Effects of ractopamine HCl dose and treatment period on pig performance in a commercial finishing facility

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Summary

Objective: To evaluate effects of ractopamine HCl (RAC) dose and treatment period on growth performance and carcass composition in a commercial finishing environment.

Materials and methods: In Experiment One, a total of 880 pigs (PIC L337 × C22; initially 106.5 ± 0.5 kg) were allotted to four treatments, including doses of 0, 5.0, 7.5, and 10.0 ppm of RAC for 21 days before slaughter. In Experiment Two, 1035 gilts (initially 103.2 ± 0.62 kg) were allotted to nine treatments. Treatments included doses of 5 or 10 ppm RAC for 7, 14, 21, or 28 days before slaughter and a control treatment without RAC.

Results: In Experiment One, average daily gain (ADG), gain-to-feed ratio (G:F), and carcass yield increased (linear, $P < .05$) with increasing dose of RAC. The largest numeric differences were observed as RAC dose increased from 0 to 5 ppm. In Experiment Two, ADG and G:F were greater ($P < .05$) for pigs fed 5 ppm RAC for 14, 21, or 28 days and for pigs fed 10 ppm for all treatment periods than for control pigs. Carcass yield was greater in pigs fed 10 ppm RAC ($P < .05$) than in pigs fed 5 ppm RAC or in the controls. RAC dose (5 ppm versus 10 ppm) did not affect carcass lean measures ($P > .16$).

Implications: Feeding RAC at 5 to 10 ppm for 14 to 28 days before slaughter increases ADG, G:F, and carcass yield of pigs reared in a commercial finishing environment.

Keywords: swine, ractopamine, growth

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Resumen - Efectos de la dosis y el periodo de tratamiento del HCL de ractopamina en el desempeño de cerdo criados en instalaciones comerciales de finalización

Objetivo: Evaluar los efectos de la dosis y el periodo de tratamiento del HCL de ractopamina (RAC por sus siglas en inglés) en el desempeño de crecimiento y la composición de la canal en un ambiente de finalización comercial.

Materiales y métodos: En el Experimento Uno, se asignaron un total de 880 cerdos (PIC L337 × C22; inicialmente 106.5 ± 0.5 kg) a cuatro tratamientos, incluyendo dosis de 0, 5.0, 7.5, y 10.0 ppm de RAC durante 21 días antes del sacrificio. En el Experimento Dos, se asignaron 1035 primerizas (inicialmente 103.2 ± 0.62 kg) a nueve tratamientos. Los tratamientos incluyeron dosis de 5 ó 10 ppm de RAC por 7, 14, 21, ó 28 días antes del sacrificio y un tratamiento control sin RAC.

Resultados: En el Experimento Uno, la ADG, la relación de ganancia-alimento (G:F por sus siglas en inglés), y el rendimiento de canal incrementaron (linear, $P < .05$) con el aumento de la dosis de RAC. Las diferencias numéricas más grandes se observaron cuando la dosis de RAC aumentó de 0 a 5 ppm. En el Experimento Dos, la ADG y la G:F fueron mayores ($P < .05$) en los cerdos alimentados con 5 ppm de RAC por 14, 21, ó 28 días y en los cerdos alimentados con 10 ppm en todos los periodos de tratamiento, que en los cerdos control. El rendimiento de canal fue mayor en cerdos alimentados con 10 ppm de RAC ($P < .05$) comparativamente a los cerdos alimentados con 5 ppm de RAC ó a los controles. La dosis de RAC (5 ppm contra 10 ppm) no afectó el rendimiento magro de la canal ($P > .16$).

Implicaciones: Alimentar con RAC de 5 a 10 ppm por 14 a 28 días antes del sacrificio aumenta la ADG, la G:F, y el rendimiento de canal de cerdos criados en un ambiente de finalización comercial.

Résumé - Effets de la dose de ractopamine HCl et de la période de traitement sur les performances des porcs dans un site de finition commercial

Objectif: Évaluer les effets du dosage et de la période de traitement avec de la ractopamine HCl (RAC) sur les performances de croissance et la composition de la carcasse dans un environnement de finition commercial.

Matériels et méthodes: Lors de l'Expérience Un, 880 porcs (PIC L337 × C22; initialement 106.5 ± 0.5 kg) ont été répartis dans quatre groupes de traitement et ont reçu des doses de 0, 5.0, 7.5, et 10.0 ppm de RAC pendant 21 jours avant l'abattage. Lors de l'Expérience Deux, 1035 cochettes (initialement 103.2 ± 0.62 kg) ont été réparties dans neuf groupes de traitement. Les traitements consistaient en des doses de 5 ou 10 ppm de RAC pour 7, 14, 21, ou 28 jours avant l'abattage ainsi qu'un traitement témoin sans RAC.

Résultats: Au cours de l'Expérience 1, le gain moyen quotidien (ADG), le ratio

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gain-nourriture (G:F) et le rendement de la carcasse augmentaient (linéaire, $P < .05$) avec des doses croissantes de RAC. Les plus grandes différences numériques étaient observées lorsque la dose de RAC a augmenté de 0 à 5 ppm. Lors de l'Expérience 2, comparativement aux témoins, l'ADG et le G:F étaient plus grands ($P < .05$) pour les porcs nourris avec 5 ppm de RAC pendant 14, 21, et 28 jours et pour les porcs nourris avec 10 ppm pour toutes les périodes de traitement. Les doses de RAC (5 ppm versus 10 ppm) n'ont pas affecté les mesures de viande maigre des carcasses ($P > .16$).

Implications: L'ajout de 5 à 10 ppm de RAC pour 14 à 28 jours avant l'abattage augmente l'ADG, le G:F, et le rendement des carcasses de porcs élevés dans un environnement de finition commercial.

Opportunities to enhance growth performance and carcass value are of primary interest to pork producers. Ractopamine hydrochloride (RAC) (Paylean; Elanco Animal Health, Greenfield, Indiana) is a *B*-adrenergic agonist commonly fed by producers in an effort to improve finishing growth rate, feed efficiency, carcass yield, carcass lean content, and producer profitability. The biological effects of feeding RAC on finishing growth performance and carcass composition have been well described.[1,2] Many of the controlled studies reported in the literature have been conducted with small groups of animals housed at eight or fewer pigs per pen. However, in small-pen university research settings, feed intake may be as much as 30% greater than that observed in commercial research environments (≥ 20 pigs per pen).[3,4] Therefore, our objective was to quantify the effect of RAC dose (0 to 10 ppm) and treatment period (0 to 28 days before slaughter) on growth performance, carcass yield, and carcass lean percentage (as determined by fat and loin depth measurements at the 10th rib) in a commercial finishing environment. Understanding the biological effects of RAC dose and treatment period in commercial finishing environments will help pork producers determine if treatment with RAC is suitable for their operations, and if so, how it may best be applied.

Materials and methods

Experiment One

A total of 880 pigs (initially 106.5 ± 0.5 kg; PIC, L337 × C22, Hendersonville, Tennessee) were assigned to treatment 21 days before slaughter in a commercial research facility. The four dietary treatments included 0, 5.0, 7.5, and 10.0 ppm of RAC. This trial was conducted as a randomized complete block, with pens allotted to treatment on the basis of gender and average pig weight. There were 20 to 23 pigs per pen, with 20 pens of barrows and 20 pens of gilts. This provided 10 observations per treatment (five gilt and five barrow). Pens were 3.05 m × 5.49 m, with a four-hole self-feeder and one cup waterer. The finishing facility had totally slatted flooring and a deep pit, and operated on mechanical ventilation in winter and natural ventilation (double curtain-sided) in summer. Diets were based on corn and soybean meal and formulated to exceed nutrient requirements for optimal growth performance.[5] Diets were formulated at 0.70%[6] and 0.90%[7] total dietary lysine (as fed) for the controls and RAC treatments, respectively (Table 1). Previous research (Main et al, 2008)[6] with the same

Table 1: Diet composition (as-fed basis) in two studies investigating effects of increasing doses of ractopamine HCl (RAC) and three different treatment periods on growth parameters in finisher pigs in a commercial swine facility*

	RAC dose (ppm of feed)			
	Experiment One		Experiment Two	
	0	5.0, 7.5 or 10.0	0	5.0 or 10.0
Ingredient (%)				
Corn	85.85	78.58	84.04	75.05
Soybean meal (46.5% CP)	11.88	19.13	13.70	22.75
Monocalcium phosphate (21% P)	0.81	0.81	0.81	0.73
Limestone	0.85	0.86	0.86	0.85
Salt	0.35	0.35	0.35	0.35
L-lysine HCl	0.15	0.15	0.15	0.15
Vitamin premix†	0.05	0.05	0.05	0.05
Trace mineral premix‡	0.05	0.05	0.05	0.05
Ractopamine HCl§	0.0	0.025 to 0.05	0.0	0.025 or 0.05
Calculated analysis¶				
Lysine:calorie ratio (g lysine: Mcal ME)	2.10	2.70	2.25	3.00
CP (%)	12.82	15.57	13.51	16.96
Lysine (%)	0.70	0.90	0.75	1.00
TID lysine (%)**	0.62	0.80	0.66	0.89
ME (Mcal/kg)	3338	3334	3337	3336
Ca (%)	0.54	0.56	0.55	0.56
Available P (%)	0.23	0.23	0.22	0.22

* In Experiment One, four groups of pigs were fed RAC at 0, 5.0, 7.5 and 10.0 ppm, respectively, for 21 days before slaughter. In Experiment Two, treatments included RAC at 5.0 or 10.0 ppm for 7, 14, 21, or 28 days before slaughter and a control treatment without RAC.

† Provided per kg of complete diet: vitamin A, 8818 IU; vitamin D, 1323 IU; vitamin E, 35.3 IU; menadione (menadione sodium bisulfate complex), 3.5 mg; vitamin B12, 0.04 mg; riboflavin, 7.9 mg; pantothenic acid, 26.5 mg; and niacin, 44.1 mg.

‡ Provided per kg of complete diet: 16.5 mg Cu as $CuSO_4.5H_2O$; 165.4 mg Fe as $FeSO_4.H_2O$; 39.7 mg Mn as $MnSO_4.H_2O$; 0.30 mg Se as Na_2SeO_3; 165.4 mg Zn as ZnO; and 0.30 mg I as $C_2H_2(Nh_2)_2.2HI$.

§ Paylean (Elanco Animal Health, Greenfield, Indiana) was used as the source of RAC.

¶ Calculated values from NRC (1998)[5] were used in diet formulation.

** True ileal digestible lysine.

CP = crude protein; ME = metabolizable energy genetic lines in the same research barns demonstrated that the lysine level required to maximize average daily gain (ADG) and gain-to-feed ratio (G:F) was not greater than the level fed to control pigs in this experiment. The second reason for feeding a lower lysine level to the control pigs than to the pigs fed diets containing RAC was to more closely represent the manner in which RAC treatment would be implemented by swine producers. Because RAC increases the lysine requirement of the pig, recommendations are to increase the lysine level of the feed by 0.25% to 0.3% when RAC is added to the diet.[7]

Pig welfare standards were in accordance with published guidelines,[8] and the research protocol was approved by the Kansas State University Institutional Animal Care and Use Committee. Pig weights and feed disappearance were measured for each pen and used to calculate ADG, average daily feed intake (ADFI), and G:F. Pigs in each pen were weighed weekly. Pigs were tattooed with unique numbers to enable pen identification to be maintained through the packing plant (Swift Inc, Worthington, Minnesota). All pigs were slaughtered on the same day, and carcass weight and fat and loin depth at the 10th rib were measured to calculate carcass yield and lean percentage, respectively.

Experiment Two

A total of 1035 gilts (initially 103.2 ± 0.62 kg; PIC, L337 × C22) were used to determine the effects of dosage of RAC and treatment period in a commercial research facility. The nine treatments included treatment with RAC at 5.0 or 10.0 ppm for 7, 14, 21, or 28 days before slaughter. Control pigs (no RAC treatment) were slaughtered on day 28 with all other pigs. A total of 45 pens (23 pigs per pen) were allotted to treatments in a randomized complete-block design (five observations per treatment). Pens were allotted to treatment and blocked by average pen weight. Diets were based on corn and soybean meal and formulated to 0.75% and 1.00% total dietary lysine (as fed) for the control and ractopamine diets, respectively. Again, our objective with diet formulation was to ensure that the diets were not limiting growth of either control[6] or RAC-fed pigs.[7] Diets used are presented in Table 1. Pigs in Experiment Two were otherwise managed and parameters were measured as described for Experiment One.

Statistical analysis

Analysis of variance was used to analyze growth and carcass performance data from each trial according to the PROC GLM procedures of SAS (SAS Institute Inc, Cary, North Carolina). Data were analyzed by using pair-wise orthogonal contrasts between the dietary treatments and the main effects of RAC dose (Experiments One and Two) and treatment period (Experiment Two).

In Experiment One, the statistical model included the fixed effects of RAC dose (0, 5.0, 7.5, and 10.0 ppm), gender, and block. Because there were no RAC dose-by-gender interactions ($P > .05$), the dose-by-gender interaction term was dropped from the model. Linear and quadratic contrasts were used to determine the effects of increasing amount of RAC in the diet. Coefficients for unevenly spaced treatments were derived using the PROC IML procedure of SAS.

In Experiment Two, the statistical model included the fixed effects of dietary treatment and block. In addition, data were analyzed as a 2 × 4 factorial, with the fixed effects of RAC dose (5.0 or 10.0 ppm) and treatment period (7, 14, 21, or 28 days). Linear and quadratic contrasts were made to determine the effect of increasing treatment period (0, 7, 14, 21, and 28 days). Backfat, loin depth, and lean percentage were adjusted using carcass weight as a covariate.

Pen was the experimental unit in all analyses. For all analyses, $P < .05$ was considered statistically significant.

Results

Experiment One

Average daily gain, G:F, carcass yield, and slaughter and carcass weights increased with increasing dose of RAC (linear, $P < .05$; Table 2). Although the increases in ADG, G:F, and yield were linear, the greatest changes were observed as RAC dose increased from 0 to 5.0 ppm. Differences were not observed in ADG, slaughter weight, or carcass weight among pigs treated with RAC at 5.0, 7.5, or 10.0 ppm ($P > .05$). In pigs fed 10 ppm RAC, G:F was greater than in pigs fed 5 ppm RAC ($P < .05$). In pigs fed 7.5 ppm RAC, G:F was intermediate. RAC supplementation did not affect feed intake, lean percentage, backfat, or loin depth in this trial ($P > .05$). However, as RAC inclusion rate increased (0, 5.0, 7.5, and 10.0 ppm), backfat decreased numerically (18.2, 18.0, 17.8, and 17.5 ± 0.44 mm, respectively) and calculated lean percentage increased numerically (55.0%, 55.3%, 55.5%, and 55.7% ± 0.34%, respectively) ($P > .05$).

Experiment Two

Average daily gain, G:F, and slaughter weight were greater, compared to those for controls, for pigs fed 5.0 ppm RAC for treatment periods of 14, 21, or 28 days, and for pigs fed 10.0 ppm RAC for all treatment periods ($P < .05$; Table 3). The 5.0-ppm 7-day treatment group was intermediate in ADG, G:F, and slaughter weight. In pigs fed 5.0 ppm RAC for 21 or 28 days and 10.0 ppm for 7, 14, 21, or 28 days, ADFI was greater than that in the controls ($P < .05$), with ADFI for the 5.0-ppm 7-day and 14-day treatments being intermediate. Carcass weight was greater, compared to that in the controls, in pigs fed RAC at 5.0 ppm for 14, 21, or 28 days and in pigs fed RAC at 10.0 ppm for all treatment periods ($P < .05$). Carcass weight was intermediate in pigs fed RAC at 5.0 ppm for 7 days.

Average daily gain tended to increase (0.74 versus 0.79 ± 0.025 kg) as RAC dose increased from 5.0 to 10.0 ppm ($P < .10$). Feed intake was not affected by RAC dose ($P > .05$). RAC dose (5.0 versus 10.0 ppm) did not affect carcass lean ($P > .05$), but carcass yield was greater in pigs fed RAC at 10.0 ppm than at 5.0 ppm or in the controls ($P < .05$). As RAC dose increased from 5.0 ppm to 10.0 ppm, carcass weight increased (95.0 versus 96.7 ± 0.54 kg) ($P < .05$).

Treatment period had no effect on ADG, G:F, or final weight ($P > .05$). Feed intake tended to increase (linear; $P < .10$) with longer treatment period (2.48, 2.50, 2.51, and 2.56 ± 0.035 kg per day for treatment periods of 7, 14, 21, and 28 days, respectively). Treatment period did not affect carcass yield ($P > .05$). Increasing treatment period had no effect on carcass weight ($P > .05$), as no numeric change in carcass weight was observed beyond the 14-day treatment. Fat depth decreased (16.4, 15.6, 15.2, 14.8 ± 0.36 mm) and lean percentage increased linearly (56.0%, 56.6%, 56.8%, 57.0% ± 0.14%) ($P < .01$) as treatment period increased from 7 to 28 days, but the control treatment was intermediate (15.8 mm backfat, 56.6% lean) to all other treatments. RAC treatment period did not affect loin depth ($P > .05$).

Table 2: Effects on growth performance of ractopamine (RAC) dose in pigs treated for 21 days before slaughter (Experiment One)*

Item	RAC (ppm) 0	5.0	7.5	10.0	SEM	Probability (P <) Linear	Quadratic
Initial weight (kg)	106.7	106.8	106.3	106.1	0.50	.70	.25
ADG (kg)	0.78[a]	0.90[b]	0.91[b]	0.94[b]	0.026	.001	.22
ADFI (kg)	2.78	2.81	2.72	2.70	0.008	.16	.38
G:F	0.278[a]	0.320[b]	0.334[bc]	0.346[c]	0.008	.001	.38
Slaughter weight (kg)	123.0[a]	125.6[b]	125.4[b]	125.8[b]	0.64	.003	.15
Yield (%)†	75.7[a]	76.2[ab]	76.3[ab]	76.5[b]	0.23	.02	.96
Carcass weight (kg)	93.2[a]	95.7[b]	95.8[b]	96.1[b]	0.60	.001	.17
Backfat (mm)‡	18.2	18.0	17.8	17.5	0.44	.31	.76
Loin depth (mm)‡	60.6	61.4	62.2	61.8	1.00	.36	.73
Carcass lean (%)‡	55.0	55.3	55.5	55.7	0.34	.14	.88

* Pigs from a total of 40 pens with 10 observations per treatment (five barrow and five gilt, with 20 to 23 pigs/pen) were fed doses of 0, 5.0, 7.5, or 10.0 ppm RAC in a commercial finishing environment.

† Yield was calculated from live-carcass pen weights attained at the slaughter plant.

‡ Backfat, loin depth, and carcass lean percentage were adjusted using carcass weight as a covariate.

[a,b,c] Means in the same row with no common superscript differ (P < .05; ANOVA).

ADG = average daily gain; ADFI = average daily feed intake; G:F = gain-to-feed ratio.

Discussion

In these studies, in pigs fed diets with RAC added at 5.0 to 10.0 ppm for 14 to 28 days before slaughter, ADG was 24% greater and G:F was 20% greater than in the controls, that received no RAC treatment. Although numeric increases in both ADG and G:F were observed with increasing RAC dose, the 5.0-ppm RAC treatment captured 80% of the increase in ADG and 72% of the increase in G:F of the 10-ppm RAC treatment when fed 14 to 28 days before slaughter. These findings are consistent with results of studies conducted by Watkins et al,[9] who observed that in pigs fed RAC at 5.0 ppm for 45 to 50 days before slaughter, this treatment captured 100% of the increase in ADG and 85% of the increase in G:F of pigs fed RAC at 10 ppm. Armstrong et al[10] also observed greater growth performance with increasing RAC dosage and treatment period. Our results are also consistent with the review and meta-analysis of Kelley et al[1] and Apple et al.[2]

The greater ADG and G:F observed in the present studies conducted under commercial finishing conditions are directionally similar, but generally larger in magnitude, than the improvements reported in many of the previous studies reported in the literature. Increase in ADG from 7% to 21% and in G:F from 9% to 17% have been previously reported,[11-13] but treatment periods in these referenced studies were generally longer than those in the present studies. This likely contributes to the elevated rate of change in growth performance observed in the current studies. A temporal response to feeding RAC has been previously described, with effects on growth and G:F diminishing over time.[14-16] These authors[14-16] have reported a smaller relative rate of increase over controls the longer RAC is fed, and suggest that the maximal improvement in growth performance is achieved during the first 14 to 22 days of RAC feeding.

Experiment Two in the current study further supports these previous observations of a temporal growth response to RAC feeding, in that no ongoing increases in overall ADG or G:F were observed for pigs fed 5.0 or 10.0 ppm RAC beyond 14 days before slaughter. It has been hypothesized that this diminished growth-performance response to RAC with extended treatment period is due to a decrease in cellular responsiveness to RAC.[17] The elevated growth performance responses in the present studies may have also been influenced by the pigs being 30 to 40 kg heavier at the start of the study than pigs in the majority of the previously reported studies. In addition, the studies herein were conducted in a commercial finishing environment, which commonly limits feed intake and growth performance, compared with those of pigs fed in research facilities housing one to eight pigs per pen.[3,4] Williams et al[16] demonstrated that improved lean gain could be achieved at lower energy intakes when RAC was fed, and hypothesized that this was due to RAC repartitioning of energy to protein accretion by decreasing lipogenesis, increasing lypolysis in adipose tissue, and increasing protein synthesis in muscle tissue.[18-20] Consequently, the response to RAC in the present studies is impressive, especially considering that the treated pigs were in a phase of increasing lipid deposition relative to protein, and that they were reared in a commercial environment.

Carcass yield was approximately 0.5% greater in pigs that received the lowest dose of RAC than in controls. Carcass yield also seemed to increase with RAC dose, inasmuch as carcass yield was on average 0.5% greater in pigs fed RAC at 10 ppm than in pigs fed RAC at 5 ppm. The present studies suggest that carcass yield is affected more by RAC dose than by treatment period. These findings are consistent with a previously reported 0.5% to 2.0% improvement in carcass yield due to feeding RAC.[10,12] Watkins et al[9] observed that carcass yield

Table 3: Effects of ractopamine (RAC) dose and treatment period on pig performance (Experiment Two)*

		RAC dose (ppm)							
		5.0				10.0			
		Treatment period (days)							
Parameter	**Control**	**7**	**14**	**21**	**28**	**7**	**14**	**21**	**28**
Initial weight (kg)	103.1	103.2	103.5	103.2	103.1	103.3	103.1	103.4	103.3
ADG (kg)	0.60^{a}	0.67^{ab}	0.76^{bc}	0.77^{bc}	0.77^{bc}	0.78^{bc}	0.81^{c}	0.78b^{c}	0.80^{c}
ADFI (kg)	2.35^{a}	2.42^{ab}	2.47^{ab}	2.50^{b}	2.54^{b}	2.53^{b}	2.52^{b}	2.51^{b}	2.59^{b}
G:F	0.255^{a}	0.273^{ab}	0.307^{bc}	0.306^{bc}	0.303^{bc}	0.310^{bc}	0.321^{c}	0.313^{bc}	0.311^{bc}
Slaughter weight (kg)	119.9^{a}	121.9^{ab}	124.7^{bc}	124.7^{bc}	124.7^{bc}	125.0^{bc}	125.7^{c}	125.3^{c}	125.8^{c}
Yield (%)†	76.3^{a}	76.7^{abcd}	76.5^{ab}	76.6^{abcd}	76.6^{abcd}	77.1^{bcd}	77.2^{cd}	77.3^{d}	76.7^{abcd}
Carcasss weight, kg	91.5^{a}	93.6^{ab}	95.4^{bc}	95.5^{bc}	95.6^{bc}	96.3^{bc}	97.1^{c}	96.9^{c}	96.5^{bc}
10th rib backfat (mm)‡	15.8^{abc}	16.6^{c}	15.4^{abc}	15.2^{ab}	15.1^{ab}	16.2^{bc}	15.7^{abc}	15.1^{ab}	14.4^{a}
Loin depth (mm)‡	68.0^{abc}	66.4^{ad}	67.0^{ab}	67.1^{abc}	67.8^{abc}	65.3^{d}	67.9^{abc}	68.7^{a}	68.4^{ad}
Lean (%)‡	56.6^{abc}	56.2^{ad}	56.6^{abc}	56.6^{abc}	56.8^{bc}	55.9^{d}	56.5^{a}	57.01^{c}	57.06^{c}

* A total of 45 pens (23 pigs/pen, five pens/treatment) of gilts were fed 5.0 or 10.0 ppm RAC for 7, 14, 21, or 28 days before slaughter. Controls were not treated with RAC. No RAC dose × treatment period interactions were observed ($P > .05$).

† Yield was calculated using live-carcass pen weights attained at the slaughter plant.

‡ Backfat, loin depth, and lean percentage were adjusted using carcass weight as a covariate.

a,b,c,d Means in the same row with no common superscript differ ($P < .05$; ANOVA).

increased with increasing RAC dose. The magnitude of increase in carcass yield in the current studies was low compared with those in some other reports.[16,21] However, those reporting carcass yield greater by 2.0% in treated pigs were feeding at or near 20 ppm RAC for treatment periods longer than 28 days.[16,21]

In the current studies, carcass lean percentage was derived from fat depth and loin depth measurements at the 10th rib. Feeding RAC did not result in consistently better back fat, loin depth, or lean percentage. Although numerically lower 10th rib back fat was observed as RAC dosage and treatment period increased, our findings did not demonstrate consistently lower back fat in treated pigs than in the control group. Numerous researchers have consistently illustrated the beneficial effects of feeding RAC on reducing back fat and increasing loin depth (or longissimus muscle area), primal lean yield, and overall carcass lean.[13,22] It has also been demonstrated that, in contrast to the temporal effects of feeding RAC on growth performance, the improvements in carcass lean increase with treatment period.[16,23] In addition, Watkins et al[9] and Crome et al[11] have demonstrated increasing longissimus muscle area as the dose of RAC increased from 0 to 20 ppm. Schinckel et al[24] demonstrated that only 20% to 50% of the true differences in fat-free lean mass between control pigs and pigs fed RAC were predicted from standard back-fat and loin-depth measurements taken at slaughter, thus suggesting that standard measures of carcass lean (back fat and loin depth) actually underestimate the true effect of RAC on carcass lean content. A consistent effect of RAC on carcass composition in the current studies was not found, which may be due to the combination of the relatively short RAC treatment period (0 to 28 days) and low dosages (0 to 10.0 ppm) evaluated.

Implications

- Feeding 5.0 to 10.0 ppm RAC for 14 to 28 days before slaughter can be an effective strategy to improve finishing ADG, G:F, and carcass yield in a commercial finishing environment.
- Improvements in carcass lean percentage, as calculated from back-fat and loin-depth measurements, may not be evident when RAC is fed for relatively short treatment periods (0 to 28 days) and at low dosages (0 to 10.0 ppm).
- These experiments suggest that most of the overall improvement in ADG and G:F is captured at the 5.0-ppm inclusion rate, and negligible improvements in overall growth performance, are observed by extending the RAC treatment period beyond 14 days before slaughter.

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Table 3 Continued

	Probability (P <)			
SEM	Trt	Dose	Linear	Quadratic
0.62	.99	.97	.87	.86
0.04	.03	.10	.17	.44
0.05	.11	.16	.09	.63
0.015	.09	.18	.36	.27
1.30	.06	.13	.24	.42
0.25	.07	.004	.37	.39
1.16	.04	.03	.36	.34
0.52	.25	.95	.005	.62
0.61	.001	.35	.16	.51
0.21	.002	.57	.001	.22

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