Effects of ractopamine hydrochloride on the growth performance and carcass characteristics of heavy-weight finishing pigs sent for slaughter using a 3-phase marketing strategy

J. W. Rickard,*[1] G. L. Allee,† P. J. Rincker,‡ J. P. Gooding,‡ R. J. Acheson,§ D. R. McKenna,§ C. L. Puls,‡ and S. N. Carr‡

*Department of Agriculture, Illinois State University, Normal 61790; †Porktech, LLC, Columbia, MO 65203; ‡Elanco Animal Health, Greenfield, IN 46140; and §Tyson Foods, Dakota Dunes, SD 57049

ABSTRACT: A total of 2,158 crossbred pigs was used to evaluate the effects of feeding 7.4 mg/kg ractopamine hydrochloride (RAC) on the growth performance and carcass characteristics of heavy-weight finishing pigs sent to slaughter using a 3-phase marketing strategy. The study was performed from 121.0 ± 4.28 kg to 144.5 ± 4.73 BW using a randomized complete block design (blocking factor was d of start on test) with 2 treatments (0 vs. 7.4 mg/kg RAC). Pigs were housed in a commercial wean-to-finish facility in groups of approximately 25 (44 groups/treatment), with ad libitum access to feed and water throughout the study, and pen weights of pigs were recorded at the start (d 0), and on d 7, 21, and 35 of study. Pigs were sent for slaughter according to the following marketing strategy: 1) after 7 d on RAC, the heaviest 16% of each pen was sent for slaughter (Phase 1), 2) after 21 d on RAC, the next 40% of each pen was sent for slaughter (Phase 2), and 3) after 35 d on RAC, the remaining 44% of each pen was sent for slaughter (Phase 3). Pigs were selected for slaughter by visual appraisal and shipped to a commercial facility where standard carcass measurements (HCW, LM depth, and backfat depth) were measured. Overall, feeding RAC increased ($P < 0.001$) ADG (18.8%) and G:F (23.7%) compared to the control, but lowered ($P < 0.001$) ADFI (3.3%). In addition, feeding RAC increased ($P < 0.001$) HCW (3.9 kg), carcass yield (0.7% units), LM depth (5.0%), and predicted lean content (1.0% units), and reduced backfat depth (6.3% lower) compared to controls. With each subsequent phase of marketing, the magnitude of improvements in response to feeding RAC decreased for ADG (43.1, 20.9, and –3.1% for Phase 1, 2, and 3, respectively) and G:F (37.5, 25.8, and 6.4% for Phase 1, 2, and 3, respectively); however, improvements in HCW (1.6, 4.5, and 4.2 kg for Phase 1, 2, and 3, respectively), carcass yield (0.2, 0.6, and 0.9% units for Phase 1, 2, and 3, respectively), LM depth (2.3, 5.7, and 5.2% for Phase 1, 2, and 3, respectively), and predicted lean content (0.2, 1.0, and 1.3% units for Phase 1, 2, and 3, respectively) generally increased from feeding RAC. These results suggest that while improvements in growth performance from feeding RAC will generally decline after 21 d of feeding, improvements in carcass traits, particularly carcass yield and lean content, will continue with feeding RAC until d 35.

Key words: carcass, growth, marketing, Paylean, pigs, ractopamine

Transl. Anim. Sci. 2017.1:406–411
doi:10.2527/tas2017.0053

INTRODUCTION

Ractopamine hydrochloride (RAC; Paylean, Elanco Animal Health, Greenfield, IN) is a β-agonist used during the marketing period in late-finishing pigs to improve growth performance and carcass leanness (Apple et al., 2007). Most studies evaluating RAC have been performed in academic settings with relatively limited group sizes and numbers of pigs and ends after a fixed-time feeding duration (Armstrong et al., 2004; Puls et al., 2015). However, in a commercial setting, pigs are often sent for slaughter using a multiple-phase

[1]Corresponding author: jwricka@ilstu.edu
Received May 11, 2017.
Accepted August 21, 2017.

marketing strategy to minimize variation in HCW and lean percentage, resulting in variable days on RAC. This marketing strategy has been shown to increase the growth performance (ADG, ADFI, and G:F) of pigs remaining in the pen after the heaviest pigs are sent for slaughter (DeDecker et al., 2005; 2007; Gerlemann et al., 2013). In theory, the increase in ADFI may result in greater RAC intake and could lead to a greater response to RAC in pigs sent later in the marketing period. Conversely, it has been shown that the improvements in growth performance generally decline as RAC feeding duration increases (Dunshea et al., 1993; Williams et al., 1994; Christianson et al., 2014), but previous research has also reported that carcass improvements continue with increasing time on RAC (Armstrong et al., 2004; Christianson et al., 2014; Gerlemann et al., 2014). Slaughter weights of pigs continue to increase, reaching near record highs for the US in 2013 through 2014, and there is a need to determine the effects of RAC in heavy-weight pigs (> 136 kg BW) managed in a commercial setting. This is the first study, to the authors' knowledge, to evaluate effects of feeding RAC in this heavy weight of pig. Therefore, the objective of this study was to evaluate the effects of feeding 7.4 mg/kg RAC on the growth performance and carcass characteristics of heavy-weight finishing pigs sent for slaughter using a 3-phase marketing strategy.

MATERIALS AND METHODS

All experimental procedures and animal care were approved by the Elanco Animal Health Institutional Animal Care and Use Committee (EIAC-0141).

Experimental Design and Treatments

The study was performed for 35 d from 121.0 ± 4.28 kg to 144.5 ± 4.73 kg BW using a randomized complete block design (blocking factor was d of start on test) with 2 treatments (0 vs. 7.4 mg/kg RAC). A total of 2,158 crossbred barrows and gilts were housed in 88 pens (44 single-sex replicates/treatment group). Ractopamine was added to the diets beginning on d 0 and remained at a constant level throughout the study period.

Pen was the experimental unit for all measurements.

Animals and Allotment to Study

Pigs used in the study were the progeny of PIC 337 sires × C22 dams (PIC North America, Hendersonville, TN). A total of 88 single-sex pens, each initially housing 25 pigs, were stratified over 2 blocks that were used in the experiment.

Allotment to the study was performed within sex at approximately 152 d of age. Within sex, pigs were weighed as a group (pen weight) and formed into outcome groups of 2 pens of similar BW, and were randomly allotted from within outcome group to treatment. Following allotment, pigs were moved to their allotted location within the facility and allowed a 15 d acclimation period prior to start of the RAC feeding period.

Animal Housing and Management

Prior to the start of the growth study, pigs were managed according to standard unit protocols, with ad libitum access to standard diets that were formulated to meet or exceed the nutrient requirements of growing pigs recommended by NRC (2012). During the study period, pigs were housed in a curtain-sided, naturally ventilated facility that had fully-slotted concrete floors. Pen dimensions provided a usable floor space of 16.25 m^2, which resulted in 0.65 m^2/pig prior to the first group of pigs being sent for slaughter. Each pen had a 4-space single-sided dry box feeder mounted on the pen division that provided a total of 122 cm of linear feeder space (4.88 cm/pig) and a single cup water drinker.

Diets and Feeding

Two diets were used during the study period: 1) Control diet (0 mg/kg RAC) vs. 2) RAC diet which included 7.4 mg/kg RAC and increased lysine for the 35 d RAC feeding period (Table 1). Diets were formulated to meet or exceed the nutrient requirements of finishing pigs recommended by NRC (2012). Diet formulations and calculated composition of the diets fed during the experimental period are presented in Table 1.

Pigs had ad libitum access to feed and water throughout the study period.

Marketing Strategy

Pigs were sent for slaughter according to the following marketing strategy: 1) after 7 d on test, the heaviest 16% of each pen (i.e., 4 pigs) was sent for slaughter such that 21 pigs remained in the pen (Phase 1); 1) after 21 d on RAC, the next heaviest 40% of each pen (i.e., 10 pigs) was sent for slaughter such that 11 pigs remained in the pen (Phase 2); and 3) after 35 d on RAC, the remaining 44% of each pen (i.e., 11 pigs) was sent for slaughter (Phase 3; Table 2). Adjustments were made to the number of pigs removed to account for differences in morbidity and mortality. Pigs were selected for slaughter by visual appraisal by the production site's normal marketing personnel. At the end of each marketing phase (d 7, 21, and 35), pigs were weighed as a group, and the heaviest pigs were selected for slaughter and re-

Table 1. Dietary composition, as-fed basis

	Ractopamine inclusion level, mg/kg	
Item	0	7.4
Ingredient, %		
Corn	82.94	73.32
Soybean meal 48%	13.00	22.25
Choice white grease	2.00	2.00
Monocalcium	0.50	0.65
Limestone	0.85	0.80
Salt	0.40	0.40
L-Lysine	0.17	0.25
L-Threonine	0.01	0.12
Alimet[1]	-	0.05
Vitamin premix with phytase[2]	0.03	0.03
Mineral premix[3]	0.10	0.10
Ractopamine hydrochloride[4]	-	0.04
Total	100	100
Calculated analysis		
ME, Mcal/kg	3.44	3.43
CP, %	13.22	16.98
Total Lys, %	0.74	1.06
SID[5] Lys, %	0.65	0.95
Total P, %	0.43	0.50
Available P, %	0.16	0.20
Ca, %	0.46	0.50
g SID lysine / Mcal ME	1.89	2.77
SID Met:Lys	31.64	30.47
SID Met+Cys:Lys	65.37	58.20
SID Thr:Lys	64.27	68.20
SID Trp:Lys	18.09	17.58
SID Ile:Lys	69.37	63.79
SID Val:Lys	83.05	72.92

[1]L-Met precursor HMTBA, an 88% aqueous solution of 2-hydrox-4-(methylthio) botanic acid (Novus International Inc., St. Louis, MO).

[2]Provided per kg of final diet: vitamin A, 6,600 IU; vitamin D_3, 704 IU; vitamin E, 26 IU; riboflavin, 4.9 mg; menadione, 2.6 mg; vitamin B_{12}, 0.02 mg; D-pantothenic acid, 16.5 mg; and niacin, 29.7 mg.

[3]Provided per kg of final diet: 66 mg iron, 66 mg zinc, 19.8 mg manganese, 66 mg copper, 14 mg iodine, and 0.12 mg selenium.

[4]Provided either 0 or 7.4 mg of ractopamine hydrochloride (Paylean; Elanco Animal Health, Greenfield, IN) per kg of diet.

[5]SID = Standardized ileal digestible.

moved from the group, which was weighed again to achieve a start weight for the subsequent marketing phase. The pigs selected for slaughter were weighed as a group, tattooed, loaded on a conventional semi-trailer, and shipped approximately 725 km (4.5 h) to a commercial slaughter facility. Descriptions of housing and marketing conditions are presented in Table 2.

Growth Study Measurements

All pigs were weighed as a group (i.e., pen basis) on d 0 (start of the RAC feeding period), and on d 7, 21, and 35 (end) of the study period. All feed additions

Table 2. Summary of housing conditions and marketing strategy of pigs fed ractopamine hydrochloride (RAC)[1] and sent for slaughter in a 3-phase marketing strategy

Item	Housing conditions
Phase 1 (d 0 to 7)	
No. pigs/pen on d 0	25
Days on RAC	7
Feeder space, cm/pig	4.88
Floor space, m^2/pig	0.65
Approximate % of pigs sent for slaughter/pen	16
No. pigs remaining/pen on d 7	21
Phase 2 (d 7 to 21)	
No. pigs/pen on d 7	21
Days on RAC	14
Feeder space, cm/pig	5.81
Floor space, m^2/pig	0.77
Approximate % of pigs sent for slaughter/pen	40
No. pigs remaining/pen on d 21	11
Phase 3 (d 21 to 35)	
No. pigs/pen on d 21	11
Days on RAC	14
Feeder space, cm/pig	11.09
Floor space, m^2/pig	1.48
Approximate % of pigs sent for slaughter/pen	44

[1]Trade name: Paylean, Elanco Animal Health, Greenfield, IN.

to the feeders were recorded and feed disappearance was recorded at the time of pig BW collection and used to calculate ADFI and G:F.

Carcass Measurements

Pigs were unloaded and held in lairage overnight with access to water, but not feed, and were humanely slaughtered using standard procedures. Immediately after carcass dressing, HCW was recorded, and back-fat and LM depth were measured using the Animal Ultrasound Services Carcass Value Technology System (Animal Ultrasound Services Inc., Ithaca, NY). Predicted lean content was calculated using a plant-proprietary equation using these measurements.

Statistical Analysis

All variables were analyzed using PROC MIXED of SAS (SAS Inst. Inc., Cary, NC). The pen of pigs was the experimental unit for all measurements. The model included the fixed effects of RAC treatment and random effects of block and replicate nested within block. Sex was not included in the statistical model, but was accounted for as replicate (single-sex) was included in the random statement. Least-squares means were separated using the PDIFF option of SAS with means being considered different at a $P \leq 0.05$.

RESULTS AND DISCUSSION

The analyzed RAC level of the diet was 7.5 mg/kg which was similar to the formulated level of 7.4 mg/kg.

Growth Performance

Pigs fed RAC were heavier ($P = 0.001$) at the end of each marketing phase and for overall end weight ($P = 0.001$) compared to controls (Table 3). For the overall 35 d feeding period, feeding RAC increased ($P = 0.001$) ADG (18.8%) and G:F (23.7%), and lowered ($P = 0.001$) ADFI (3.3% lower) compared to controls (Table 3). Generally speaking, the improvements in growth performance from feeding 7.4 mg/kg RAC observed in the current study are slightly greater than those observed in previous research. Christianson et al. (2014) reported a 20% improvement compared to controls in overall growth rate and feed efficiency in pigs fed 7.4 mg/kg RAC for 35 d; however, Gerlemann et al. (2014) reported smaller improvements of only 10.9% and 12.9% in ADG and G:F in RAC-fed pigs, respectively, compared to controls. Christianson et al. (2014) reported no difference in overall ADFI between RAC-fed pigs and controls whereas Gerlemann et al. (2014) reported 2.7% lower ADFI for RAC-fed pigs, results similar to the current study (3.3% lower; $P < 0.001$; Table 3).

During Phase 1 (d 0 to d 7), feeding RAC increased ($P = 0.001$) ADG and G:F, but had no effect ($P = 0.78$) on ADFI compared to the control. During Phase 2 (d 7 to d 21), pigs fed RAC had greater ($P = 0.001$) ADG and G:F, and lower ($P = 0.001$) ADFI compared to the control. Finally, during Phase 3 (d 21 to d 35), feeding RAC had no effect ($P > 0.05$) on ADG, but lowered ($P = 0.001$) ADFI, which resulted in increased ($P < 0.05$) G:F compared to the control (Table 3).

Improvements over controls from feeding RAC with respect to ADG were greatest in Phase 1 (d 0 to d 7) and gradually declined with increasing time on RAC (43.1% greater, 20.9% greater, and 3.1% lower for Phases 1, 2, and 3, respectively). Interestingly, feeding RAC longer than 21 d (through Phase 3) resulted in similar ($P = 0.19$) ADG as the control (Table 3). Compared to the controls, feeding RAC lowered ADFI, and this reduction increased with increasing time on RAC (0.3% lower, 2.9% lower, and 6.7% lower for Phases 1, 2, and 3 respectively). Similarly, the magnitude of improvements in G:F from feeding RAC declined with increasing time on RAC (37.5, 25.8, and 6.4% greater for Phases 1, 2, and 3, respectively).

The study was designed as a fixed-time study, where pigs were removed from pens and sent for slaughter on specific d (7, 21, and 35) during the RAC feeding period. As such, the growth performance of pigs during each phase of the marketing strategy is confounded with the start and end weight of the respective phase, as RAC-fed pigs were heavier than the controls at each marketing phase. Nonetheless, feeding RAC improved the growth rate and feed efficiency of pigs compared to the controls up to the end of Phase 2, similar to the results of Armstrong et al. (2004) which demonstrated that the greatest response to RAC was measured within the first 6 d on feed, and generally speaking, the improvements in RAC declined after 20 d on feed. There is relatively limited published research utilizing a similar study duration and design in a commercial production setting as the current study. Gerlemann et al. (2014) used a similar market-

Table 3. Effects of ractopamine hydrochloride (RAC)[1] on the growth performance of heavy-weight finishing pigs sent for slaughter using a 3-phase marketing strategy

	RAC inclusion level, mg/kg			
Item	0	7.4	SEM	*P*-value
No. of pens	44	44	-	-
Phase 1 (d 0 to 7)[2]				
No. pigs/pen	25	25	-	-
BW, kg				
d 0 (start)	121.0	121.0	0.72	0.98
d 7	126.2	128.3	1.52	0.001
ADG, kg	0.72	1.03	0.104	0.001
ADFI, kg	2.87	2.86	0.056	0.78
G:F	0.261	0.359	0.0361	0.001
Phase 2 (d 7 to 21)[3]				
No. pigs/pen	21	21	-	-
BW, kg				
d 7	124.2	126.2	1.66	0.001
d 21	136.2	140.8	1.23	0.001
ADG, kg	0.86	1.04	0.033	0.001
ADFI, kg	3.06	2.97	0.051	0.001
G:F	0.279	0.351	0.0075	0.001
Phase 3 (d 21 to 35)[4]				
No. pigs/pen	11	11	-	-
BW, kg				
d 21	130.6	135.0	1.05	0.001
d 35 (end)	144.4	148.2	1.04	0.001
ADG, kg	0.97	0.94	0.013	0.19
ADFI, kg	3.26	3.04	0.036	0.001
G:F	0.296	0.315	0.0057	0.01
Overall (d 0 to 35)[5]				
BW, kg				
d 0 (start)	121.0	121.0	0.72	0.98
d 35 (end)	142.6	146.5	1.18	0.001
ADG, kg	0.85	1.01	0.019	0.001
ADFI, kg	3.06	2.96	0.015	0.001
G:F	0.278	0.344	0.0067	0.001

[1]Trade name: Paylean, Elanco Animal Health, Greenfield, IN.
[2]Heaviest ~16% of pigs sent for slaughter on d 7.
[3]Next heaviest 40% of pigs sent for slaughter on d 21.
[4]Final 44% of pigs sent for slaughter on d 35.
[5]Weighted average of growth performance for entire 35-d feeding period.

ing strategy (16, 18, and 66% of pigs sent for slaughter on d 7, 21, and 35 of RAC feeding, respectively) and reported gradual reductions in ADG (18.2, 13.0, and 1.9% for Phases 1, 2, and 3, respectively) and G:F (16.7, 21.2, and 6.9% for Phases 1, 2, and 3, respectively) as the RAC-feeding duration increased. Similarly, Christianson et al. (2014) reported continual reductions for the improvement in growth rate (30.0, 17.7, and 10.8% for Phases 1, 2, and 3, respectively) and feed efficiency (30.3, 18.9, and 8.8% for Phases 1, 2, and 3, respectively) when 26, 31, and 43% of the pen was sent for slaughter on d 7, 21, and 35, respectively. In contrast to the current study, Hinson et al. (2012a) reported increases in growth rate and feed efficiency with increasing RAC feeding durations. In the current study, feeding RAC reduced ADFI and this reduction increased with time on RAC, which contributed to the greater feed efficiency as time on RAC increased. However, this has not been observed in other studies of similar study design (Hinson et al., 2012a; Christianson et al., 2014; Gerlemann et al., 2014). Collectively, these results, along with others, suggest that, while RAC consistently improves overall growth rate and feed efficiency, the greatest improvement is observed soon after RAC implementation, and may decline after 21 d of feeding.

Although the effect of marketing strategy was not directly evaluated in the current study, ADG and ADFI of pigs was generally lowest in Phase 1, when floor space and feeder space were most restrictive (Table 3). After Phase 1, ADG and ADFI were greater in both control and RAC-fed pigs during Phase 2, with the ADG of controls being 20.0% greater in Phase 2 compared to Phase 1. Interestingly, the removal of 16% of pigs from the RAC-fed pens on d 7 did not produce a substantial response in subsequent growth rate during phase 2 (d 7 to 21). Whether it was due to remaining floor space still being restrictive or due to maximal growth rates already being achieved remains unclear. Growth performance in Phase 3 was generally similar to that of Phase 2, suggesting that the additional removal of 10 pigs on d 21, and resulting increase in floor and feeder space, did not further improve growth performance of the remaining pigs in the pen, which is generally in agreement with previous research evaluating effects of removing pigs from a pen on subsequent growth performance of remaining pigs (DeDecker et al., 2005; 2007; Gerlemann et al., 2013).

Table 4. Effects of ractopamine hydrochloride (RAC)[1] on the carcass characteristics of heavy-weight finishing pigs sent for slaughter using a 3-phase marketing strategy

	RAC inclusion level, mg/kg			
Item	0	7.4	SEM	*P*-value
No. of pens	44	44	-	-
Phase 1 (d 0 to d 7)[2]				
No. pigs sent for slaughter on d 7	4	4	-	-
Slaughter live weight, kg	139.2	140.8	0.96	0.15
HCW, kg	104.4	106.0	0.58	0.08
Carcass yield, %	75.1	75.3	0.13	0.28
Backfat depth, mm[3]	16.4	16.8	0.30	0.46
LM depth, mm[3]	74.8	76.5	0.67	0.01
Predicted lean content, %	56.7	56.9	0.16	0.31
Phase 2 (d 7 to 21)[4]				
No. pigs sent for slaughter on d 21	10	10	-	-
Slaughter live weight, kg	142.5	147.2	1.48	0.001
HCW, kg	107.7	112.2	1.20	0.001
Carcass yield, %	75.6	76.2	0.08	0.001
Backfat depth, mm[3]	16.4	15.8	0.11	0.01
LM depth, mm[3]	74.8	79.1	0.69	0.001
Predicted lean content, %	56.5	57.5	0.21	0.001
Phase 3 (d 21 to 35)[5]				
No. pigs sent for slaughter on d 35	11	11	-	-
Slaughter live weight, kg	144.4	148.2	1.04	0.001
HCW, kg	108.9	113.1	0.50	0.001
Carcass yield, %	75.4	76.3	0.25	0.002
Backfat depth, mm[3]	19.3	17.3	0.24	0.001
LM depth, mm[3]	73.7	77.5	0.27	0.001
Predicted lean content, %	55.7	57.0	0.14	0.001
Overall (d 0 to 35)[6]				
Slaughter live weight, kg	142.9	146.8	1.20	0.001
HCW, kg	107.8	111.7	0.78	0.001
Carcass yield, %	75.4	76.1	0.12	0.001
Backfat depth, mm[3]	17.7	16.6	0.10	0.001
LM depth, mm[3]	74.3	78.0	0.34	0.001
Predicted lean content, %	56.2	57.2	0.07	0.001

[1]Trade name: Paylean, Elanco Animal Health, Greenfield, IN.

[2]Heaviest ~16% of pigs sent for slaughter on d 7.

[3]Backfat depth and LM depth measured using Animal Ultrasound Services Carcass Value Technology System (Animal Ultrasound Services Inc., Ithaca, NY).

[4]Next heaviest 40% of pigs sent for slaughter on d 21.

[5]Final 44% of pigs sent for slaughter on d 35.

[6]Weighted average of carcass characteristics for entire 35 d feeding period.

Carcass Characteristics

Pigs fed RAC were heavier ($P < 0.001$) at the end of Phase 2 and 3 and for overall end weight (Table 4). Overall, feeding RAC increased ($P < 0.001$) HCW (3.9 kg), which falls within the range reported in previous research (Apple et al., 2007; Puls et al., 2015). In addition, carcass yield (0.7% units), LM depth (4.98%), and predicted lean content (1.0% units) were all increased from feeding RAC, results similar to other studies (Hinson et al., 2012b; Christianson et al., 2014; Gerlemann et al., 2014) whereas backfat depth was reduced ($P < 0.001$; 6.3% lower) compared to controls.

Improvements over controls in carcass yield (0.20, 0.60, and 0.90% units for Phase 1, 2, and 3, respectively) and predicted lean content (0.2, 1.0, and 1.3% units greater for Phase 1, 2, and 3, respectively) from feeding RAC increased with increasing time on RAC. This is likely driven by the sharp reduction in backfat in RAC-fed pigs compared to the control (2.4% greater, 4.0% lower, and 10.4% lower for Phase 1, 2, and 3, respectively).

In the current study, improvements in carcass traits associated with feeding RAC increased with increasing time on feed, which concurs with the results of Hinson et al. (2012a), who reported greater improvements compared to controls for HCW, carcass yield, LM depth, and lean content, as well as decreased backfat depth as RAC feeding duration increased. Additionally, Gerlemann et al. (2014) reported improvements in carcass yield of 0.1, 0.9, and 1.1% units for pigs slaughtered after 7, 21, and 35 d of RAC feeding, respectively. Similarly, Christianson et al. (2014) reported a 0.1% unit lower, 0.7% unit greater, and 0.7% unit greater carcass yield for RAC-fed pigs sent for slaughter on d 7, 21, and 35, respectively, compared to controls. Similar to the current study, these authors reported greater reductions in backfat depth, but greater LM depth, and an increase in predicted lean content as RAC feeding duration increased (Gerlemann et al., 2014; Christianson et al., 2014). The results of this study, along with other previous research, suggest that even in heavy-weight finishing pigs, RAC-induced responses on carcass traits relative to those of controls-fed pigs continue to increase with greater RAC feeding durations.

Conclusions

These results validate the consistent response observed from feeding RAC on increased growth performance, carcass yield, and carcass leanness. Moreover, these results also suggest that with increasing time on RAC, growth rate and feed efficiency will decrease, but improvements in carcass yield and leanness will continue to increase with longer feeding periods in heavy-weight (144 kg) pigs.

LITERATURE CITED

Apple, J. K., P. J. Rincker, F. K. McKeith, S. N. Carr, T. A. Armstrong, and P. D. Matzat. 2007. Review: Meta-analysis of the ractopamine response in finishing swine. Prof. Anim. Sci. 23:179–196. doi:10.15232/S1080-7446(15)30964-5

Armstrong, T. A., D. J. Ivers, J. R. Wagner, D. B. Anderson, W. C. Weldon, and E. P. Berg. 2004. The effect of dietary ractopamine concentration and duration of feeding on growth performance, carcass characteristics, and meat quality of finishing pigs. J. Anim. Sci. 82:3245–3253. doi:10.2527/2004.82113245x

Christianson, E. L., R. J. Kaptur, Jr., Z. McCracken, D. D. Boler, S. N. Carr, and P. J. Rincker. 2014. Effect of constant dose and step-up ractopamine-feeding programs on live performance and carcass traits of finishing pigs in a 3-phase marketing system. Prof. Anim. Sci. 30:543–550. doi:10.15232/pas.2014-01312

DeDecker, J. M., M. Ellis, B. F. Wolter, B. P. Corrigan, S. E. Curtis, E. N. Parr, and D. M. Webel. 2005. Effects of proportion of pigs removed from a group and subsequent floor space on growth performance of finishing pigs. J. Anim. Sci. 83:449–454. doi:10.2527/2005.832449x

DeDecker, J. M., M. Ellis, B. P. Corrigan, S. E. Curtis, B. A. Peterson, M. J. Ritter, J. L. Usry, D. M. Webel, and B. F. Wolter. 2007. Impact of pig removal strategies at market on growth performance and production efficiency. J. Anim. Sci. 85(Suppl. 2):4 (Abstr.).

Dunshea, F. R., R. H. King, R. G. Campbell, R. D. Sainz, and Y. S. Kim. 1993. Interrelationships between sex and ractopamine on protein and lipid deposition in rapidly growing pigs. J. Anim. Sci. 71:2919–2930. doi:10.2527/1993.71112919x

Gerlemann, G. D., G. L. Allee, D. D. Boler, M. J. Ritter, M. K. Pierdon, and S. N. Carr. 2013. The effects of ractopamine hydrochloride feeding programs on growth and carcasses of finishing pigs marketed in 2 different groups. Prof. Anim. Sci. 29:271–277. doi:10.15232/S1080-7446(15)30233-3

Gerlemann, G. D., G. L. Allee, P. J. Rincker, M. J. Ritter, D. D. Boler, and S. N. Carr. 2014. Impact of ractopamine hydrochloride on growth, efficiency, and carcass traits of finishing pigs in a three-phase marketing strategy. J. Anim. Sci. 92:1200–1207. doi:10.2527/jas.2013-6548

Hinson, R. B., G. L. Allee, M. J. Ritter, C. W. Parks, D. D. Boler, and S. N. Carr. 2012a. Evaluation of different doses and durations of ractopamine (Paylean) on growth performance and carcass characteristics of late finishing market pigs. Prof. Anim. Sci. 28:395–402. doi:10.15232/S1080-7446(15)30379-X

Hinson, R. B., H. O. Galloway, D. D. Boler, M. J. Ritter, F. K. McKeith, and S. N. Carr. 2012b. Effects of feeding ractopamine (Paylean) on growth and carcass traits in finishing pigs marketed at equal slaughter weights. Prof. Anim. Sci. 28:657–663. doi:10.15232/S1080-7446(15)30425-3

NRC. 2012. Nutrient requirements of swine. 11th rev. ed. Natl. Acad. Press, Washington, DC.

Puls, C. L., W. E. Trout, M. J. Ritter, F. K. McKeith, S. N. Carr, and M. Ellis. 2015. Impact of ractopamine hydrochloride on growth performance, carcass and pork quality characteristics, and responses to handling and transport in finishing pigs. J. Anim. Sci. 93:1229–1238. doi:10.2527/jas.2014-8097

Williams, N. H., T. R. Cline, A. P. Schinckel, and D. J. Jones. 1994. The impact of ractopamine, energy intake, and dietary fat on finisher pig growth performance and carcass merit. J. Anim. Sci. 72:3152–3162. doi:10.2527/1994.72123152x