Comparison of feeding behavior between black and red Angus feeder heifers

B. Wolfger, C. Quinn, G.W. Torres, M. Taylor, and K. Orsel

Abstract: The objective of this study was to compare feeding behavior between red and black Angus heifers during a 161-d finishing period as a potential explanation for performance differences. Sixty-eight single-sourced purebred red (n = 35) and black (n = 33) Angus heifers, leptin genotype TT, and average starting weight 360 kg (±19 kg) were used. Heifers were randomly and equally allocated into one of two feedlot pens, equipped with five feed bunks that recorded feeding behavior. Individual time spent at the feed bunk, interval between feeding events, feed intake, and meal frequency were recorded daily, and eating rate was calculated. Heifers were fed a barley-based diet (>75% concentrate). After 161 d, at the end of the feeding period, feedlot performance was calculated as average daily gain (ADG) and gain to feed conversion rate. Additionally, carcass data were obtained from the abattoir. Overall, black Angus heifers ate more, spent more time at the feed bunk, and had more meals compared with red Angus (P < 0.001). Red Angus heifers had better gain to feed ratios (P < 0.02) and significantly more red heifers were assigned to Canadian yield category 1 (≥59% lean meat) compared with black heifers (P = 0.02), whereas black heifers had higher back fat thickness throughout the study (P ≤ 0.04). All other performance parameters (ADG and carcass weight) were not different.

Key words: cattle, Angus, feedlot, color, feeding behavior.

Résumé : L’objectif de cette étude était de comparer les comportements à l’alimentation entre les génisses Angus rouges et noires pendant la période de finition de 161 jours comme explication potentielle des différences de performances. Soixante-huit génisses Angus pure race d’une seule source, rouges (n = 35) et noires (n = 33), au génotype leptine TT, de poids initial moyen de 360 kg (±19 kg), ont été utilisées. Les génisses ont été assignées de façon aléatoire et égale à une de deux enclos de parcs d’engraissement équipés de cinq mangeoires capables d’enregistrer le comportement à l’alimentation. Le temps individuel à la mangeoire, l’intervalle entre les événements d’alimentation, la prise alimentaire et la fréquence des repas ont été enregistrés quotidiennement et le taux d’alimentation a été calculé. Les génisses ont reçu une diète à base d’orge (≥75% de concentrés). Après 161 jours, à la fin de la période d’alimentation, la performance au parc d’engraissement a été calculée par le gain moyen quotidien et l’indice de consommation. De plus, les données de la carcasse ont été obtenues de l’abattoir. De façon générale, les génisses Angus noires ont plus mangé, ont passé plus de temps aux mangeoires et ont pris plus de repas que les génisses Angus rouges (P < 0.001). Les génisses Angus rouges avaient un meilleur indice de consommation (P < 0.02) et significativement plus de génisses rouges ont été assignées à la catégorie canadienne 1 de rendement (≥59% de viande maigre) par rapport aux génisses noires (P = 0.02), tandis que les génisses noires avaient des épaisseurs de gras dorsal plus élevées pendant toute l’étude (P ≤ 0.04). Tous les autres paramètres de performance (gain moyen quotidien et poids de la carcasse) ne différaient pas. [Traduit par la Rédaction]

Mots-clés : bovins, Angus, parc d’engraissement, couleur, comportement à l’alimentation.

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Abbreviations: α-MSH, alpha-melanocyte stimulating hormone; ADG, average daily gain; DM, dry matter; DMI, dry matter intake; R, Pearson’s correlation coefficient; SD, standard deviation.

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Introduction

Red and black Angus are genetically very similar (Kuehn 2010), but despite their close relatedness, there has been a preference for black Angus cattle within the breed. However, in the US, black and red Angus are listed as different breeds, although in Canada, red and black are color phases of the same breed. Recent research documented a lower treatment rate for health problems, lower death loss, higher body-weight gain, and earlier harvest maturity in black Angus compared with other colors (Laudert 2010). The color difference between black and red Angus is a result of the melanocortin-1 receptor gene (Khungland et al. 1995). The allele expressed by black cattle binds alpha-melanocyte stimulating hormone (α-MSH), but the recessive red allele creates a nonfunctional receptor, which will not bind α-MSH (McLean and Schmutz 2009). In the same gene family, Melanocortin-4 receptor also binds α-MSH hormone in both red and black cattle. This binding results in reduced appetite (Huszar et al. 1997). The hypothesis therefore is that as a result of less available α-MSH in black cattle compared with other colors, satiety in black cattle starts later and, therefore, they eat more and longer. Previous research revealed a faster rate of gain and better carcass quality in black cattle compared with red cattle (McLean and Schmutz 2009), which is hypothesized to be a result of increased appetite in black cattle. Feeding behavior, however, is also influenced by several other factors, including environmental conditions (Mitloehner et al. 2001), bunk management (Gonzalez et al. 2008), and feeding strategies (Schwartzkopf-Genswein et al. 2003).

The primary objective of this study was to compare feeding behavior between black- and red-coated Angus cattle. The secondary objective was to evaluate the effect of coat color on performance and carcass characteristics. Our hypotheses were that black cattle have more frequent feed bunk visits, remain longer at the feed bunk, and consume more than red cattle. We also hypothesized that as a result, black Angus cattle perform better regarding average daily gain (ADG), gain to feed conversion, and carcass characteristics compared with red-coated Angus cattle. Understanding the differences in feeding behavior could be the explanatory link between the receptor regulating the appetite and the carcass and feedlot performance.

Materials and Methods

Study design and inclusion criteria

A longitudinal observational study enrolled 80 pure-bred Angus yearling heifers, 68 had complete records for feeding as well as carcass data and were analyzed in the present study. Heifers were selected from a group of 174 backgronded, single-source heifers received at the Integrated Beef Research Station at Cattelands Feedyards (Strathmore, AB, Canada) in May 2010. The phenotypic inclusion criteria for the trial were either a solid red or a solid black coat color and leptin genotype TT (Quantum Genetix, Saskatoon, SK, Canada). Fifty-one percent were red and 49% were black, equally distributed between two home pens. Heifers were handled and housed according to industry standards and compliant with the Canadian Council on Animal Care guidelines. The outdoor dirt floor pens were arranged side by side with a central feed alley. The pen dimensions (41.5 m × 17 m) provided an average of 17.6 m² for each heifer. Heifers were excluded if their arrival body weight was more than two standard deviations from the median of all heifers on arrival (360.15 ± 2 SD). After processing, heifers were randomly assigned to one of two research pens, each equipped with five radio-frequency identification feeding system nodes (GrowSafe Systems Ltd., Airdrie, AB, Canada).

Animals and processing

All heifers were processed through the working facility after a rest of approximately 12–24 h. During this rest interval, cattle were provided with grass/legume blended chopped hay in the bunk at approximately 1 kg per heifer (as-fed basis) and ad libitum access to fresh clean water. Processing involved 4 mL dexamethasone 5 (Vétoquinol N.-A. Inc., Lavaltrie, QC, Canada), 1.5 mL Estrumate (Merck Animal Health, Kirkland, QC, Canada), 35 mL Vetrimic pour on (MWI Veterinary Supply, Boise, ID, USA) for internal and external parasites, a vaccination protocol including Ultrabac 7 (Pfizer, London, ON, Canada) for clostridial diseases, and BoviShield 5 (Pfizer) for bovine herpes virus-1, bovine viral diarrhea virus types 1 and 2, parainfluenza-3, and bovine respiratory syncytial virus, as well as the growth implant Revalor-XS (Merck, Summit, NJ, USA). All heifers were uniquely identified with an RFID tag (half duplex, Allflex USA Inc., Dallas/Ft. Worth Airport, TX, USA) that was used for individual identification in the feed bunk system. During the trial, the ration consisted of dry-rolled barley (75%–85% of DM), barley-based silage (7%–18% of DM), wet wheat distillers’ grain (5%–15% of DM) or corn distillers’ grain (15% of DM, if wheat was not available in sufficient amounts), and supplement (2.7%) with an energy density of 84.92–89.46 Mcal 45.35 kg⁻¹. Feed was provided as a total mixed ration (60%–76% DM) twice per day at 0600 (40%) and 1500 (60%) for ad libitum intake. Clean water was provided ad libitum in water tanks.

Every day at approximately 0700, health of the study population was assessed. When clinical signs for sickness were observed, affected heifers (n = 5) were pulled from their home pens and treated according to the standard operating procedure manual of standard commercial health procedures. Health and necropsy (n = 2) findings were recorded and made available to the researchers. The pen checkers were blinded to feeding behavior data.
The first 40 d (settling period) were not included in the analysis to give the heifers time to adjust to the feeding system (GrowSafe Systems Ltd., Airdrie, AB, Canada). After the initial settling period, upon entry as well as every 28 d, the heifers were weighed and back fat thickness was measured ultrasonographically at the space between the 12th and 13th rib (Brethour 2004). The feeding behavior-related data were recorded on five nodes of a radio-frequency identification feeding system (GrowSafe Systems Ltd., Airdrie, AB, Canada) per pen, which housed 40 heifers. The individual feeding units consisted of a feed tub on two load bars and an antenna embedded in the rim of the tub. They recorded individual feeding events, including the amount of feed consumed and the starting time of the event. Additionally, the time spent at the bunk, the interval between feeding events, and meals per day were determined. Wireless transfer enabled the data to be accessed from a computer located in the office area. Analysis software (GrowSafe Software Version 10, Airdrie, AB, Canada) converted data into readable formats ready for analysis after standard data cleaning. Data were removed if a heifer had more than 3 d without any recording of feeding behavior (n = 6), or if the heifer died during the observation period (n = 2). An internal audit system, calculating daily assigned feed disappearance for each feeding node, was used for quality control purposes as described (Durunna et al. 2011). Feeding behavior was recorded for 161 d, starting after the settling period until the day of shipping.

Performance parameters were calculated retrospectively. These included: ADG for the entire feeding period, gain to feed conversion calculated using the ADG for the entire trial, divided by the total amount of feed intake, and back fat thickness. At the abattoir, each heifer was given a label, which was cross referenced with her unique national identification tag. Individual hot carcass weight, grading, and yielding results were collected.

Calculations and statistical analyses

Time spent at the feed bunk was summarized by meal, which was defined as a feeding event that was not interrupted for longer than 300 s (Schwartzkopf-Genswein et al. 2002). Feeding events that started before midnight and ended the following morning were assigned to the day when the feeding event started. Calculated variables for the analysis included dry matter intake per day, time at the bunk per day, mean duration between meals (min), and meals per day. Eating rate was calculated as the amount of DMI per minute (g min\(^{-1}\)).

All analyses were performed using Stata/IC 11.0 (StataCorp LP, College Station, TX, USA). The level of significance was set at a P of < 0.05. Differences in starting weight, ADG, gain to feed conversion, and back fat thickness between red and black Angus heifers were assessed using t-tests for normally distributed data. Differences in yielding and grading categories between black and red Angus heifers were assessed using \(\chi^2\) analysis. Pearson’s correlation matrix was used to determine the correlation between the different feeding behavior variables. Generalized estimating equation was fit to the data to assess the relationship between feeding behavior as an outcome and coat color as the main predictor. Distributions of the outcome variables were assessed with exploration graphs. Daily intake and time at the feed bunk were normally distributed, but eating rate and between meal intervals were log transformed to achieve normal distribution. The outcome was back converted in the result section. Autoregressive correlation structure was chosen to account for the within-subject correlation over time (time series). Housing pen neither modified (Wald test \(P > 0.05\)) nor confounded (exclusion resulted in a coefficient change for coat color by <20%) the association between feeding behavior and coat color.

### Results

Of 80 eligible heifers, 68 had complete records for feeding as well as carcass data and were analyzed in the present study. Although there was no overall difference in the starting weight between red and black Angus (Table 1), on average, red cattle were 9.98 kg (SE = 4.42 kg) heavier than black cattle in pen 1 (\(P = 0.045\)), whereas black cattle were 14.20 kg (SE = 5.33 kg) heavier than red cattle in pen 2 (\(P = 0.001\)) at the beginning of the trial. This body-weight difference persisted throughout the trial with a final difference of

### Table 1. Performance data for the study population — stratified by color.

<table>
<thead>
<tr>
<th></th>
<th>Start of the study</th>
<th>End of the study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>Red</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>408.61 (403.43–413.79)</td>
<td>412.53 (404.93–420.12)</td>
</tr>
<tr>
<td>Back fat (mm)</td>
<td>5.22 (4.85–5.60)</td>
<td>4.48 (4.04–4.93)</td>
</tr>
<tr>
<td>Gain to feed ratio</td>
<td>0.13 (0.12–0.15)</td>
<td>0.15 (0.14–0.16)</td>
</tr>
<tr>
<td>Hot carcass weight (kg)</td>
<td>367.87 (361.63–374.12)</td>
<td>374.12 (363.22–384.56)</td>
</tr>
</tbody>
</table>

Note: Means within a row with different lowercased letters differ according to t-tests between red and black Angus within the same timeframe (\(P < 0.05\)). Ranges are set in parentheses.
23.11 kg (SE = 12.32 kg) in pen 1 and 29.94 kg in pen 2 (SE = 13.94 kg) (\(P < 0.05\)). There was a significant correlation (\(R = 0.70; P < 0.001\)) between time at the bunk and average daily intake (kg d\(^{-1}\)). The number of meals was correlated to time at the bunk (\(R = 0.51; P < 0.001\)) and mean time between meals (\(R = 0.72; P < 0.001\)). Gain to feed ratios were, on average, better in red Angus heifers than in black Angus heifers (\(P < 0.02\)). Final back fat thickness was, on average, 1.45 mm (SE = 0.83 mm) higher in black compared with red heifers (\(P = 0.043\)) (Table 1).

Quality grades (Prime, AAA, AA, A) according to the Canadian grading system were not different between black and red Angus cattle (\(P = 0.111\)). Significantly more red heifers were yield category 1 (\(\geq 59\%\) lean meat) compared with black heifers. None of the other performance variables (ADG and hot carcass weight) differed significantly between red and black heifers.

**Association between coat color and feeding behavior**

Means and standard deviations of feeding behavior (stratified by coat color) are summarized in Table 2. In the analysis that accounted for repeated measures per heifer, black Angus heifers spent, on average, 18.4 min (SE = 6.4 min) more per day at the bunk (\(P = 0.004\)) and ate, on average, 1.9 kg (SE = 0.8 kg) more per day (\(P = 0.013\)) than red Angus heifers regardless their home pen (Fig. 1). Coat color did not have a significant effect on eating rate, intermeal interval, or number of bunk visits (Table 3).

**Discussion**

Our primary hypotheses that black cattle remain longer at the feed bunk and consume more than red cattle could not be rejected. Red and black Angus heifers had significantly different daily intake and time at the feed bunk throughout the entire 161-d feeding period. Time spent at the feed bunk was longer in black heifers compared with red heifers and black heifers also consumed significantly more than red heifers. Feeding behavior differences have previously been compared between performance categories. For example, Schwartzkopf-Genswein et al. (2011) reported more time spent at the feed bunk in high-performance Charolais cross cattle compared with their lower performing pen mates (Schwartzkopf-Genswein et al. 2011). Although feeding behavior differed between black and red Angus heifers, no performance differences were measured. Another possible explanatory factor for the difference in feeding behavior is the nutrigenetic effect (Kussman et al. 2006), which explains the interaction between diet and the genome to alter phenotype (Kapute et al. 2005). However, with both red and black cattle sourced from the same farm, it is unlikely that nutrigenetic effects explain the difference in feeding behavior in the present study. Differences in feeding behavior have also been described between healthy and sick cattle (Wolfer et al. 2015). One study presented lower treatment rates for health problems and lower death loss, in black

![Fig. 1. (a) Daily feeding duration and (b) dry matter intake of red and black Angus from 18 May to 26 Oct. 2010.](image-url)
Angus compared with other colors (Laudert 2010). With only six treated and two dead heifers, our study could not provide any further evidence for differences in health treatments or death between black and red cattle. The performance indices ADG and carcass characteristics were not different between black and red Angus heifers. However, in the current study, red Angus heifers had better gain to feed ratios than black Angus heifers, whereas back fat thickness was higher in black Angus heifers compared with red Angus heifers throughout the study. Although the remaining performance measurements did not differ significantly, evidence for superior performance of black cattle compared with red cattle has been described previously (McLean and Schmutz 2009). Although no comparison was performed between different coat-colored animals, in a study with red Angus-sired progeny, it was concluded that feeding behavior duration traits may be useful predictors of DMI in red Angus cattle and therefore predictors of performance (McGee et al. 2014).

Other studies reported feeding behavior differences with different feeding regimes (Schwartzkopf-Genswein et al. 2002) and forage content (DeVries et al. 2007), but to our knowledge, this study is the first to show differences in feeding behavior between cattle of different coat colors.

Time spent at the feed bunk in the present study was notably shorter, and DMI and eating rate were higher compared with previous studies (Moya et al. 2011). This could be explained by fewer feed bunks (Gonzalez et al. 2008) in the present study, the energy density of the ration (84.92–89.46 Mcal 45.35 kg⁻¹), and the difference in the length of the trials with similar starting BWs (51 vs. 160 d) as well as environmental factors. Previous research has provided evidence that increasing energy density results in less time feeding and intake in cattle compared with lower energy diets (Schwartzkopf-Genswein et al. 2011). Because energy density and DMI increase as the feeding period progresses, the length of the trial compared with the study carried out by Moya et al. (2011) could have influenced the difference in time spent and DMI. Additionally, environmental factors like heavy precipitation during spring, which resulted in mud with lower accessibility of the feed bunk, or heat during the summer months could have affected feeding behavior. A recent study compared four beef populations (e.g., Cycle VII, Angus, Hereford, and Simmental × Angus) and identified several large-effect quantitative trait loci that cumulatively explained a significant percentage of additive genetic variance within each population. These results provide enhanced understanding of, e.g., feed intake and can explain differences in beef cattle breed performances (Saatchi 2014).

High correlations between time at the bunk and intake in the current study indicate that the majority of the time at the feed bunk was indeed feeding. These findings were expected, as Schwartzkopf-Genswein et al. (1999) reported 84% of bunk attendance time as consuming feed. Eating rate, the combined variable of time at the bunk and intake, in beef and dairy cattle has been described as a valuable tool for determining how individuals are constrained by their social environment (Nielsen 1999). Eating rate therefore might not necessarily be associated with daily DMI but rather with restricted feeding which could be reflected in the present study by the limited number of individual feed bunks. Cattle in competitive feeding environments had higher eating rate compared with cattle in noncompetitive feeding environments (Proudfoot et al. 2009). Eating rate also increases with increasing body weight and bite size (Moya et al. 2011). Our primary hypothesis was based on previous research that provided evidence for better performance in black cattle; one potential explanation is the feeding behavior difference between black and red cattle observed in this study. With its limited sample size, however, our study might have lacked the power necessary to find differences in some performance variables (i.e., ADG and hot carcass weight). In fact, despite not statistically significant, red Angus had numerically higher ADG compared with black Angus heifers. In contrast to feeding behavior, which was summarized per day, performance in the sample population was measured only once at the end of the trial. The only significantly higher performance variable in black Angus compared with red Angus heifers was back fat thickness, which was already higher at the beginning of the study. In conclusion, black cattle differed in feeding behavior with higher intake and longer meals than red cattle, which had limited effects on performance.

Acknowledgements

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References


Table 3. Association between feeding behavior and coat color; autoregressive (AR-1) correlation structure.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intercept (mean ± SE)</th>
<th>Color (mean ± SE)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake (kg d⁻¹)</td>
<td>9.56 ± 0.26</td>
<td>1.86 ± 0.75</td>
<td>0.013</td>
</tr>
<tr>
<td>Bunk (min d⁻¹)</td>
<td>83.42 ± 2.81</td>
<td>18.41 ± 6.40</td>
<td>0.004</td>
</tr>
<tr>
<td>Eating rate (g min⁻¹)</td>
<td>117.79 ± 4.71</td>
<td>5.48 ± 5.84</td>
<td>0.325</td>
</tr>
<tr>
<td>Between meals (min)</td>
<td>167.35 ± 5.02</td>
<td>14.66 ± 9.84</td>
<td>0.108</td>
</tr>
<tr>
<td>Meals per day</td>
<td>8.33 ± 0.25</td>
<td>0.67 ± 0.46</td>
<td>0.145</td>
</tr>
</tbody>
</table>

Red was used as the reference color.


