Ractopamine hydrochloride and the environmental sustainability of pork production

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Summary

We (Patience et al. 2006) 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 N and water balance in finishing swine. Paylean improved 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 NH_3 which has odour and other environmental implications. Ractopamine hydrochloride (RAC), or Paylean (Elanco Animal Health, Guelph, ON) is a ß-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) x 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 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 (NRC, 1998).

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

Table 1. The effects of RAC and lysine on final body weight, growth rate, feed intake, feed efficiency and water intake in finishing barrows[1]

	Body Weight, kg		ADG,	ADFI,	G:F
Item	Initial	Final	kg/d[2]	kg/d[2,3]	kg/kg[2,3]
RAC (ppm)					
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
RAC x Lysine	-	0.654	0.650	0.918	0.579

[1] Data expressed as least square means. Data analyzed with initial body weight as a covariate
[2] Calculated based on 15 d experimental period.
[3] As-fed basis.
[4] (–) indicates no statistics were calculated on that parameter

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increased (P < 0.001) and ADFI decreased (P < 0.001) with increasing Lys levels (Table 1). Pigs fed no RAC averaged 19 d to reach market and RAC fed pigs required 17 d.

Table 2 describes water balance and fecal ouput. 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.

Table 2. The effect of RAC and lysine on feed and water intake, faecal and urine output, water excretion and retention in finishing barrows[1]

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	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			P values			
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

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

[2] Includes water consumption and diet moisture.

[3] Sum of faecal water output and urine output.

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

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.

The Bottom Line

RAC feeding has the potential to improve 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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(continued from page 9 Ractopamine ...)

Table.3 The effect of RAC and lysine concentration on nitrogen balance in finishing barrows[1]

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	85.2	84.8	28.6	13.1	41.7	43.6
SEM	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 values			
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

[1] Data expressed as least square means. Data analyzed as repeated measures.

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

	RAC (mg/kg)		
Item	02	52	102
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, liters3	73.2	60.4	54.6
Urine Output, liters	66.9	54.1	48.8
Fecal 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*

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The plant extract Micro-Aid, has unexpected effects on litter size.

Micro-Aid® (DPI Global) is an all-natural product, produced from a plant extract which has been marketed primarily as an aid to reduce the emission of ammonia and odours from livestock production facilities. However, due to reports that colostrum from sows fed Micro-Aid® had increased levels of immunoglobulins a study was conducted at PSCI to determine the impact of Micro-Aid, on weight gain in piglets.

A total of 196 parity 2 to 7 sows were randomly assigned to one of 3 treatments; 1) Control, no Micro-Aid; or Micro-Aid, included in the gestation diet at 125 ppm for either 2) 5 or 3) 30 days pre-farrowing. In this study the inclusion of Micro-Aid had no effect on colostrum IgG levels or on serum IgG measured at birth in the piglets. Micro-Aid in the sow's diet for 30 days pre-farrowing resulted in one additional piglet born alive per litter (P < 0.01 Chi-square analysis). The increase in litter size appears to be primarily due to a decrease in stillborns rather than through increased IgG delivered to the pigs prenatally.

There was no effect of Micro-Aid, on colostrum IgG levels or on serum IgG measured at birth in the piglets. Moreover, there was no beneficial effect of Micro-Aid inclusion on piglet growth from birth until weaning (day 19).

One additional piglet per litter or more than two additional piglets per sow per year is a significant improvement in the reproductive efficiency of sows and the mechanism responsible for this warrants further research.

Funding for this study from DPI Global is appreciated.

Table 1. The effect of Micro-Aid in the diet on either 5 or 30 days prefarrowing on litter size and body weights of piglets.

			Treatment			P value	P values, comparisons		
Parameter		Control	MicroAid5	MicroAid30	SEM	Trt	Trt 1 vs 3	Trt 1 vs 2	Trt 2 vs 3
Number of litters	n	65	66	65					
Total pigs born live	n	745	751	811					
Stillborns	n	65	40	44					
Mummies	n	7	13	8					
Live pigs/litter, n	Day 0	11.4	11.7	12.4	0.4	0.14	0.05	0.58	0.17
Avg BW, kg	Day 0	1.58	1.55	1.55	0.03	0.59	0.40	0.35	0.93
	Day 5	2.40	2.37	2.30	0.05	0.25	0.11	0.64	0.25
	Day 12	4.38	4.21	4.13	0.08	0.07	0.03	0.11	0.49
	Weaning	7.01	6.81	6.73	0.12	0.22	0.09	0.22	0.64
Total litter wt, kg	Day 0	17.66	17.73	18.88	0.53	0.19	0.11	0.93	0.13