Effects of ractopamine hydrochloride supplementation on feeding behavior, growth performance, and carcass characteristics of finishing steers[1,2]

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ABSTRACT: Ractopamine hydrochloride (RAC) is a β-adrenergic agonist that functions as a repartitioning agent to improve muscling in feedlot cattle. Many studies have investigated the effects of RAC on growth performance and carcass characteristics; however, there is minimal information about the influence of RAC on feeding behavior. Sixty-nine steers (body weight [BW] = 364 ± 3.9 kg) predominately of Angus and Simmental breeding were subjected to a 126-d (n = 46) or 154-d (n = 23) feeding period and randomly assigned to one of two treatment groups: supplementation to provide 0 (CON; n = 34) or 267 ± 4.9 mg/d of RAC (n = 35). Ractopamine was provided as Optaflexx 45 at 0.024% of the diet (dry matter [DM] basis; Elanco Animal Health, Greenfield, IN). Dietary treatments were fed the final 42 d in the feed yard (treatment period). Feeding behavior and growth performance were measured using radio frequency identification tags and the Insentec feeding system. Following the final day of treatment, steers were slaughtered and carcass measurements were recorded. Data were analyzed using MIXED models in SAS. There were no differences in BW, average daily gain (ADG), DM intake (DMI), gain:feed ratio (G:F), or feeding behavior during the pretreatment period (P > 0.44). Ractopamine supplementation increased G:F during the treatment period (P = 0.02) and during the total period (P = 0.03) and tended to increase ADG during the treatment and total period ($P \leq 0.08$). DMI was not affected during the treatment or total period (P > 0.67). Eating time per visit, per meal, and per day were decreased (P < 0.02) in steers supplemented with RAC during the treatment period. DMI per minute was increased (P = 0.02) in steers supplemented with RAC. Hot carcass weight, dressing percentage, and 12th rib fat were not influenced by RAC supplementation. Ractopamine supplementation decreased marbling (P = 0.008) and kidney, pelvic, and heart percentage (P = 0.04) and increased longissimus muscle area (P = 0.01). These data demonstrate that RAC supplementation for 42 d improves feed efficiency, increases the rate of DMI without altering DMI, and increases muscling in finishing cattle.

Key words: β-adrenergic receptor agonist, beef production, feeding behavior, feed intake, feedlot nutrition, ractopamine

Transl. Anim. Sci. 2019.3:1143–1152
doi: 10.1093/tas/txz114

INTRODUCTION

Dietary supplementation of β-adrenergic receptor agonists has shown improvements in growth performance and carcass characteristics of various livestock species, including cattle (Ricks et al., 1984), sheep (Baker et al., 1984), poultry

[1]This work was partially supported by the North Dakota Beef Commission.

[2]The authors would like to thank the staff at the North Dakota State University (NDSU) Beef Cattle Research Complex for assistance with feeding and animal management and the NDSU Nutrition Laboratory staff for feed analysis.

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Received March 11, 2019.
Accepted July 16, 2019.

(Dalrymple et al., 1984), and swine (Jones et al., 1985). Ractopamine hydrochloride (RAC) is currently the most commonly used β-adrenergic receptor agonist in the United States for finishing beef cattle production (Samuelson et al., 2016). RAC is predominantly a β_1-adrenergic receptor agonist (Moody et al., 2000) but has binding affinities for both β_1- and β_2-adrenergic receptors (Colbert et al., 1991). Functioning as a repartitioning agent (Moloney et al., 1991), RAC increases average daily gain (ADG), hot carcass weight (HCW), and longissimus muscle area (LMA; Lean et al., 2014) with minimal effects on adipose tissue (Liu et al., 1994; Mersmann, 1998).

There are multiple reports (Laudert et al., 2004; Abney et al., 2007; Boler et al., 2012) that RAC supplementation can increase ADG and gain:feed ratio (G:F) in finishing cattle during the last 28 to 42 d on feed without changing dry matter intake (DMI). However, there is limited information on how RAC affects feeding behavior of finishing cattle. Steers supplemented with RAC at 300 mg/d for 28 d had a greater number of daily meal events that tended to be shorter in duration and smaller in size (Boler et al., 2012). In contrast, a dose of 200 mg/d for 30 d of RAC extended the time required to consume 50% and 75% of daily feed allowance in steers (Abney et al., 2007). Moreover, there are no reports about the effects of feeding RAC over a longer period (42 d) on feeding behavior in steers. Increasing the length of feeding of RAC in a complete feed is recommended for increased ADG, G:F, and carcass leanness. Therefore, the objectives of this experiment were to evaluate the effects of feeding RAC for 42 d to finishing steers on feeding behavior, growth performance, and carcass characteristics.

MATERIALS AND METHODS

All animal procedures were approved by the North Dakota State University (NDSU) Institutional Animal Care and Use Committee.

Experimental Design

Sixty-nine steers (body weight [BW] = 364 ± 3.9 kg) predominately of Angus and Simmental breeding were stratified by weight into three pens (n = 23 per pen) and were subjected to a 126-d (n = 46) or 154-d (n = 23) feeding period and randomly assigned to dietary treatment group within pen. The total feeding period consisted of the pretreatment and treatment periods. The treatment period was a fixed length of 42 d. Thus, the pretreatment period was either 84 or 112 d. Steers were fed a common concentrate-based finishing diet containing monensin (Elanco Animal Health, Greenfield, IN) for all periods in the trial (Table 1). The total mixed rations were delivered once daily at 0800 hours with a feed delivery truck. Steers had *ad libitum* access to feed and water. The pens consisted of both indoor (monoslope barn) and outdoor access.

On the final day of the pretreatment period, steers were weighed (BW = 537 ± 6.4 kg) on 2 consecutive days and began the treatment period: supplementation to provide 0 mg/d RAC (CON; n = 34) or RAC (267 ± 4.9 mg/d; n = 35) for the last 42 d in the feed yard. For the RAC treatment, Optaflexx 45 (Elanco Animal Health) was mixed into the diet at 0.024% of dry matter (DM) as part of the supplement (5% of DM). To assure that we did not provide more than the maximum allowable dose listed on the label, our original formulation was calculated to provide 400 mg/d for a 660 kg steer consuming 2.5% of BW (DM basis) daily, which was greater than the predicted intake of the heaviest steer on test. Following the 42-d treatment period, steers were slaughtered at a commercial packing facility.

Feed Analysis

Diet samples were collected weekly, dried overnight in a 55 °C oven, and ground to pass through a 2-mm screen using a Wiley mill. Weekly samples were then analyzed (Table 2) for DM, ash, N

Table 1. Ingredient composition of the basal diet fed to finishing steers[a]

Ingredient	%
Dry-rolled corn	60.0
Corn silage	10.0
Grass hay	5.0
Dried corn distillers' grains with solubles	20.0
Fine ground corn	2.52
Limestone	1.4
Urea	0.9
Salt	0.1
Trace mineral premix[b]	0.05
Vitamin premix[c]	0.01
Monensin premix[d]	0.02

[a]The diet for steers assigned to the ractopamine treatment contained 0.024% Optaflexx 45 (DM basis; Elanco Animal Health, Greenfield, IN) in the diet, which replaced fine ground corn for the last 42 d on feed.

[b]Contained 3.62% calcium (Ca), 2.56% copper (Cu), 16% zinc (Zn), 6.5% iron (Fe), 4% manganese (Mn), 1,050 mg/kg iodine (I), and 250 mg/kg cobalt (Co).

[c]Contained 48,510 kIU/kg vitamin A and 4,630.5 kIU/kg vitamin D.

[d]Contained 176.4 g monensin/kg premix.

Table 2. Chemical composition (% of DM) of the control (CON) and ractopamine (RAC) diets fed to finishing steers[a]

	Diet	
Ingredient	CON	RAC[b]
Dry matter, %	72.7	72.6
Organic matter	95.1	95.0
Crude protein	16.3	16.0
Neutral detergent fiber	28.5	29.4
Acid detergent fiber	9.8	10.4
Ether extract	3.94	4.09
Calcium	0.63	0.65
Phosphorus	0.39	0.40

[a]Average of weekly samples.

[b]Contained 0.024% Optaflexx 45 (DM basis; Elanco Animal Health, Greenfield, IN).

(Kjeldahl method), ether extract, Ca, and P by using standard procedures (AOAC, 1990). Neutral detergent and acid detergent fiber were determined using a fiber analyzer (Ankom Technology Corporation, Fairport, NY) according to the procedures of Van Soest et al. (1991). Crude protein was calculated by multiplying N concentration by 6.25.

Feeding Behavior and Growth Performance

Steers were weighed for 2 consecutive days at the beginning of the pretreatment and treatment periods and the end of the experiment and every 28 d during the study. ADG was calculated by linearly regressing BW on day of the experiment. G:F was calculated as the mass of BW gain (kg) divided by DMI (kg).

Radio frequency identification tags were placed in the right ear of each steer before the beginning of the experiment. Each pen contained eight automated electronic feeding stations (Insentec, Hokofarm Group, Marknesse, the Netherlands; four feeding stations dedicated for each treatment) as described previously (Mader et al., 2009; Islas et al., 2014; Swanson et al., 2014) allowing for offering specific dietary treatments and monitoring of individual feed intake and feeding behavior characteristics.

DMI per day and feeding behavior traits were summarized (Montanholi et al., 2010; Islas et al., 2014) as follows: events (number of bunk visits and meals daily), eating time (minutes; per visit, per meal, and per day), and DMI (kg; per visit, per meal, and per minute) and these data were summarized as the average of each individual steer over the pretreatment period, the treatment period, and the total feeding period, and weekly during the treatment period. A visit was defined as each time the Insentec system detected a steer at a bunk. A meal was defined as eating periods that might include short breaks separated by intervals not longer than 7 min (Forbes, 1995; Montanholi et al., 2010).

Carcass Characteristics

Following the end of the treatment period, 12 steers (CON, $n = 6$; RAC, $n = 6$) were selected at random to be slaughtered at the NDSU Meat Science Laboratory for tissue collection and the results will be presented elsewhere. The remaining 57 of the 69 steers were slaughtered at a commercial packing facility. HCW was measured on the day of slaughter and carcass measurements were measured following a 24-h chill. Measurements collected were subcutaneous fat thickness at the 12th rib, LMA, marbling score, dressing percentage, and kidney, pelvic, and heart fat percentage (KPH). Dressing percentage was calculated as (HCW/final BW) × 100. Carcass characteristics are presented from all 69 steers.

Statistical Analysis

All data were analyzed using the MIXED model of SAS (SAS 9.3, SAS Inst. Inc., Cary, NC). Feeding behavior and growth performance traits were analyzed as a randomized complete block design using animal as the experimental unit and slaughter group as the blocking factor. For carcass characteristics, slaughter location was also included in the model as a blocking factor. Data were analyzed separately based on pretreatment, treatment, and the total period. In addition, feeding behavior traits during the treatment period were analyzed using repeated measures (averages per week) and tested for the effect of slaughter group, week, treatment (CON vs. RAC), and the week × treatment interaction. Appropriate (minimize information criterion) covariance structures were used (Wang and Goonewardene, 2004). Results were considered significant if $P \leq 0.05$. Tendencies were declared when $0.05 > P \leq 0.10$.

RESULTS

Initial, start of treatment, and final BW were not affected by RAC supplementation (Table 3). Pretreatment ADG did not differ between treatments. There were tendencies for RAC supplementation to increase ADG during the treatment period

Table 3. Influence of ractopamine hydrochloride supplementation to finishing steers on growth performance[a]

Item	Treatment		SEM[c]	*P*-value
	CON	RAC[b]		
Body weight, kg				
Initial pretreatment	363	364	5.46	0.92
Initial treatment	535	538	6.41	0.72
Final	600	613	7.36	0.19
Average daily gain, kg/d				
Pretreatment period	1.80	1.80	0.041	0.98
Treatment period	1.54	1.78	0.092	0.06
Total period	1.70	1.79	0.037	0.08
Dry matter intake, kg/d				
Pretreatment period	11.2	11.0	0.20	0.44
Treatment period	11.1	11.0	0.19	0.69
Total period	11.0	11.0	0.19	0.87
Gain:feed				
Pretreatment period	0.164	0.166	0.0038	0.77
Treatment period	0.136	0.160	0.0075	0.02
Total period	0.154	0.164	0.0031	0.03

CON = control; RAC = ractopamine hydrochloride.

[a]Steers were fed for a total of 126 or 154 d. Dietary treatments were fed during the final 42 d of the total period (treatment period). The time preceding the treatment period (84 or 112 d) was the pretreatment period.

[b]Contained 0.024% Optaflexx 45 (DM basis; Elanco Animal Health, Greenfield, IN).

[c]Standard error of the mean (CON, n = 35; RAC, n = 34).

(P = 0.06) and total period (P = 0.08). DMI and pretreatment G:F were unaffected by RAC. RAC supplementation increased G:F during the treatment period (P = 0.02) and total period (P = 0.03).

There were no differences in the pretreatment period feeding events, time eating, or DMI (Table 4). Visits per day and per meal during the treatment period were not influenced by RAC supplementation. Ractopamine supplementation reduced time eating per visit (P = 0.02), per meal (P = 0.01), and per day (P = 0.008). DMI per visit and per meal were not influenced by RAC supplementation in the treatment period. Over the total period, feeding events, time eating, and DMI were not influenced by RAC supplementation. DMI per minute during the treatment period increased (P = 0.02) in steers supplemented with RAC. A week × treatment interaction (P < 0.001) was observed for DMI per minute for steers supplemented with RAC (Figure 1). For weeks 1 and 2 of the treatment period, there were tendencies for RAC supplementation to increase DMI per minute (P = 0.08, P = 0.06, respectively)

Table 4. Influence of ractopamine hydrochloride supplementation to finishing steers on feeding behavior[a]

Item	Treatment		SEM[c]	*P*-value
	CON	RAC[b]		
Pretreatment period				
Events, per day				
Visits	27.8	28.6	1.53	0.67
Meals	8.18	7.96	0.198	0.41
Time eating, min				
Per visit	4.10	3.92	0.239	0.58
Per meal	12.7	13.1	0.42	0.53
Per day	102	102	2.5	0.95
Dry-matter intake, kg				
Per visit	0.440	0.418	0.0553	0.52
Per meal	1.37	1.39	0.074	0.58
Per min	0.109	0.109	0.0055	0.93
Treatment period				
Events, per day				
Visits	24.3	25.0	1.58	0.72
Meals	6.57	6.70	0.201	0.64
Time eating, min				
Per visit	3.78	3.05	0.220	0.02
Per meal	12.6	10.7	0.537	0.01
Per day	79.6	70.0	2.60	0.008
Dry-matter intake, kg				
Per visit	0.539	0.476	0.074	0.17
Per meal	1.76	1.69	0.126	0.35
Per min	0.146	0.165	0.0125	0.02
Total period				
Events, per day				
Visits	26.8	27.6	1.48	0.48
Meals	7.70	7.58	0.186	0.62
Time eating, min				
Per visit	3.96	3.64	0.228	0.32
Per meal	12.6	12.4	0.41	0.72
Per day	95.3	92.3	2.30	0.34
Dry-matter intake, kg				
Per visit	0.461	0.431	0.059	0.40
Per meal	1.46	1.47	0.081	0.93
Per min	0.118	0.121	0.0062	0.34

CON = control; RAC = ractopamine hydrochloride.

[a]Steers were fed for a total of 126 or 154 d. Dietary treatments were fed during the final 42 d of the total period (treatment period). The time preceding the treatment period (84 or 112 d) was the pretreatment period.

[b]Contained 0.024% Optaflexx 45 (DM basis; Elanco Animal Health, Greenfield, IN).

[c]Standard error of the mean (CON, n = 35; RAC, n = 34).

and RAC supplementation increased DMI per minute in weeks 3 (P = 0.01) and 4 (P < 0.001). After week 4, differences were not observed for DMI per minute. Furthermore, a week × treatment interaction was observed (P < 0.001; Figure 2) for eating time per day. Ractopamine supplementation

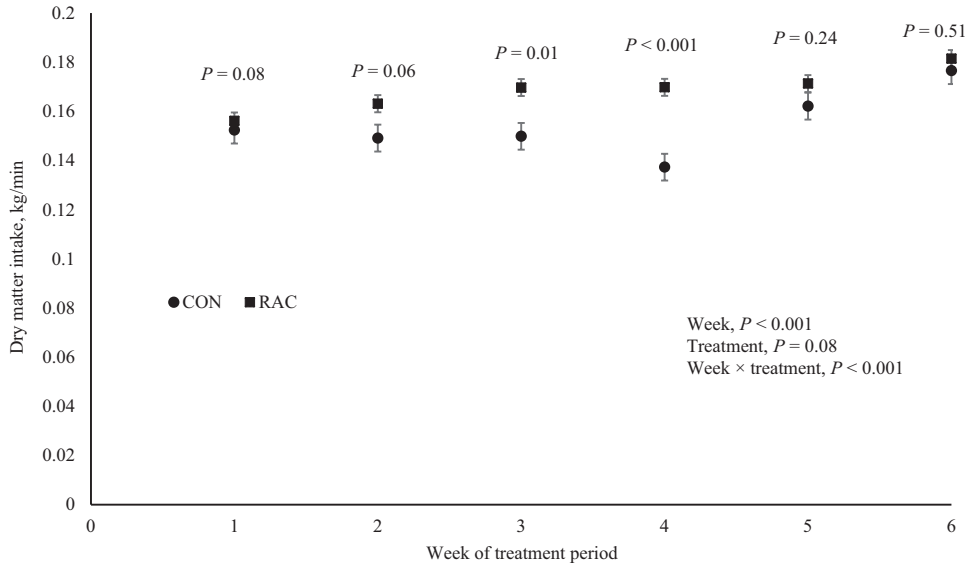

Figure 1. Weekly dry matter intake per minute (kg/min) during the treatment period (last 42 d of total feeding period) for steers fed diets containing 0 (CON) or 0.024% Optaflexx 45 (DM basis; RAC; Elanco Animal Health, Greenfield, IN). *P*-values above plotted means correspond to effects of treatment for the average daily dry matter intake per minute within each week.

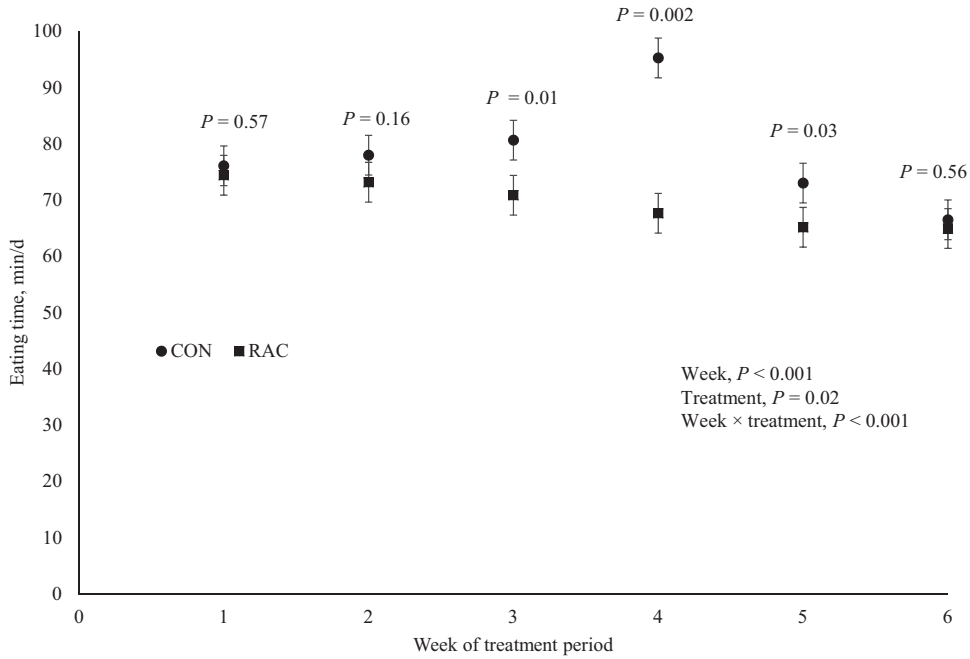

Figure 2. Weekly eating time (min/d) during the treatment period (last 42 d of total feeding period) for steers fed 0 (CON) or 0.024% Optaflexx 45 (DM basis; RAC; Elanco Animal Health, Greenfield, IN). *P*-values above plotted means correspond to effects of treatment for the average daily eating time within each week.

reduced eating time for weeks 3 (P = 0.01), 4 (P = 0.002), and 5 (P = 0.03). DMI by week during the treatment period did not differ between treatments (data not shown).

HCW and dressing percentage were not affected by RAC supplementation (Table 5). Ractopamine supplementation reduced marbling score (P = 0.008) and increased LMA (P = 0.04). There was no effect of RAC on 12th rib fat. KPH decreased (P = 0.01) with RAC supplementation.

DISCUSSION

Because there were no differences observed in growth performance and feeding behavior traits in the pretreatment period, there were no differences between groups before the initiation of the RAC

Table 5. Influence of ractopamine hydrochloride supplementation to finishing steers on carcass characteristics[a]

	Treatment			
Item	CON	RAC[b]	SEM[c]	*P*-value
Hot carcass weight, kg	362	368	5.48	0.34
Dressing %[d]	60.1	59.9	0.37	0.59
USDA marbling score[e]	478	431	14.3	0.008
Longissimus muscle area, cm^2	85.6	89.1	1.38	0.04
12th rib fat, cm	1.10	1.05	0.070	0.62
Kidney, pelvic, and heart fat, %	2.21	2.05	0.052	0.01

CON = control; RAC = ractopamine hydrochloride.

[a]Steers were fed for a total of 126 or 154 d. Dietary treatments were fed during the final 42 d of the total period (treatment period). The time preceding the treatment period (84 or 112 d) was the pretreatment period.

[b]Contained 0.024% Optaflexx 45 (DM basis; Elanco Animal Health, Greenfield, IN).

[c]Standard error of the mean (CON, $n = 35$; RAC, $n = 34$).

[d]Calculated as (HCW/Final BW) × 100.

[e]United States Department of Agriculture marbling scores: 400–499 = slight.

treatment period that could have influenced treatment responses. Supplementation of β-adrenergic receptor agonists has been shown to stimulate feed intake in ruminants, possibly by increasing γ-aminobutyric acid levels in the brain (Baile and McLaughlin, 1987). The maximal response of β-adrenergic receptor agonists is affected by the dose and duration of the sustained dose (Smith et al., 1989; Johnson et al., 2014). However, RAC supplementation has typically been shown to have no effect on DMI (kg/d) of steers (Abney et al., 2007; Boler et al., 2012; Lean et al., 2014). Similarly, in this study, DMI during the treatment period was not affected by RAC supplementation at 267 mg/d. Interestingly, Boler et al. (2012) reported a tendency for steers supplemented with 300 mg/d of RAC to have reduced DMI compared with steers supplemented with RAC at 200 mg/d. Ractopamine intake among RAC steers did not differ between weeks of the treatment period.

The observed improvement in feed efficiency (G:F) with RAC supplementation was likely because of its function as a repartitioning agent (Moloney et al., 1991). Koontz et al. (2010) found that RAC does not change whole-body energy balance yet reduces splanchnic energy use, and therefore increases energy availability for use by peripheral tissues. The reductions in KPH and marbling score and increases in LMA in this study are carcass indicators for effects of repartitioning of energy from adipose tissue by RAC.

Physiological factors, such as heart and respiration rates, were not measured in this study. However, research has shown that cattle fed RAC at 300 mg/d have greater mean heart rates through the first 24 d of supplementation than cattle fed a control diet (Frese et al., 2016). These authors noted that RAC supplementation increased mean heart rate, with a peak observed at day 14, followed by a plateau, and failure to detect a treatment difference in heart rate on day 25. Similarly, after feeding RAC at 400 mg/d for 28 d, heart rates were found to be lower in cattle supplemented with RAC (Hagenmaier et al., 2017). This pattern seems to be similar to the divergent responses detected for eating time and rate of DMI in this study. Furthermore, it is unclear if mean heart rates continue to decrease after β-agonist administration past 28 d. In general, it is thought that these responses may be attributed to β-adrenergic receptor desensitization and downregulation after prolonged β-agonist administration (Hausdorff et al., 1990; Zimmerli and Blum, 1990). In addition, lower heart rates after feeding ractopamine for 28 to 42 days may be associated with improved feed efficiency in steers supplemented with RAC, as heart rates have been shown to be associated with feed efficiency (Montanholi et al., 2014; Munro et al., 2017).

Feeding behavior measurements can be used to evaluate daily feed intake tendencies between different groups of finishing cattle and may have implications toward metabolic disorders such as ruminal acidosis (Gonzalez et al., 2012). Moreover, general factors affecting feeding behavior include feed formulation, feeding and animal management, and environmental influences. These factors can influence short- or long-term eating events, time eating, or rate of intake of feedlot cattle. Feed intake is largely responsible for volatile fatty acid production in the rumen and consequently, the amount of chewing and rumination that influences buffering capacity (Beauchemin et al., 1994). The combination of these factors affects acid–base balance in the rumen and are likely to be related to feeding behavior.

Abney et al. (2007) reported that RAC supplementation extended the time to consume 50% ($P = 0.09$) and 75% ($P = 0.10$) of the daily ration compared with control steers and a tendency ($P = 0.12$) in time to consume 100% of the daily feed allowance. In contrast, we observed that DMI per minute was greater (13.0%) for steers supplemented with RAC and was likely the driving factor

for reducing time eating per day (13.7%) compared with CON steers. Because of the observed increase in DMI per minute during the treatment period in RAC steers, these data were analyzed for effects of week, treatment, and the week × treatment interaction. Interestingly, there is a divergent response between CON and RAC supplemented steers for rate of DMI as week increases. Subsequently, when comparing treatment effects across weeks, the responses in eating rate are abolished in weeks 5 and 6. These data suggest that RAC can increase the rate of DMI and reduce eating time per day, but only during the first 4 weeks (~28 d) of supplementation. Similarly, zilpaterol hydrochloride supplementation (8.33 mg/kg diet DM) to Holstein steers increased DMI per minute during the first 5 d (18.5%), the following 20 d (6.3%), and the final 3 d (3.8%) of feeding (Walter et al., 2016). Reductions in eating time from RAC supplementation have previously been reported (Boler et al., 2012).

It should be noted that all diets in this study contained monensin, which is thought to reduce feed intake variation between days (Stock et al., 1995) and contributes to a more stable fermentation and ruminal pH balance (Erickson et al., 2003). Although Abney et al. (2007) reported an extended time to consume the daily ration in RAC-supplemented steers, it should be recognized that monensin was not included in the diets. Therefore, the lack of monensin in the diets used may have caused more fluctuations in ruminal pH, leading to periods of reduced rate of intake throughout the day (Schwartzkopf-Genswein et al., 2003). In this study, alterations in the rate of DMI and time eating by steers supplemented with RAC could potentially influence rumen fermentation and result in decreased ruminal pH (Gonzalez et al., 2012). Although visual signs of acidosis were not observed in steers from either treatment, changes in forage source and level (Swanson et al., 2017), grain source (Rodenhuis et al., 2017) and processing (Swanson et al., 2014), time of feeding (Prezotto et al., 2017), and feed additive inclusion (Swanson et al., 2018) can potentially alter effects and interactions with RAC.

Ractopamine, a phenethanolamine, is similar in structure and function to catecholamines such as dopamine, norepinephrine, and epinephrine (NRC, 1994; Bell et al., 1998). The distribution of β_2-adrenergic receptor in cattle is largely concentrated in skeletal muscle (>99%) and adipose tissue (>90%; Mills and Mersmann, 1995; Mersmann, 1998) and feeding ractopamine at 200 mg/d for the last 28 d does not increase β_1-, β_2-, or β_3-adrenergic receptor mRNA expression in biceps femoris or longissimus dorsi muscles (Walker et al., 2010). Ricks et al. (1984) proposed that β-adrenergic receptor agonists reduce adipose tissue accretion by decreasing lipogenesis (Blum et al., 1982; Eisemann et al., 1988) and stimulating lipolysis (Thornton et al., 1985; Mitchell et al., 1991; Chwalibog et al., 1996). Furthermore, the net effect of increased muscle tissue (Smith et al., 1989; Grant et al., 1993; Schroeder et al., 2003) is thought to be because of reduced muscle degradation (Eadara et al., 1989; Wheeler and Koohmaraie, 1992; Scramlin et al., 2010) and increased protein synthesis (Scramlin et al., 2010). The effects of RAC on carcass measurements were similar in this study to others in terms of reduced marbling (Gruber et al., 2007; Winterholler et al., 2007), increased LMA (Bryant et al., 2010; Boler et al., 2012; Ebarb et al., 2017), and no effect on dressing percentage (Laudert et al., 2004; Quinn et al., 2008). Results from this study also support the findings of Thompson et al. (2016), where monensin was supplemented at 36.4 mg/kg DM and RAC at 300 mg/d for 32 d. In both studies, RAC increased LMA and G:F. RAC supplementation did not affect DMI, HCW, dressing percentage, or 12th rib fat. Many authors have reported that RAC increases HCW (Laudert et al., 2004; Dunshea et al., 2005; Gruber et al., 2007). However, it appears that when both RAC and monensin were included in the diet, there was less of an effect on HCW compared with steers that are supplemented with solely ractopamine (Bohrer et al., 2016; Thompson et al., 2016). This could be due to the depression in DMI commonly associated with monensin supplementation (Goodrich et al., 1984; Galyean et al., 1992; Duffield et al., 2012). However, future experimentation evaluating the effects of RAC with and without monensin supplementation on feeding behavior, growth performance, and carcass characteristics is needed to confirm these observations.

CONCLUSIONS

Feeding RAC at 267 mg/d for 42 d influenced feeding behavior, growth performance, and carcass characteristics of finishing steers. RAC supplementation tended to increase ADG and improve feed efficiency. Evidence of repartitioning was observed through reductions in marbling score and KPH, and an increase in LMA. Supplementation of ractopamine increased DMI per minute and subsequently reduced eating time by 13% per day. Although the biological significance of the effects of RAC on rate of DMI are not clear, there are potential concerns

related to feeding management to avoid digestive disturbances, such as ruminal acidosis. Future research should be directed toward investigating effects of RAC supplementation on feeding behavior and associated potential for influencing rumen fermentation and gastrointestinal function.

Conflict of interest statement. None declared.

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