Effect of Constant or Step-Up Ractopamine HCl (Paylean) Feeding Programs on Growth Performance and Carcass Characteristics of Late-Finishing Pigs[1]

J. Y. Jacela[2], S. S. Dritz[2], M. D. Tokach, J. M. DeRouchey, R. D. Goodband, and J. L. Nelssen

Summary
A total of 1,099 pigs (PIC 337 × C22; initial BW = 208 lb) were used to evaluate the effect of ractopamine HCl (RAC) feeding programs on growth and carcass traits of late-finishing pigs. Pigs were randomly assigned to 1 of 3 treatments balanced by average BW within gender. There were 14 pens per treatment and 26 pigs per pen. Treatments were a basal diet with: (1) 0 g/ton RAC for 28 d (control), (2) 0 g/ton RAC from d 0 to 7 and 4.5 g/ton RAC from d 7 to 28 (constant), and (3) 4.5 g/ton from d 0 to 14 and 6.75 g/ton from d 14 to 28 (step-up). Pig ADG, ADFI, and F/G were determined weekly, and carcass data were collected at the end of experiment. From d 0 to 7, step-up pigs had improved ($P < 0.04$) ADG, ADFI, and F/G compared with pigs in all other treatments. From d 0 to 14, RAC-fed pigs, regardless of the feeding program, had greater ($P < 0.01$) ADG and better ($P < 0.01$) F/G than control pigs. From d 14 to 28, although pigs in both RAC-fed treatments had greater ($P < 0.01$) ADG than control pigs, the step-up pigs had lower ($P < 0.05$) ADG and ADFI than the constant-fed pigs. Regardless of the RAC feeding program, all RAC-fed pigs exhibited better ($P < 0.01$) F/G than control pigs. From d 7 to 28, pigs fed the constant and step-up treatments exhibited greater ($P < 0.01$) ADG and better ($P < 0.05$) F/G than control pigs. However, when pigs fed the RAC-fed treatments were compared, step-up pigs had lower ($P < 0.01$) ADG and ADFI but similar ($P > 0.27$) F/G. Overall (d 0 to 28), ADFI ($P = 0.15$) was similar between treatments, but RAC-fed pigs had greater ($P < 0.01$) ADG than control pigs, which led to improved ($P < 0.01$) F/G. Pigs fed either RAC feeding strategy had similar performance overall. RAC-fed pigs had heavier ($P < 0.05$) carcass weights and tended ($P < 0.10$) to have greater yield than control pigs. Among the 3 groups, step-up pigs had the greatest ($P < 0.05$) percentage lean, loin depth, and fat-free lean index as well as the lowest ($P < 0.01$) backfat depth. The pigs fed either RAC program had greater ($P < 0.05$) revenue than control pigs. Although feed cost was higher ($P < 0.01$) in the RAC-fed pigs than in the control, income over feed cost tended ($P < 0.07$) to be higher for RAC-fed pigs than for control pigs. In conclusion, feeding a constant level of 4.5 g/ton RAC for 21 d improved growth similarly to feeding the 28-d step-up program. However, the 28-d RAC step-up program resulted in additional improvement in carcass traits of late-finishing pigs.

Key words: growth, ractopamine HCl

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[2] Food Animal Health and Management Center, College of Veterinary Medicine, Kansas State University.

Introduction

Ractopamine HCl (RAC; Paylean; Elanco Animal Health, Greenfield, IN) is widely used in the swine industry to improve growth and carcass traits of finishing pigs. It is classified as a β-agonist and exerts beneficial effects on growth and carcass by diverting nutrients to favor lean rather than fat tissue growth. Ractopamine HCl is the only β-agonist approved by the U.S. Food and Drug Administration as a feed additive in pig diets. It is labeled to be added at levels of 4.5 to 9 g/ton and fed continuously for the last 45 to 90 lb of gain before market. Dietary inclusion has shown consistent improvement in pig growth performance and has led to its widespread use in the swine industry. When RAC is used at the recommended dosage, pigs fed RAC-supplemented diets have rapid improvement in growth performance. The maximum growth response to RAC occurs within the first 2 wk. However, the response progressively declines over the remaining days of the feeding period.[3,4,5] The observed decrease in growth response to RAC has been attributed to down-regulation or desensitization of β-receptors when RAC is fed at a constant level for longer periods.[6]

A step-up feeding program can be used to counteract the decline in growth improvement and optimize the use of RAC. Previous studies have shown that the growth performance benefit gained during the first 2 wk of RAC feeding can be extended by increasing the dosage of RAC added in the diet.[7,8] However, given the challenging economics and high diet costs associated with RAC use, it is necessary to determine if implementing a RAC step-up feeding program is economically feasible.

Therefore, we conducted a study to determine the effect on growth performance and economic impact of two different RAC-feeding programs.

Procedures

This study was approved by and conducted in accordance with the guidelines of the Kansas State University Institutional Animal Care and Use Committee. The experiment was conducted in a commercial research finishing barn in southwestern Minnesota. The barn was naturally ventilated and double curtain sided. Pens had completely slatted flooring and deep pits for manure storage. Each pen was equipped with a 5-hole, stainless steel, dry self-feeder and a cup waterer for ad libitum access to feed and water. The barn had an automated feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of delivering and measuring feed amounts added on an individual pen basis.

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[8] See, M. T., T. A. Armstrong, and W. C. Weldon. 2004. Effect of a ractopamine feeding program on growth performance and carcass composition in finishing pigs. J. Anim. Sci. 82(8):2474-2480.

A total of 1,099 pigs (PIC 337 × C22; initial BW = 208 lb) were randomly assigned to 1 of 3 treatments balanced by average BW within gender. There were 14 pens per treatment with 26 pigs per pen (8 barrow pens and 6 gilt pens). Treatments were a basal diet with: (1) 0 g/ton RAC for 28 d (control), (2) 0 g/ton RAC from d 0 to 7 and 4.5 g/ton RAC from d 7 to 28 (constant), and (3) 4.5 g/ton from d 0 to 14 and 6.75 g/ton from d 14 to 28 (step-up). Composition of diets used in each of the treatments is shown in Table 1. Pigs from each pen were weighed as a group and feed disappearance was determined weekly to determine ADG, ADFI, and F/G.

On d 14 of the experiment, the 3 heaviest pigs from each pen (determined visually) were sold in accordance with the normal marketing procedure of the farm. At the end of the experiment, pigs were individually tattooed according to pen number to allow for carcass data collection at the packing plant and data retrieval by pen. Pigs were transported to JBS Swift and Company (Worthington, MN) for processing and carcass data collection. Standard carcass criteria of loin and backfat depth, HCW, percentage lean, and yield were collected. Fat-free lean index was calculated using the equation: 50.767 + (0.035 × HCW) - (8.979 × backfat).

Statistical analysis was performed by analysis of variance using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC). Data were analyzed as a completely randomized design with pen as the experimental unit. The main effects of the different RAC feeding regimens and gender as well as their interactions were tested.

Results and Discussion

There were no treatment × gender interactions ($P > 0.15$) for any of the criteria evaluated. Although barrows and gilts had similar ($P > 0.92$) overall ADG, barrows had greater ($P < 0.01$) ADFI with poorer ($P < 0.01$) F/G than gilts. From d 0 to 7, step-up pigs (the only group fed RAC at this time) had improved ($P < 0.04$) ADG, ADFI, and F/G compared with pigs in all other treatments (Table 2). This shows that positive growth responses to RAC can be seen immediately during the first 7 d of feeding. Pigs fed the control and constant treatments had similar ADG and ADFI during the same period, which was expected because both groups were fed the same diet. However, the constant group exhibited better F/G than the control even though both groups were fed the same diets. It is not clear what contributed to the improved F/G in the constant-fed pigs during this period.

From d 0 to 14, RAC-fed pigs, regardless of the feeding program, had greater ($P < 0.01$) ADG and better ($P < 0.01$) F/G than control pigs. When pigs fed RAC treatments were compared, step-up pigs had better ($P < 0.05$) F/G than pigs fed the constant treatment. The greater improvement in F/G of the step-up pigs may be due to the pigs having been fed RAC-supplemented diets for 14 d compared to only 7 d for the constant-fed pigs. This is consistent with previous research indicating that the greatest improvement in performance occurs during the first 2 wk of feeding RAC-supplemented diets.[9] The improvements in F/G were 16% and 20% for the constant and step-up pigs, respectively, relative to pigs fed the control diet. During the second half of the experiment (d 14 to 28), although all RAC-fed pigs had greater ($P < 0.01$)

[9] Schinckel, A. P., B. T. Richert, and C. T. Herr. 2002. Variation in the response of multiple genetic populations of pigs to ractopamine. J. Anim. Sci. 80(E-Suppl_2):E85-E89.

ADG than the control pigs, step-up pigs had decreased ADG compared with pigs fed the constant treatment. This occurred because the step-up pigs had decreased ($P < 0.01$) ADFI compared with both control and constant-fed pigs but their F/G remained similar to that of pigs in the constant treatment. Regardless of the RAC feeding program, all RAC-fed pigs exhibited better ($P < 0.01$) F/G than control pigs. There was no difference ($P > 0.19$) in pig weight between treatments in any period of the experiment. However, it is worth noting that RAC-fed pigs numerically had the heaviest live weight (262.3 and 261.7 vs. 253.0 lb for constant and step-up vs. control pigs, respectively) at the end of the trial.

Because the constant-fed pigs were not fed RAC diets until d 7, we also evaluated the d 7 to 28 performance. During this period, pigs fed the constant and step-up treatments exhibited greater ($P < 0.01$) ADG and better ($P < 0.05$) F/G than control pigs. However, when RAC-fed treatments were compared, step-up pigs had decreased ($P < 0.01$) ADG and ADFI but similar ($P > 0.27$) F/G. Overall (d 0 to 28), ADFI ($P = 0.15$) was similar between treatments, but RAC-fed pigs had greater ($P < 0.01$) ADG than control pigs, which resulted in improved ($P < 0.01$) F/G. There were no differences in performance between the RAC-fed pigs. This indicates that the increased RAC dosage in the diets used in the step-up program did not result in additional improvement in growth performance.

In addition to improved growth performance, RAC is also known to improve carcass traits in pigs. In this study, both RAC feeding programs resulted in heavier ($P = 0.03$) carcass weight with no difference between RAC treatments (Table 3). Pigs fed the RAC treatments also tended ($P < 0.10$) to have greater carcass yield than control pigs. Interestingly, pigs fed the step-up feeding program had increased ($P < 0.01$) percentage lean, loin depth, and fat-free lean index as well as the lowest ($P < 0.01$) backfat compared with the control and constant-fed pigs. These results indicate that, although it will not result in additional improvement in growth performance, increasing the levels of RAC in the diets or feeding RAC for a longer duration will result in improvements in carcass quality. This has significant management implications because pigs tend to develop more fat than muscle at heavier weights. This observation suggests that a step-up program can be an effective tool in managing the carcass quality of pigs if they have to stay for an extended period during the finishing stage.

Pigs fed the control treatment numerically incurred the greatest weight discounts ($2.60 vs. $1.26 and $1.87/pig for control vs. constant-fed and step-up pigs, respectively; $P > 0.24$; Table 4). Both RAC-fed groups generated higher ($P < 0.03$) revenue than the control group. Feed consumption was similar ($P > 0.14$) between treatments, although pigs fed the step-up program numerically consumed the least feed (150.9 vs. 156.6 and 155.6 lb/pig for step-up vs. control and constant-fed pigs, respectively). Feed cost for both the constant and step-up programs was higher ($P < 0.01$) relative to the control diet. However, because of improved efficiency, income over feed cost tended ($P < 0.07$) to be higher in both the constant and step-up programs compared with the control treatment.

In conclusion, feeding diets supplemented with at least 4.5 g/ton RAC during the last 3 wk of the finishing stage will improve the growth performance of late-finishing pigs. Adding RAC in the diet at levels greater than 4.5 g/ton did not result in any additional improvement in growth. However, implementing a step-up RAC feeding program 4 wk before market improved carcass traits of late-finishing pigs. Thus, feeding RAC at a constant level of 4.5 g/ton continuously for 3 wk prior to market is ideal from a growth performance standpoint. However, if pigs cannot be marketed in a timely manner and must be kept in the finishing barn for additional days, increasing the level of RAC in the diets is recommended. There will be no additional benefit to growth performance, but carcass quality will be improved.

Table 1. Diet composition (as-fed basis)

Ingredient, %	0 g/ton RAC[1]	4.50 g/ton RAC	6.75 g/ton RAC
Corn	75.04	66.73	66.72
Soybean meal (46.5% CP)	11.19	19.36	19.36
Dried distillers grains with solubles	10.00	10.00	10.00
Choice white grease	2.00	2.00	2.00
Limestone	0.95	0.95	0.95
L-lysine-HCl	0.33	0.40	0.40
Salt	0.35	0.35	0.35
L-threonine	0.03	0.08	0.08
RAC, 9 g/lb	---	0.0250	0.0375
Vitamin and trace mineral premix	0.10	0.10	0.10
Phytase[2]	0.02	0.02	0.02
Total	100.00	100.00	100.00
Calculated analysis			
Standardized ileal digestible (SID) amino acids, %			
Lysine	0.70	0.95	0.95
Isoleucine:lysine	68	64	64
Leucine:lysine	187	158	158
Methionine:lysine	33	28	28
Met & Cys:lysine	67	57	57
Threonine:lysine	65	65	65
Tryptophan:lysine	17	17	17
Valine:lysine	83	75	75
Total lysine, %	0.81	1.08	1.08
ME, kcal/lb	1,568	1,567	1,566
SID lysine:ME ratio, g/Mcal	2.02	2.75	2.75
Ca, %	0.42	0.45	0.45
P, %	0.36	0.39	0.39
Available P, %	0.22	0.22	0.22

[1] Ractopamine HCl (Paylean; Elanco Animal Health, Greenfield, IN).
[2] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN) provided 363, 272, and 272 phytase units per pound of diet in diets with 0, 4.5, and 6.75 g/ton RAC, respectively.

Table 2. Effect of different feeding programs using diets containing ractopamine HCl (RAC) on growth performance of late-finishing pigs[1]

	Feeding program[2]			
Item	Control	Constant	Step-up	SEM
Weight, lb				
d 0	208.1	208.0	208.1	3.62
d 7	222.2	223.0	226.0	3.58
d 14 (before topping)	235.3	240.4	241.7	3.64
d 14 (top pigs)	265.7	270.9	272.0	2.89
d 14 (after topping)	231.3	236.3	237.8	3.83
d 21	242.9	251.2	251.5	3.74
d 28	253.0	262.3	261.7	3.99
d 0 to 7				
ADG, lb	2.00[a]	2.14[a]	2.50[b]	0.064
ADFI, lb	6.11[a]	6.04[a]	6.42[b]	0.104
F/G	3.06[a]	2.84[b]	2.60[c]	0.069
d 0 to 14				
ADG, lb	1.94[a]	2.31[b]	2.37[b]	0.036
ADFI, lb	6.13	6.13	6.02	0.091
F/G	3.17[a]	2.66[b]	2.55[c]	0.034
d 14 to 28				
ADG, lb	1.55[a]	1.85[b]	1.70[c]	0.045
ADFI, lb	5.72[a]	5.63[a]	5.38[b]	0.087
F/G	3.72[a]	3.05[b]	3.19[b]	0.065
d 7 to 28				
ADG, lb	1.66[a]	2.08[b]	1.89[c]	0.034
ADFI, lb	5.87[a]	5.85[a]	5.47[b]	0.085
F/G	3.54[a]	2.82[b]	2.90[b]	0.049
d 0 to 28				
ADG, lb	1.76[a]	2.09[b]	2.05[b]	0.034
ADFI, lb	5.94	5.90	5.72	0.081
F/G	3.39[a]	2.82[b]	2.79[b]	0.036

[1] A total of 1,099 pigs (PIC 337 × C22) were used with 26 pigs per pen and 14 pens per treatment.
[2] Control = 0 g/ton RAC for 28 d; Constant = 0 g/ton RAC on d 0 to 7 and 4.50 g/ton RAC on d 7 to 28; and Step-up = 4.50 g/ton RAC on d 0 to 14 and 6.75 g/ton RAC on d 14 to 28.
[abc] Within a row, means without a common superscript differ ($P < 0.05$).

Table 3. Effect of different feeding programs using diets containing ractopamine HCl (RAC) on carcass characteristics of late-finishing pigs[1]

	Feeding program[2]			
Item	Control	Constant	Step-up	SEM
Carcass weight, lb	191.7[a]	201.7[b]	199.3[b]	3.30
Yield, %	75.35	76.18	75.96	0.332
Lean, %[3]	55.21[a]	56.11[a]	57.04[b]	0.442
Loin[3], in.	2.38[a]	2.48[a]	2.56[b]	0.049
Backfat[3], in.	0.68[a]	0.66[a]	0.62[b]	0.023
Fat-free lean index[3]	50.02[a]	50.34[a]	50.84[b]	0.256

[1] A total of 1,099 (PIC 337 × C22; initial BW = 208 lb) pigs were used with 26 pigs per pen and 14 pens per treatment.

[2] Control = 0 g/ton RAC for 28 d; Constant = 0 g/ton RAC on d 0 to 7 and 4.50 g/ton RAC on d 7 to 28; and Step-up = 4.50 g/ton RAC on d 0 to 14 and 6.75 g/ton RAC on d 14 to 28.

[3] Values are adjusted to a common carcass weight.

[ab] Within a row, means without a common superscript differ ($P < 0.05$).

Table 4. Economic impact of different feeding programs using diets containing ractopamine HCl (RAC)[1]

	Feeding program[2]			
Item	Control	Constant	Step-up	SEM
Weight discount, $/pen	62.30	30.35	44.85	15.82
Weight discount, $/pig	2.60	1.26	1.87	0.66
Revenue, $/pen[3]	2,997[a]	3,264[b]	3,220[b]	87.3
Revenue, $/pig[3]	115.3[a]	125.6[b]	123.8[b]	3.36
Feed consumed, lb/pen	4,071	4,046	3,924	55.4
Feed consumed, lb/pig	156.6	155.6	150.9	2.13
Feed cost, $/pen[4]	366.4[a]	418.7[b]	393.0[c]	5.45
Feed cost, $/pig[4]	14.09[a]	16.10[b]	15.12[c]	0.21
Income over feed cost, $/pen	2,631	2,835	2,824	85.5
Income over feed cost, $/pig	101.18	109.03	108.61	3.287

[1] A total of 1,099 pigs (PIC 337 × C22; initial BW = 208 lb) were used with 26 pigs per pen and 14 pens per treatment.

[2] Control = 0 g/ton RAC for 28 d; Constant = 0 g/ton RAC on d 0 to 7 and 4.50 g/ton RAC on d 7 to 28; and Step-up = 4.50 g/ton RAC on d 0 to 14 and 6.75 g/ton RAC on d 14 to 28.

[3] Calculated based on $60.99/cwt carcass value.

[4] Calculated based on the following values: $180/ton for diets containing 0 g/ton RAC; $217/ton for diets containing 4.5 g/ton RAC; and $226/ton for diets containing 6.75 g/ton RAC.

[abc] Within a row, means without a common superscript differ ($P < 0.05$).