

Ractopamine Hydrochloride and the Environmental Sustainability of Pork Production

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experiment was conducted to measure the effect of 5 or 10 mg/kg ractopamine (RAC) from Paylean on nitrogen (N) and water balance in finishing swine. Paylean improved average daily gain (ADG), N retention in the carcass and feed efficiency and decreased water intake and urine output. Because of the improvement in N and water utilization in finishing pigs, we concluded that Paylean can reduce the environmental impact of pork production.

INTRODUCTION

The excretion of nitrogen (N) in the manure of swine is problematic because it is in the form of NH₃ which has odour and other environmental implications. Ractopamine hydrochloride (RAC), or Paylean (Elanco Animal Health, Guelph, ON) is a β-adrenergic agonist which, when added to the diet of finishing swine, improves ADG, feed efficiency, and carcass lean growth. These growth performance and carcass improvements are well noted in the literature but there is limited research on other potential benefits of Paylean.

A small number of studies have looked at RAC's impact on reducing nutrient excretion; however inclusion levels of 18 to 20 mg/kg were used. Currently, the Canadian Food Inspection Agency approves RAC at inclusion levels of 5 and 10 mg/kg, thus, these were the levels used in the following study.

The overall objective of this experiment was to define the impact of RAC on the efficiency of pork production with a view to reducing the environmental impact of pork production. Specifically we wanted to determine the effect of RAC on the efficiency of N utilization, and to evaluate the effect of RAC on the efficiency of animal performance, including carcass quality and water and feed requirements for growth.

MATERIALS AND METHODS

The experiment utilized 54 barrows assigned to one of 9 treatments when they reached 95 ± 3 kg bodyweight. Treatments were 3 levels of RAC (0, 5 or 10 mg/kg) × 3 lysine:DE ratios (1.75, 2.25 or 2.75 g ileal digestible lysine:kcal DE). Barrows were on test for 15 days and maintained in pens which allowed the collection of faeces and urine. Collection of urine and faeces occurred on days 6 to 8 and 13 to 15 of the experiment allowing us to determine if the response to RAC changed over time. Diets were based on wheat, barley, and soybean meal and also contained

SUMMARY

PSCI and others have shown improvements in lean growth and feed efficiency when ractopamine (Paylean®) was fed to finishing pigs. The objective of the following experiment was to determine if the improvements in nutrient utilization with Paylean can lead to a demonstrable reduction in the environmental footprint of pork production. A metabolism

experiment was conducted to measure the effect of 5 or 10 mg/kg ractopamine (RAC) from Paylean on nitrogen (N) and water balance in finishing swine. Paylean improved average daily gain (ADG), N retention in the carcass and feed efficiency and decreased water intake and urine output. Because of the improvement in N and water utilization in finishing pigs, we concluded that Paylean can reduce the environmental impact of pork production.

Table 1. The effect of (RAC) and lysine on final body weight, growth rate, feed intake, feed efficiency and water intake in finishing barrows¹

| Item | Body Weight, kg | | ADG | ADFI | G:F |
|-------------------|-----------------|-------|-------------------|---------------------|----------------------|
| | Initial | Final | kg/d ² | kg/d ^{2,3} | kg/kg ^{2,3} |
| RAC (ppm) | g/d | | ml/d | | |
| 0 | 93.8 | 110.2 | 1.1 | 3.2 | 0.34 |
| 5 | 93.8 | 112.9 | 1.3 | 3.2 | 0.39 |
| 10 | 94.1 | 112.7 | 1.3 | 3.0 | 0.41 |
| SEM | 0.65 | 0.54 | 0.04 | 0.06 | 0.01 |
| Lysine (g/Mcal) | | | | | |
| 1.75 | 93.5 | 110.9 | 1.1 | 3.3 | 0.35 |
| 2.25 | 94.2 | 112.9 | 1.3 | 3.1 | 0.40 |
| 2.75 | 94.0 | 112.0 | 1.2 | 3.0 | 0.40 |
| SEM | 0.65 | 0.54 | 0.04 | 0.06 | 0.01 |
| Statistics | P-value | | | | |
| RAC | - ⁴ | 0.002 | 0.002 | 0.051 | <0.001 |
| Lysine | - | 0.039 | 0.039 | 0.027 | <0.001 |
| Paylean x Lysine | - | 0.654 | 0.650 | 0.918 | 0.579 |

¹Data expressed as least square means. Data analyzed with initial body weight as a covariate

²Calculated based on 15 d experimental period.

³As-fed basis.

⁴(-) indicates no statistics were calculated on that parameter

canola oil, vitamin/mineral premix, and synthetic amino acids. All diets were formulated to contain 3,300 kcal DE/kg and formulated to meet or exceed the nutrient requirements of the finisher pig.

"It is proven that Paylean can reduce the environmental impact of pork production because of the improvement in nitrogen and water utilization"

RESULTS AND DISCUSSION

Final BW, ADG, ADFI and G:F (P<0.05) increased as RAC concentration in the diet increased. Final BW, ADG (P<0.05), and G:F increased (P<0.001) and ADFI decreased (P<0.001) with increasing Lysine (lys) levels (Table 1). Pigs fed no RAC averaged 19 days (d) to reach market and RAC fed pigs required 17 d.

Table 2 describes water balance and fecal output. A decrease in water intake and excretion (urine output and fecal moisture) (P<0.05) was observed with increased RAC. Apparent water retention tended to decrease with RAC inclusion (P=0.10). Fecal output (dry basis) was greatest for the 5 mg/kg RAC-fed pigs when compared to the 0 and 10 mg/kg treatments (P<0.05). Greater Lys concentrations tended to decrease fecal output (P<0.10) but Lys had no effect on water intake, excretion, and apparent water retention (P>0.10).

Nitrogen intake, N digestibility, urinary N excretion, fecal N excretion, and total N excretion decreased and N retention increased ($P < 0.05$) with increased RAC (Table 3). Nitrogen intake, N digestibility, urinary N excretion, total N excretion, and N retention increased with greater dietary Lys concentration (Table 3, $P < 0.05$) but fecal N excretion was unaffected ($P > 0.10$; Table 3).

Calculations based on the present data were applied to a commercial situation to define the potential impact of RAC on the environment. The values obtained in the metabolism study were utilized to calculate nutrient balance in a 1,000 head finishing barn (Table 4). In these calculations, we assumed that pigs started on treatment diets at 95-kg and finished at 120-kg.

Our calculations indicated that 10 mg/kg Paylean supplemented at 95-kg and fed for 17 days would reduce feed intake and water consumption by 7.5 kg and 33.1 liters per pig, respectively. Water and faecal excretion would be reduced by 18.6 liters and 0.9 kg per pig, respectively. N intake was reduced by 0.2 kg per pig, and N excretion declined by 0.2 kg per pig. When comparing the 5 mg/kg Paylean level to the 10 mg/kg level, the 10 mg/kg Paylean-fed pigs had the most substantial reduction in intake and excretion of both water and nitrogen. Utilizing the results obtained in this experiment and applying them to a commercial situation demonstrates that Paylean can have a significant impact on reducing the environmental footprint from pork production. Therefore, feeding either 5 or 10 mg/kg RAC can improve environmental sustainability of market hogs by reducing feed requirements, decreasing water consumption and excretion, and improve utilization of dietary N.

IMPLICATIONS

RAC feeding has the potential to reduce the environmental footprint associated with marketing hogs. Results from these experiments indicate that supplementing either 5 or 10 mg/kg RAC in finishing swine diets can improve N utilization. A decrease in urinary N excretion from 35.1% to 29.8% and improvement in N retention from 49.3 to 54.0% in control and 10 mg/kg RAC-fed pigs, respectively, can reduce excess N being released in soil and water when manure is spread on land. RAC also improved protein deposition rates to 189.2 g/d in the 10 mg/kg RAC-fed pigs, whereas lipid deposition rates decreased to 542.3 g/d. Supplementing RAC produced a leaner carcass with improved nutrient utilization. As well, RAC-feeding reduced water intake by 1 l/d and water excretion was reduced by 0.7 l/d with 10 mg/kg RAC-feeding, which can decrease water consumption requirements for finishing hogs.

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Table 2. The effect of RAC and lysine on feed and water intake, faecal and urine output, water excretion and retention in finishing barrows¹

| Item | ADFI (dry basis), kg/d | Water Intake, l/d ² | Faecal Output (dry basis), kg/d | Urine Output, l/d | Water Excretion, l/d ³ | Apparent Water Retention, l/d ⁴ |
|----------------------|------------------------|--------------------------------|---------------------------------|-------------------|-----------------------------------|--------------------------------------------|
| RAC (ppm) | | | | | | |
| 0 | 2.8 | 8.3 | 0.4 | 3.5 | 3.9 | 4.4 |
| 5 | 2.9 | 7.9 | 0.5 | 3.2 | 3.6 | 4.4 |
| 10 | 2.7 | 7.3 | 0.4 | 2.9 | 3.2 | 4.1 |
| SEM | 0.05 | 0.25 | 0.01 | 0.18 | 0.18 | 0.12 |
| Lysine (g/Mcal) | | | | | | |
| 1.75 | 2.9 | 7.9 | 0.5 | 3.2 | 3.6 | 4.4 |
| 2.25 | 2.8 | 7.5 | 0.5 | 3.0 | 3.3 | 4.2 |
| 2.75 | 2.7 | 8.1 | 0.4 | 3.4 | 3.7 | 4.4 |
| SEM ³ | 0.05 | 0.25 | 0.01 | 0.18 | 0.18 | 0.12 |
| Sample Period (days) | | | | | | |
| d 6-8 | 2.7 | 7.7 | 0.4 | 3.0 | 3.4 | 4.3 |
| d 13-15 | 2.9 | 8.0 | 0.5 | 3.3 | 3.7 | 4.3 |
| SEM | 0.04 | 0.15 | 0.01 | 0.12 | 0.12 | 0.09 |
| Statistics | | | | | | |
| RAC | 0.057 | 0.017 | 0.018 | 0.031 | 0.033 | 0.102 |
| Lysine | 0.053 | 0.186 | <0.001 | 0.221 | 0.276 | 0.337 |
| RAC x Lysine | 0.846 | 0.994 | 0.060 | 0.840 | 0.769 | 0.125 |
| Sample Period | <0.001 | 0.051 | 0.025 | 0.022 | 0.014 | 0.828 |

¹Data expressed as least square means. Data analyzed as repeated measures with sampling periods and the Toeplitz model used for the covariance structure.

²Includes water consumption and diet moisture.

³Sum of faecal water output and urine output.

⁴Calculated as the difference between water intake and urine and faecal excretion. Other moisture losses (ie. respiration) were not accounted for.



Weighing feed

Table 3. The effect of RAC and lysine concentration on nitrogen balance in finishing barrows

| Item | N Intake g/d | N Digestibility, % | Urinary N Excretion, g/d | Faecal N Excretion g/d | Total N Excretion, g/d | N Retention g/d |
|----------------------|-----------------|-----------------------|--------------------------------|------------------------------|------------------------------|--------------------|
| RAC (ppm) | | | | | | |
| 0 | 80.5 | 84.4 | 28.5 | 12.6 | 41.1 | 39.4 |
| 5 | 84.1 | 83.2 | 25.5 | 14.1 | 39.6 | 44.5 |
| 10 | 77.0 | 83.8 | 23.3 | 12.6 | 35.9 | 41.1 |
| SEM | 1.43 | 0.26 | 0.95 | 0.37 | 1.12 | 1.03 |
| Lysine (g/Mcal) | | | | | | |
| 1.75 | 76.0 | 83.0 | 24.6 | 13.0 | 37.6 | 38.4 |
| 2.25 | 80.4 | 83.7 | 24.1 | 13.2 | 37.3 | 43.0 |
| 2.75 | 1.44 | 0.26 | 0.96 | 0.37 | 1.13 | 1.07 |
| SEM ³ | 1.44 | 0.26 | 0.96 | 0.37 | 1.13 | 1.07 |
| Sample Period (days) | | | | | | |
| d 6-8 | 77.1 | 83.7 | 24.1 | 12.7 | 36.8 | 40.3 |
| d 13-15 | 89.0 | 83.9 | 27.4 | 13.5 | 41.0 | 43.0 |
| SEM | 1.10 | 0.20 | 0.74 | 0.27 | 0.84 | 0.79 |
| Statistics | | | | | | |
| | P-value | | | | | |
| RAC | 0.003 | 0.008 | 0.001 | 0.003 | 0.004 | 0.003 |
| Lysine | <0.001 | <0.001 | 0.002 | 0.907 | 0.010 | 0.001 |
| RAC x Lysine | 0.441 | 0.001 | 0.137 | 0.080 | 0.072 | 0.002 |
| Sample Period | <0.001 | 0.412 | 0.002 | 0.021 | 0.001 | 0.015 |

Table 4. Calculated water and nutrient balance for the finishing period (95-120 kg BW)¹

| Item | RAC (mg/kg) | | |
|--------------------------------------|----------------|----------------|-----------------|
| | 0 ² | 5 ² | 10 ² |
| Feed Intake (as-fed), kg | 60.8 | 54.4 | 51.0 |
| N Intake, kg | 1.5 | 1.4 | 1.3 |
| Water Intake, liters | 157.5 | 134.8 | 124.4 |
| Water Excretion, liters ³ | 73.2 | 60.4 | 54.6 |
| Urine Output, liters | 66.9 | 54.1 | 48.8 |
| Faecal Output (dry basis), kg | 8.4 | 8.3 | 7.5 |
| N excreted, kg | 0.8 | 0.7 | 0.6 |
| N retained, kg | 0.8 | 0.8 | 0.7 |

¹ Except days to market, which were obtained from the growth experiment, calculations were based on results obtained in the metabolism experiment.

² Pigs fed ractopamine were considered to reach market weight (120-kg) in 17 days from 95-kg and pigs fed no ractopamine were considered to reach market weight in 19 days from 95-kg

³ Water excretion is the sum of urine output and fecal moisture