrome framework to a livestock production system, behavioral traits were only measured for 36 individuals (18 per year) and the supplement was

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administered in an unconventional fashion (individually hand-fed supplement in confinement, biweekly). Thus, little is known about the repeatability and effects of supplement intake behavior on grazing beef cattle performance in more conventional production scenarios. Therefore, the specific objective of this research was to 1) evaluate the repeatability of individual animal supplement intake behavior across multiple years and 2) determine the relationships between supplement intake behavior, performance, and grazing behavior by beef cattle offered a self-fed protein supplement during dormant season grazing.

MATERIALS AND METHODS

The use of animals in this study was approved by the Institutional Animal Care and Use Committee of Montana State University. This study was conducted at the Thackeray Ranch (48°21′N, 109°30′W), part of the Montana Agricultural Experiment Station located 21-km south of Havre, MT. Climate is characterized as semiarid steppe with an average annual precipitation of 410 mm. Vegetation is dominated by Kentucky bluegrass (*Poa pratensis* L.), bluebunch wheatgrass (*Pseudoroegnaria spicata* [Pursh] A. Love), and rough fescue (*Festuca scabrella* Torr.).

A commercial herd of bred cows (Angus, Angus × Simmental) ranging in age from 1- to 12-yr-old grazed on a 329-ha rangeland pasture (~1.2 ha/AUM) during 2 yr (272 cows in the first year, and 302 cows in the second year). All cattle were managed as one contemporary group, where females were synchronized, and timed artificially inseminated in early June. Cattle were exposed to cover bulls for an additional 45 d of natural service post-artificial insemination. Calves were weaned early fall (mid-September to mid-October). Calf birth date, birth weight, and adjusted 205 d weaning weight were collected for each cow during both years of the study as measures of cow performance. The dormant grazing season in which supplement intake behavior was measured occurred from December 1, 2016 to January 12, 2017, and November 1, 2017 to December 31, 2017. Cow weights and body condition scores were taken pre- and post-grazing to evaluate weight and condition change over the course of the dormant grazing season. All cattle had free-choice access to a 30% crude protein (CP) self-fed canola meal-based pelleted supplement with 25% salt to limit intake (Table 1). The target daily intake was 0.91 kg per cow. Each individual animal was equipped with an electronic ID tag (Allflex USA, Inc., Dallas–Fort Worth, TX) attached to the exterior of the left ear for the measurement of individual supplement intake, supplement consumption rate, time spent at the supplement feeder (minutes), and the coefficient of variation for supplement intake using a SmartFeed Pro self-feeder system (C-Lock, Inc., Rapid City, SD) which provided a total of eight feeding stations. Time spent grazing and distance traveled were monitored for 30 randomly selected individuals each year with Lotek GPS collars (n = 60; 3300LR; Lotek Engineering, Newmarket, Ontario, Canada) containing head position sensors that record timing and location of grazing activities (Turner et al., 2000; Ungar et al., 2005; Brosh et al., 2010).

Table 1. Supplement composition for cattle winter grazing rangeland in 2016 and 2017 at the Thackeray Ranch, Havre, MT (as-fed basis)

CP[1]	30.00%
Crude fat	1.00%
Crude fiber	8.00%
Ca	2.00%
P	1.00%
Salt	25.00%
K	0.75%
Se	1.5 ppm
Vitamin A	9,072 IU/kg
Vitamin D	907 IU/kg
Vitamin E	9 IU/kg

[1]9.9% nonprotein N.

The repeatability of individual supplement intake behavior for individuals that were present in both years of the study (n = 226) and the relationship between supplement intake behavior, performance, and grazing behavior were evaluated using a Pearson product-moment correlation test. An $\alpha \leq 0.05$ was considered a significant relationship. All data were analyzed in R (R Core Team, 2017).

RESULTS

The relationship of individual average daily supplement intake (R = 0.65), supplement consumption rate (R = 0.58), the coefficient of variation of supplement intake (R = 0.51), and the amount of time spent at the feeder (R = 0.47) were positively correlated across years ($P < 0.01$), suggesting individual animal supplement intake behavior is repeatable for cattle grazing dormant season rangelands (Figure 1). Average daily supplement intake and time spent at the feeder had no significant correlation to beef

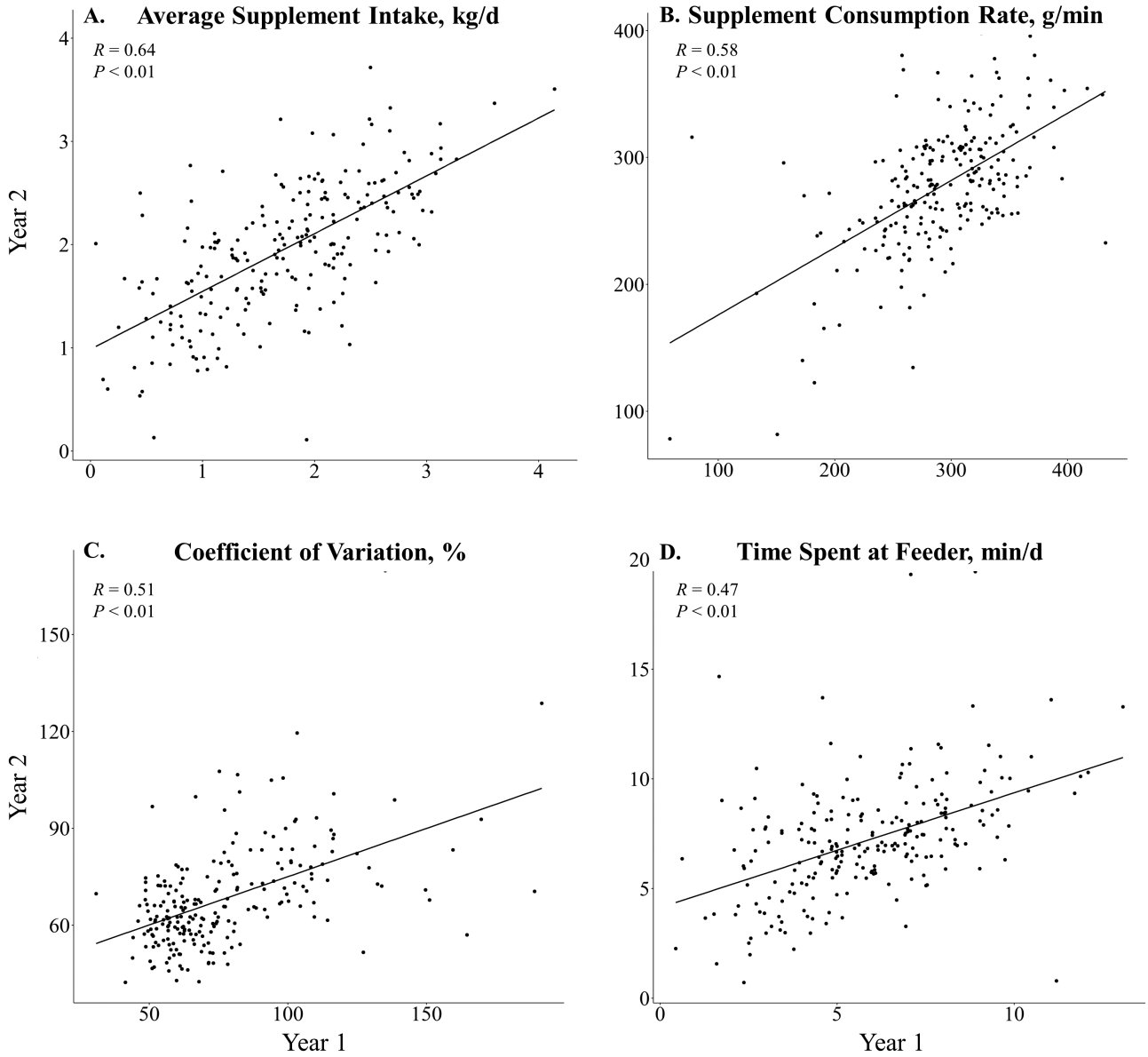

Figure 1. Linear regression between (A) supplement intake, (B) supplement consumption rate, (C) coefficient of variation of supplement intake, and (D) time spent at the feeder for individual cattle present during both the 2016 and 2017 dormant grazing season.

Table 2. Pearson correlation coefficients for pair-wise associations between supplement intake behavioral traits, performance, and grazing behavior for cattle winter grazing rangeland in 2016 and 2017 at the Thackeray Ranch, Havre, MT

	Average intake, g/d	Supplement intake rate, g/mo	Intake CV, %	Time spent at feeder, min/d
Calf birth date	−0.04	−0.10*	0.08†	0.02
Calf birth weight, kg	0.02	−0.05	0.06	0.04
Calf weaning weight, kg	−0.04	<0.01	0.13*	−0.03
Change in cow weight, kg	0.06	0.03	−0.13*	0.05
Change in cow BCS	0.03	0.10*	0.02	−0.03
Distance traveled, km/d	0.16	0.25†	−0.27*	0.04
Time spent grazing, h/d	−0.21	−0.23†	−0.09	−0.12

BCS, body condition score; CV, coefficient of variation.
P values were not adjusted for multiple comparisons.
*Significant associations $P \leq 0.05$.
†Associations $P \leq 0.10$.

cattle performance and grazing behavior ($P > 0.05$; Table 2). Supplement consumption rate had a weak negative association with calving date ($R = -0.10$; $P < 0.01$), indicating that cattle with rapid supplement consumption rates are more likely to calve earlier in the year. In addition, there was a weak positive association between supplement consumption rate and change in body condition ($R = 0.10$; $P = 0.02$), where cattle with rapid rates of supplement consumption were more likely to have a positive change in body condition while grazing dormant forage. Variation in supplement intake had a weak positive association with calf weaning weights ($R = 0.13$), however, was negatively associated with change in cow weight ($R = -0.13$) and distance traveled per day ($R = -0.27$; $P < 0.05$). Thus, cattle with higher levels of variation in supplement intake are more likely to wean larger calves but travel less per day and lose more weight when grazing dormant season rangelands.

DISCUSSION

Previous literature evaluating the relationships between supplement intake behavior, grazing behavior, and beef cattle performance have found that cattle which rapidly consume supplement are more likely to distribute on the landscape and perform better in terms of weight gains and reproductive efficiency (Wesley et al., 2012). Our results contradict these previous findings as we found no significant relationship between grazing distribution, weight gains, and supplement intake rate. Our contradictory results may be due to substantial differences in supplement delivery systems, as we measured supplement intake behavior with a self-fed supplement feeder rather than hand-feeding supplement in confinement. Our findings do suggest that supplement intake behavior can be repeatable for individuals across years and that supplement intake behavior can have significant associations with animal performance. However, despite the significant relationships in our results, supplement intake behavior explained very little variation in animal performance and grazing behavior ($r^2 < 0.07$).

IMPLICATIONS

Evaluating behavioral traits that may serve as metrics to predict suitability of beef cattle to limited nutritional environments are important to the western livestock industry. Results from our research suggest supplement intake behavioral traits may be repeatable across years, however, their use as a metric to predict animal performance and grazing behavior is limited due to weak associations that account for little variation in animal performance and grazing behavior. Thus, future research should consider using multivariate approaches when evaluating the effects of animal behavior and temperament on grazing livestock performance.

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Conflict of interest statement. None declared.

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