

Effects of ractopamine HCl on growth performance and within-pen weight variation in finishing pigs

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Summary

Objective: To determine if ractopamine HCl added to finishing pig diets during the final 21 days to market affects within-pen variation and growth performance.

Methods: A total of 336 pigs (12 pigs per pen, 14 pens per treatment) were weighed and assigned to treatment groups (diets with or without ractopamine) in a randomized complete block design so that, within gender, mean weight and degree of weight variation were the same in each pen. Diets were based on sorghum and soybean meal and formulated to contain 1.00% total

lysine, with or without 10 mg per kg of ractopamine HCl. Pigs were weighed and feed intake was measured every 7 days during the 21-day experiment to determine average daily gain (ADG), average daily feed intake (ADFI), feed efficiency (G:F), and pen coefficient of weight variation (CV).

Results: In pigs fed ractopamine HCl, compared to control pigs, ADG was greater, G:F was better, and final weight was greater at the end of the 21-day trial, but ADFI and CV did not differ between dietary treatments.

Implications: These findings suggest that, under the conditions of this study, ractopamine supplementation results in better growth performance and feed efficiency. The greater gain associated with ractopamine supplementation affects all pigs proportionally, with no impact on final weight variation within a pen.

Keywords: swine, finishing pigs, growth, ractopamine, coefficient of weight variation

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Resumen - Efectos del HCl de ractopamina en el desempeño del crecimiento y la variación del peso dentro de corral en cerdos de finalización

Objetivo: Determinar si agregar HCl de ractopamina a la dieta de cerdos en finalización durante los últimos 21 días antes de la venta afecta el desempeño del crecimiento y la variación dentro del corral.

Métodos: Un total de 336 cerdos (12 cerdos por corral, 14 corrales por tratamiento) se pesaron y se asignaron a grupos de tratamiento (dietas con o sin ractopamina) en un diseño al azar de bloque completo de manera que, el sexo, peso promedio y grado de variación de peso fueran los mismos dentro de cada corral. Las dietas se basaron en sorgo y harina de soya y fueron formuladas para contener 1.00% total de lisina, con ó sin 10 mg por kg de HCl de ractopamina. Se pesaron los cerdos y se midió el consumo de alimento cada 7 días durante los 21 días del experimento, para determinar la ganancia

diaria promedio (ADG por sus siglas en inglés), el consumo diario promedio de alimento (ADFI por sus siglas en inglés), la eficiencia alimenticia (G:F por sus siglas en inglés) y el coeficiente de variación de peso por corral (CV por sus siglas en inglés).

Resultados: En los cerdos alimentados con HCl de ractopamina, comparados con los cerdos control, la ADG fue mayor, la G:F fue mejor, y el peso final fue mayor al final de los 21 días de prueba, pero el ADFI y el CV no difirieron entre los tratamientos dietéticos.

Implicaciones: Estos hallazgos sugieren que, bajo las condiciones de este estudio, el suplemento con ractopamina resulta en un mejor desempeño del crecimiento y eficiencia alimenticia. La mayor ganancia asociada con el suplemento de ractopamina afecta a todos los cerdos de manera proporcional, sin tener un impacto en la variación final del peso dentro de un mismo corral.

Résumé - Effets du HCl de ractopamine sur la performance de la croissance et la variation du poids en les parcs de cochons de finition

Objectif : Déterminer si le HCl de ractopamine qui a été ajouté à la moulée du cochon de finition pendant les 21 jours avant la vente affecte la variation en les parcs et la croissance.

Méthodes: Un total de 336 cochons (12 cochons par parc, 14 parcs par traitement) a été pesé et assigné aux groupes du traitement (moulée avec ou sans ractopamine) dans un dessin randomisé du bloc complet afin que le genre, poids moyen et degré de variation du poids étaient les mêmes dans chaque parcs. La moulée ont été basées sur sorgho et farine de soja et ont été formulées pour contenir 1.00% de lysine totaux, avec ou sans 10 mg par kg de HCl de ractopamine. Les cochons ont été pesés et la ration a été mesurée chaque 7 jours pendant les 21 jours de l'expérience pour déterminer le gain journalier moyen (ADG par ses sigles en anglais), la consommation de aliment journalier moyenne (ADFI para ses sigles en anglais), l'efficacité de l'alimentation (G:F par ses sigles en anglais), et le coefficient de la variation du poids (CV para ses sigles en anglais) entre le parc.

Résultats: Dans les cochons qui ont été nourris avec le HCl de ractopamine, comparé a les cochons contrôle, le ADG a

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été plus grand, le G:F a été meilleur, et le poids final a été plus grand à la fin du 21 jours, mais le ADFI et le CV n'ont pas différés entre les traitements.

Implications: Ces résultats suggèrent que, sous les conditions de cette étude, la supplémentation du ractopamine résulte en une meilleure performance de la croissance et l'efficacité alimentaire. Le plus grande augmentation associée avec la supplémentation du ractopamine affecte tous les cochons proportionnellement, sans impact sur la variation du poids en un parc.

Swine producers are continually looking for methods to reduce the number of lightweight pigs at marketing. Lightweight pigs in all-in, all-out (AIAO) facilities either incur packer penalties or increase cost of production by necessitating use of the facility to provide more time for the lightweight pigs to gain weight.¹ Reducing body weight variation would result in fewer lightweight pigs at market. Sorting pigs into uniform body-weight groups is thought to reduce the number of lightweight pigs at marketing by reducing body weight variation. However, sorting pigs into pens of similar size had no effect on final variation of individual body weights, and not sorting by weight may actually increase overall pork produced and reduce turnaround time within the barn.² Ractopamine HCl (Paylean; Elanco, Indianapolis, Indiana), a β -adrenergic agonist, is an effective growth promotant in swine. Ractopamine HCl supplementation increases average daily gain, improves feed conversion, and increases dressing percentage.³⁻⁵ Additionally, field observations suggested that body weight variation was reduced when pigs were fed ractopamine. Therefore, our objective was to determine if ractopamine HCl supplementation during the final 21 days before market would affect within-pen weight variation and growth performance of finishing pigs.

Materials and methods

Animals and housing

Experimental procedures were approved by the Kansas State University Institutional Animal Care and Use Committee. The experiment was divided into two trials conducted in May and July of 2002 at the Kansas State University Swine Teaching and Research Center. A total of 336

finishing pigs (PIC L327 \times 1050 genetics; 168 barrows and 168 gilts), initially weighing 110.5 kg \pm 2.2 kg, were housed 12 per pen in 28 pens, allowing 0.74 m² space per pig. Pigs were free of clinical signs of enteric or respiratory disease for the 2 weeks prior to the trials.

Pigs were housed in a modified open-front finishing barn with partially-slatted pens (1.8 m \times 4.9 m; 50% slatted), operated AIAO by group. Each pen contained a single nipple waterer and a two-hole self-feeder to allow ad libitum access to water and feed. Diets were based on sorghum and soybean meal and formulated to contain 1.00% total lysine, with or without 10 mg per kg of ractopamine HCl (Table 1).

Experimental Design

Pens were randomly assigned to one of two treatments (Control or Ractopamine) in a randomized complete block design with trial and gender as blocking factors. Each treatment consisted of 14 replicates (pens), with seven replicates per gender (four in Trial 1 and three in Trial 2). Individual pigs within gender and trial were then randomly assigned to pens so that mean weight and coefficient of body weight variation did not differ across treatment.

Response criteria

At 7-day intervals during the 21-day experiment, pigs were weighed individually and feed intake was measured for determination of average daily gain (ADG), average daily feed intake (ADFI), feed efficiency (gain-to-feed ratio: G:F), and pen coefficient of weight variation (CV). The CV was determined by dividing the standard deviation of pig weights in the pen by the mean weight of the pigs in that pen.

Statistical analysis

Treatment differences were evaluated using an analysis of variance mixed model for a randomized complete block design with the fixed effect of treatment and random effects of gender and trial.⁶ Pen was the experimental unit for the analysis of variance. Data were analyzed using the Proc Mixed procedure of SAS version 8.1 (SAS Institute, Cary, North Carolina).

A secondary analysis was performed using pig as the experimental unit. For this analysis, a frequency distribution histogram of individual pig weights by either Control or Ractopamine treatment was first developed, then the association between initial pig weight and subsequent ADG over the 21-day experiment was examined using the

Table 1: Composition of diet (as-fed) for 336 finishing pigs in a 21-day trial*

Ingredient	% of diet
Sorghum	74.03
Soybean meal (46.5% crude protein)	23.82
Monocalcium phosphate (21% phosphorus)	0.55
Calcium carbonate	0.90
Sodium chloride	0.35
Vitamin premix†	0.10
Trace mineral premix‡	0.10
Lysine HCl	0.15
Total	100.00
Calculated analysis	
Metabolizable energy (Mcal/kg)	3.28
Lysine (%)	1.00
Calcium (%)	0.55
Phosphorus (%)	0.49

* Equal numbers of pigs were fed the base diet with or without ractopamine (Paylean; Elanco, Indianapolis, Indiana) added at 0.05% (providing 10 mg/kg ractopamine HCl).

† Provided per kg of complete diet: vitamin A, 4409 IU; vitamin D₃, 661 IU; vitamin E, 18 IU; vitamin K, 1.8 mg; vitamin B₁₂, 0.02 mg; riboflavin, 3.3 mg; pantothenic acid, 11 mg; and niacin, 20 mg.

‡ Provided per kg of complete diet: manganese, 27 mg; iron, 110 mg; zinc, 110 mg; copper, 11 mg; iodine, 0.2 mg; and selenium, 0.2 mg.

Proc Mixed procedure of SAS to develop two regression models. The first model contained the fixed effects of treatment, initial weight as a covariate, the treatment-by-initial-weight interaction term, and the random effects of gender and trial. The second model was the same without the interaction term.

Results

Pigs were free of clinical signs of enteric or respiratory disease during the trials. The Ractopamine pigs had greater ADG ($P < .01$) and better feed efficiency than the Control pigs; however, ADFI was not affected by dietary treatment (Table 2). As a result of the greater ADG, final weight was heavier for the Ractopamine pigs. Pen CV decreased between the start and the finish of the 21-day trial for both the Control and Ractopamine pigs, and neither starting nor final CV differed between dietary treatments ($P > .05$). Average pen CV for Control pigs was 3.5%; thus, 68% of these pigs weighed between 112.3 and 120.5 kg, a range of 8.2 kg. Average pen CV for Ractopamine pigs was 3.7%; thus 68% of these pigs weighed between 115.5 and 124.3 kg, a range of 8.9 kg.

The secondary analysis of the frequency distribution of final weights showed that the distribution was shifted to the right for the Ractopamine pigs (Figure 1). In the first regression model, the initial weight-by-interaction term was not significant ($P = .81$). In the second regression model, there was no evidence of an effect of initial weight on ADG, ie, the slope of the relationship did not differ from zero ($P = .27$). However, the intercepts of the relationship were different ($P < .01$) because AGD was higher for the Ractopamine pigs compared to the Control pigs (Figure 2).

Discussion

Ractopamine HCl, a phenethanolamine, alters the manner in which nutrients are directed toward fat deposition and muscle accretion. Adipose tissue is reduced through a decrease in lipogenesis, and protein accretion is increased.⁷ The 16% higher ADG in the Ractopamine pigs in this study is consistent with results of recent research.^{4,8,9} Studies on ractopamine supplementation of finishing diets have shown either no effect on feed intake or a decrease in feed intake,^{3,5,10} in agreement with the present study, and the 16% higher G:F in the Ractopamine pigs in this study

is also in agreement with previous results.^{3,11}

The lack of a significant interaction term in the regression analysis of initial weight and subsequent ADG suggests that there is no evidence that the relationship between initial weight and subsequent ADG was different in Control and Ractopamine pigs.

Thus, on the basis of the results of this experiment, we believe that the reduction in number of lightweight pigs that is associated with ractopamine HCl supplementation, from our field observations, is a result of a shift to the right of the weights of the whole population of pigs. If the smaller

Table 2: Growth performance and weight variation in 336 finishing pigs fed either a diet containing ractopamine or a control diet for 21 days*

Production variable	Control	Ractopamine	SEM	P†
Initial weight (kg)	100.3	100.8	2.25	.62
Initial weight CV (%)	4.2	3.9	0.27	.52
ADG (kg/day)	0.80	0.94	0.07	.01
ADFI (kg/day)	2.76	2.77	0.17	.96
G:F	0.31	0.36	0.01	.01
Final weight (kg)	116.4	119.9	2.35	.02
Final weight CV (%)	3.5	3.7	0.19	.42

* Equal numbers of pigs were fed the control sorghum-soybean diet or the same diet containing ractopamine (10 mg/kg). At 7-day intervals during the trial, feed intake was measured and all pigs were weighed individually. Two trials were conducted, with four replicates per gender in Trial 1 and three in Trial 2. Values represent the least squares means for 14 pens (replicates) per treatment, with seven pens of barrows, seven pens of gilts, and 12 pigs per pen. Average daily gain (ADG) was calculated as pen weight gain ÷ total pig days; average daily feed intake (ADFI) was calculated as pen feed intake ÷ total pig days; feed efficiency (G:F) was calculated as individual pen ADG ÷ individual pen ADFI; and pen coefficient of weight variation (CV) was calculated as within-pen weight standard deviation ÷ pen mean average pig weight.

† A mixed model analysis of variance was used to determine statistical significance, with treatment a fixed effect and gender and trial as random effects.

Figure 1: Frequency distribution of final weights for treatment groups of pigs fed the same diet either with 10 mg/kg ractopamine HCl (Ractopamine) or without ractopamine (Control). A total of 336 pigs (96 barrows and 96 gilts in Trial 1 and 72 barrows and 72 gilts in Trial 2) were fed for 21 days prior to obtaining the final weight.

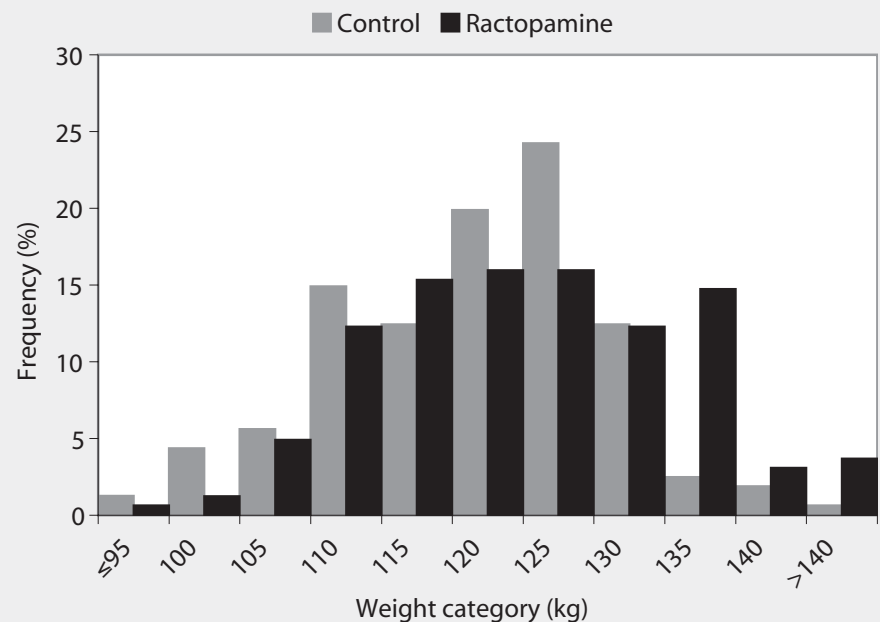
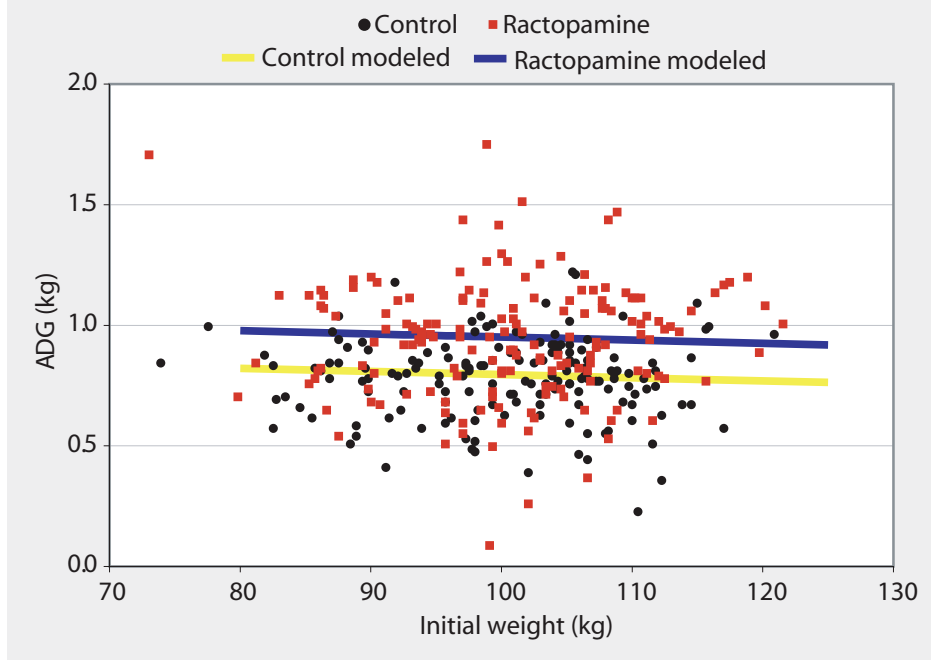


Figure 2: Regression analysis of initial weight and subsequent average daily gain (ADG) for pigs fed the same diet either with 10 mg/kg ractopamine HCl (Ractopamine) or without ractopamine (Control). A total of 336 pigs (96 barrows and 96 gilts in Trial 1 and 72 barrows and 72 gilts in Trial 2) were fed for 21 days. The regression model contained the fixed effects of treatment, initial weight as a covariate, and the random effects of gender and trial. There was no evidence for a relationship between initial weight and ADG, ie, there was no evidence ($P = .27$) that the slope of the relationship was different from zero. The regression equations were $ADG \text{ (kg)} = -0.00131 \times \text{initial weight (kg)} + 0.9264$ (Control pigs) and $ADG \text{ (kg)} = -0.00131 \times \text{initial weight (kg)} + 1.0824$ (Ractopamine pigs).



number of lightweight pigs had been due to a smaller weight variation, we would have expected to observe a significantly lower within-pen CV in the Ractopamine pigs. Further support is provided by the lack of interaction between treatment and initial weight and lack of influence of initial weight on subsequent ADG. In order for a smaller CV to be responsible for the smaller number of lightweight pigs, we would expect lightweight Ractopamine pigs to have had a higher ADG than lightweight Control pigs. The lack of association or interaction indicates that this is not the case.

Implications

- Under the conditions of this study, ractopamine HCl supplementation for 21 days before marketing finisher pigs results in better gain and feed efficiency.
- The greater gain associated with ractopamine supplementation affects all pigs proportionally, with no impact on final weight variation within a pen.

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