Evaluation of Four Ractopamine Use Programs on Pig Growth and Carcass Characteristics

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Introduction

Paylean™ (ractopamine hydrochloride by Elanco) is a feed additive approved to be fed at levels of 4.5 to 18 grams per ton (5 to 20 ppm) from 150 to 240 lb body weight, increasing growth performance while also increasing carcass leanness. In previous research trials, the ractopamine response began to decline near day 22 when fed at a constant dietary concentration, resulting in decreased growth performance over the remaining duration of the feeding period.

Therefore, the objective of this study was to determine the level and timing of Paylean step-up programs to enhance and extend the ractopamine response by increasing the dietary concentration of Paylean. Data collected also provided additional data to model the optimal Paylean use strategy.

Materials and Methods

Barrows (n = 143) and gilts (n = 149) of Danbred Hamp x Duroc sires and York x Landrace dams were used in a six-week study evaluating different ractopamine use programs for late finishing pigs. Pigs were allotted into blocks by initial body weight (average initial body weight = 156.1 lb), ancestry, and sex and then randomly assigned to be fed one of five ractopamine sequences as described in Table 1. Treatment 1, the control treatment, contained no ractopamine (CTL). Treatment 2 included a constant rate of 4.5 g/ton ractopamine from weeks 0-6 (CST). Treatments 3, 4, and 5 evaluated three step-up programs in which the dietary concentration of ractopamine increased at different time intervals. Treatment 3 contained ractopamine at 4.5 g/ton through week 4 followed by the ractopamine dose being stepped-up to 9 g/ton during weeks 5-6 (4,2 STP). Treatment 4 contained ractopamine at 4.5 g/ton through week 3 and 9 g/ton the remaining three weeks (3,3 STP). Treatment 5 contained two step-ups of ractopamine dose, beginning at 4.5 g/ton during weeks 0-2, then increasing to 6.75 g/ton ractopamine for weeks 3-4, and finally increasing to 9 g/ton ractopamine during weeks 5 and 6 (2,2,2 STP). Treatments began when the average block body weight was between 150-160 lbs and were continued through a six-week period to market weight.

The experimental diet compositions are outlined in Table 2. Barrows and gilts were split sex fed, both consuming a constant nutrient concentration in their diets respectively throughout the six week study. The corn-soy based diets contained at least 18% crude protein as well as 0.7% Ca and 0.6% total P. Barrows were fed a 1.1% total Lys diet and gilts were fed a 1.2% total Lys diet with all other nutrients meeting or exceeding NRC (1998) requirements.

The pigs were housed 5 pigs/pen with 11 square feet/pig in a curtain-sided, naturally ventilated building with 20 pens on test (4 pens/trt) for the first repetition. During the second repetition, 30 pens were on test (6 pens/trt) and they were housed in another naturally ventilated barn at 5 or 6 pigs/pen with 11 or 9 square feet/pig respectively. Overall, there were 50 pens on test, 10 pens/trt, or 5 pens per trt/sex combination. Pen was the observational unit of the study.

Pig and feeder weights were recorded weekly through day 42 to determine average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (G:F). In addition, all pigs were ultrasonically scanned at days 0, 14, 21, 28, and 42 to measure loin eye area (LEA), last rib backfat, and tenth rib backfat. With this real-time ultrasound data, lean and adipose tissue accretion curves will be generated. After six weeks on test, the gilts were taken to a commercial pork processor where individual hot carcass weights, dressing percentages, and carcass probe data of loin and backfat depth measurements were collected, allowing for the calculation of the predicted percent lean of the carcass. Statistical analysis of all the data was performed using the GLM procedures of SAS, allowing dietary treatment to be examined for its effect on growth and carcass characteristics of the finishing pigs.

Results and Discussion

Ractopamine effects. The growth performance data of the finishing pigs can be found in Tables 3 and 4. Pigs fed ractopamine had increased ADG (2.40 vs. 2.17 lb/d; $P < 0.002$) and increased G:F (0.390 vs. 0.363; $P < 0.03$) compared to the control treatment during weeks 0-2. The ractopamine step-up programs had greater ADG ($P < 0.05$) than the CTL treatment during weeks 2-6, and pigs fed the 3,3 STP program specifically had greater ADG ($P < 0.02$) than both the CTL and CST programs during weeks 2-6. For the entire six week period, pigs fed ractopamine had increased ADG (2.28 vs. 2.06 lb/d; $P < 0.001$) and G:F (0.359 vs. 0.324; $P < 0.001$) compared to pigs fed the CTL treatment. Pigs fed the 3,3 STP program had greater overall ADG ($P < 0.05$) than all the other ractopamine treatments. There were no significant differences in overall ADFI found among treatments for the six week feeding period.

Pigs fed ractopamine had increased final body weights (251.7 vs. 242.6 lb; $P < 0.01$) and the 3,3 STP program had greater ($P < 0.05$) final body weights than the other ractopamine treatments. The results of the plant-measured carcass characteristics are shown in Tables 5 and 6. Pigs fed ractopamine had increased hot carcass weights (192.8 vs. 183.1 lb; $P < 0.001$) and greater dressing percentage (76.4% vs. 75.4%; $P < 0.02$) than the pigs fed the CTL treatment. Only pigs fed the 4,2 STP and 3,3 STP programs had significantly increased loin depths (2.69 and 2.67 vs. 2.57 in. respectively, $P < 0.03$) over the pigs fed the CTL treatment. However, no significant differences were found for processor measured fat depths at slaughter and only the 4,2 STP program resulted in increased percent lean ($P < 0.04$) compared to the CTL treatment. Additionally, the pigs fed the 4,2 STP program had increased ($P < 0.03$) carcass grade premiums (6.27 $/cwt.) compared to pigs fed the CTL or CST treatments (5.20 and 5.33 $/cwt.) while pigs fed the 3,3 STP and 2,2,2 STP programs were intermediate and not different (5.60 and 5.48 $/cwt) from pigs fed the other treatments. Further, pigs fed ractopamine resulted in a higher ($P < 0.05$) total value per pig than those pigs fed the control treatment ($104.12 vs. $98.07).

The real-time ultrasound data can be found in Tables 7 and 8. Loin eye area (LEA) was greater for pigs fed ractopamine (6.77 vs. 6.35 in^2; $P < 0.01$) than the CTL treatment. Additionally, pigs fed the 3,3 STP program had the greatest overall change in LEA (1.55, 1.87, 2.07, 2.16, 2.05 in^2; trts 1-5 respectively, $P < 0.01$), differing significantly from the CTL treatment. Initial tenth rib backfat ultrasound data show the pigs on the 3,3 STP program began with slightly higher backfats than the other programs due to random chance. By day 42 the trend continued and when calculated as an overall change in backfat, the 3,3 STP pigs ended with a greater change in backfat than the 4,2 STP pigs (0.27 vs. 0.22 in; $P < 0.05$) with the other programs all being intermediate. This may be attributed to the higher ADFI of the 3,3 STP pigs.

Sex effects. Over the entire six week study, barrows had greater ADG (2.31 vs. 2.17 lb/d; $P < 0.002$), increased ADFI (6.75 vs. 6.02 lb/d; $P < 0.001$), but decreased feed efficiency (0.343 vs. 0.361; $P < 0.004$) than the gilts. Additionally, the barrows finished the study with greater

final body weights (255.1 vs. 247.5 lb; $P < 0.001$) and greater hot carcass weights (193.4 vs. 188.4 lb; $P < 0.004$) than the gilts.

Processor measured fat depths indicate that the barrows had increased fat depths (0.78 vs. 0.64 in; $P < 0.001$) and decreased processor determined percent lean (54.45 vs. 55.45%; $P < 0.001$) than the gilts, however the barrows still resulted in a greater total value at slaughter ($104.39 vs. $101.42; $P < 0.03$) than the gilts. Real-time ultrasound data also concluded that the barrows had greater tenth rib backfat (0.86 vs. 0.67 in; $P < 0.001$) and greater overall change in backfat (0.29 vs. 0.20 in; $P < 0.001$) than the gilts. Additionally, based on the real-time ultrasound data, gilts had greater LEA (6.86 vs. 6.50 in^2; $P < 0.001$) and greater overall change in LEA (2.04 vs. 1.84 in^2; $P < 0.04$) than the barrows.

Application

All ractopamine use programs increased pig growth rate and feed efficiency. The ractopamine step-up programs sustained the ractopamine growth response during weeks 5 and 6 better than constant level of ractopamine. However, the 3 week-3 week ractopamine program with levels of 4.5 and 9 g/ton, respectively, had the greatest increase in pig growth rate and provides a more effective step-up program that will maximize pig performance while using ractopamine.

Table 1. Five experimental sequences of dietary ractopamine included in feeds for finishing pigs

Ractopamine sequence[a]	CTL	CST	4,2 STP	3,3 STP	2,2,2 STP
Ractopamine, g/ton					
Week 1	0	4.5	4.5	4.5	4.5
Week 2	0	4.5	4.5	4.5	4.5
Week 3	0	4.5	4.5	4.5	6.75
Week 4	0	4.5	4.5	9.0	6.75
Week 5	0	4.5	9	9	9
Week 6	0	4.5	9	9	9

[a]CTL = Control; CST = 4.5 g/ton ractopamine wk 0-6; 4,2 STP = 4.5 g/ton ractopamine wk 0-4, 9 g/ton ractopamine wk 5-6; 3,3 STP = 4.5 g/ton ractopamine wk 0-3, 9 g/ton ractopamine wk 4-6; 2,2,2 STP = 4.5 g/ton ractopamine wk 0-2, 6.75 g/ton ractopamine wk 3-4, 9 g/ton ractopamine wk 5-6.

Table 2. Experimental diet compositions for finishing pigs fed five different ractopamine use programs

Ractopamine, g/ton	0	4.5	9	6.75
Diet Ingredient, %				
Barrow Diets				
Corn	64.5600	64.5350	64.5100	64.5225
SBM - 48%	27.6000	27.6000	27.6000	27.6000
Swine Yellow Grease	5.0000	5.0000	5.0000	5.0000
Limestone	0.9200	0.9200	0.9200	0.9200
Dical. Phos.	1.2200	1.2200	1.2200	1.2200
Salt	0.2500	0.2500	0.2500	0.2500
Microaid	0.0500	0.0500	0.0500	0.0500
Vitamin Premix	0.1500	0.1500	0.1500	0.1500
T.M. Premix	0.1000	0.1000	0.1000	0.1000
Selenium 600 Premix	0.0250	0.0250	0.0250	0.0250
Lysine	0.1250	0.1250	0.1250	0.1250
Paylean-9™	0.0000	0.0250	0.0500	0.0375
Totals	100.000	100.000	100.000	100.000
Gilt Diets				
Corn	61.6350	61.6100	61.5850	61.5975
SBM - 48%	30.5000	30.5000	30.5000	30.5000
Swine Yellow Grease	5.0000	5.0000	5.0000	5.0000
Limestone	0.9200	0.9200	0.9200	0.9200
Dical. Phos.	1.2200	1.2200	1.2200	1.2200
Salt	0.2500	0.2500	0.2500	0.2500
Microaid	0.0500	0.0500	0.0500	0.0500
Vitamin Premix	0.1500	0.1500	0.1500	0.1500
T.M. Premix	0.1000	0.1000	0.1000	0.1000
Selenium 600 Premix	0.0250	0.0250	0.0250	0.0250
Lysine	0.1500	0.1500	0.1500	0.1500
Paylean-9™	0.0000	0.0250	0.0500	0.0375
Totals	100.000	100.000	100.000	100.000

™ Paylean (ractopamine hydrochloride) is a registered trademark of Elanco Animal Health.

Table 3. The effect of four ractopamine use sequences on ADG, ADFI, and feed efficiency of finishing pigs

							Probability, P <		
Treatment[d]	**CTL**	**CST**	**4,2 STP**	**3,3 STP**	**2,2,2 STP**	**SE**	**Trt**	**Sex**	**Trt ´ Sex**
Pigs/trt: n =	54	54	54	54	53				
Initial wt., lb	156.2[a]	156.6[a]	156.3[a]	156.2[a]	155.4[a]	0.949	0.930	0.007	0.873
Weeks 0-2									
ADG, lb/d	2.17[c]	2.43[ab]	2.36[bc]	2.57[a]	2.24[bc]	0.068	0.002	0.005	0.070
ADFI, lb/d	6.02[b]	6.25[ab]	5.96[b]	6.43[a]	6.08[ab]	0.134	0.118	0.001	0.483
G:F	0.36[a]	0.39[ab]	0.40[b]	0.40[b]	0.37[a]	0.010	0.029	0.330	0.154
Weeks 2-6									
ADG, lb/d	2.01[c]	2.14[bc]	2.24[ab]	2.29[a]	2.21[ab]	0.045	0.009	0.007	0.809
ADFI, lb/d	6.59[a]	6.39[a]	6.43[a]	6.60[a]	6.44[a]	0.113	0.569	0.001	0.387
G:F	0.31[a]	0.34[b]	0.35[b]	0.35[b]	0.34[b]	0.007	0.005	0.009	0.206
Weeks 0-6									
ADG, lb/d	2.06[c]	2.24[b]	2.28[b]	2.39[a]	2.22[b]	0.038	0.001	0.002	0.377
ADFI, lb/d	6.41[a]	6.34[a]	6.28[a]	6.55[a]	6.33[a]	0.099	0.359	0.001	0.449
G:F	0.32[a]	0.35[b]	0.36[b]	0.37[b]	0.35[b]	0.005	0.001	0.004	0.423

[a,b,c] Means in a row with different superscripts differ, P < 0.05.

[d]CTL = Control; CST = 4.5 g/ton ractopamine wk 0-6; 4,2 STP = 4.5 g/ton ractopamine wk 0-4, 9 g/ton ractopamine wk 5-6; 3,3 STP = 4.5 g/ton ractopamine wk 0-3, 9 g/ton ractopamine wk 4-6; 2,2,2 STP = 4.5 g/ton ractopamine wk 0-2, 6.75 g/ton ractopamine wk 3-4, 9 g/ton ractopamine wk 5-6.

Table 4. Performance summary by sex of finishing pigs fed by four different ractopamine management programs

Sex	Barrows	Gilts	SE	Probability, P <
Initial Wt, lbs	157.4	154.9	0.600	0.007
Weeks 0-2				
ADG, lb/d	2.45	2.27	0.043	0.005
ADFI, lb/d	6.47	5.82	0.085	0.001
G:F	0.38	0.39	0.006	0.330
Weeks 2-6				
ADG, lb/d	2.24	2.12	0.029	0.007
ADFI, lb/d	6.88	6.10	0.071	0.001
G:F	0.33	0.35	0.004	0.009
Weeks 0-6				
ADG, lb/d	2.31	2.17	0.024	0.002
ADFI, lb/d	6.75	6.02	0.063	0.001
G:F	0.34	0.36	0.003	0.004

Table 5. The effect of four ractopamine management programs on carcass characteristics of finishing pigs

							Probability, P <		
Treatment[f]	**CTL**	**CST**	**4,2 STP**	**3,3 STP**	**2,2,2 STP**	**Std. Err.**	**Trt**	**Sex**	**Trt × Sex**
Slaughter wt., lb	243.5[c]	251.3[ab]	254.6[ab]	256.5[a]	250.6[b]	1.897	0.001	0.001	0.784
HCW, lb	183.1[c]	191.6[ab]	193.9[ab]	195.3[a]	190.5[b]	1.545	0.001	0.004	0.759
Avg. fat depth, in	0.71[a]	0.72[a]	0.68[a]	0.73[a]	0.70[a]	0.022	0.519	0.001	0.270
Avg. loin depth, in	2.57[b]	2.61[ab]	2.69[a]	2.67[ab]	2.61[ab]	0.039	0.207	0.337	0.869
% Lean	54.68[b]	54.84[ab]	55.38[a]	54.96[ab]	54.90[ab]	0.240	0.310	0.001	0.666
% Yield	75.40[b]	76.47[a]	76.53[a]	76.41[a]	76.23[a]	0.264	0.017	0.170	0.582
Base meat price, $/cwt.	48.12[a]	48.16[a]	48.29[a]	48.49[a]	48.38[a]	0.515	0.986	0.170	0.999
Carcass grade premium, $/cwt.	5.20[b]	5.33[b]	6.27[a]	5.60[ab]	5.48[ab]	0.299	0.107	0.117	0.443
Total value, $	98.07[b]	102.42[a]	105.41[a]	105.70[a]	102.94[a]	1.542	0.004	0.032	0.964
% Lights[e]	1.72	3.39	1.72	1.69	1.72				

[a,b,c,d] Means in a row with different superscripts differ, $P < 0.05$.

[e] Percent lights equals the percent of pigs that did not reach a minimum market weight (220 lb) and did not go to slaughter.

[f] CTL = Control; CST = 4.5 g/ton ractopamine wk 0-6; 4,2 STP = 4.5 g/ton ractopamine wk 0-4, 9 g/ton ractopamine wk 5-6; 3,3 STP = 4.5 g/ton ractopamine wk 0-3, 9 g/ton ractopamine wk 4-6; 2,2,2 STP = 4.5 g/ton ractopamine wk 0-2, 6.75 g/ton ractopamine wk 3-4, 9 g/ton ractopamine wk 5-6.

Table 6. Carcass characteristics by sex of finishing pigs fed by four different ractopamine management programs

Sex	Barrows	Gilts	SE	Probability, P <
Slaughter wt., lb	255.1	247.5	1.198	
HCW, lb	193.4	188.4	0.984	0.004
Ave. fat depth, in	0.78	0.64	0.014	0.001
Ave. loin depth, in	2.61	2.65	0.024	0.337
% Lean	54.45	55.45	0.151	0.001
% Yield	76.05	76.37	0.167	0.170
Base meat price, $/cwt.	48.61	47.97	0.324	0.170
Carcass grade premium, $/cwt.	5.36	5.79	0.189	0.117
Total value, $	104.39	101.42	0.975	0.032

Table 7. The effect of four ractopamine management programs on real time ultrasounds of back fat and loin eye area in a subset of finishing pigs

							Probability, P <		
Treatment[d]	**CTL**	**CST**	**4,2 STP**	**3,3 STP**	**2,2,2 STP**	**SE**	**Trt**	**Sex**	**Trt ´ Sex**
Day 0									
Body wt., lb	156.6[a]	156.6[a]	156.9[a]	156.9[a]	155.8[a]	0.860	0.913	0.005	0.967
10th rib BF, in	0.53[ab]	0.52[ab]	0.50[b]	0.55[a]	0.50[b]	0.014	0.077	0.001	0.187
Last rib BF, in	0.52[ab]	0.53[ab]	0.51[b]	0.54[a]	0.50[b]	0.013	0.160	0.001	0.051
Loin eye area, in^2	4.80[a]	4.89[a]	4.79[a]	4.72[a]	4.74[a]	0.078	0.515	0.043	0.589
Day 14									
Body wt., lb	187.2[c]	190.9[ab]	190.5[abc]	193.3[a]	187.7[bc]	1.275	0.004	0.001	0.524
10th rib BF, in	0.59[abc]	0.57[abc]	0.56[c]	0.62[a]	0.57[bc]	0.018	0.196	0.001	0.112
Last rib BF, in	0.54[a]	0.54[a]	0.49[b]	0.55[a]	0.52[ab]	0.015	0.035	0.001	0.109
Loin eye area, in^2	5.44[c]	5.84[a]	5.74[ab]	5.59[bc]	5.62[abc]	0.092	0.026	0.001	0.924
Day 42									
Body wt., lb	241.5[c]	248.8[b]	252.5[ab]	254.8[a]	248.3[b]	1.815	0.001	0.001	0.817
10th Rib BF, in	0.78[ab]	0.77[abc]	0.71[c]	0.82[a]	0.74[bc]	0.022	0.001	0.001	0.650
Last Rib BF, in	0.73[ab]	0.73[ab]	0.68[b]	0.78[a]	0.70[b]	0.020	0.009	0.001	0.458
Loin eye area, in^2	6.35[b]	6.69[a]	6.81[a]	6.86[a]	6.70[a]	0.100	0.004	0.001	0.212
Overall									
Change in 10th rib BF, in	0.25[ab]	0.25[ab]	0.22[b]	0.27[a]	0.24[ab]	0.018	0.239	0.001	0.970
Change in LEA, in^2	1.55[b]	1.87[a]	2.07[a]	2.16[a]	2.05[a]	0.110	0.007	0.042	0.186

[a,b,c] Means in a row with different superscripts differ, $P < 0.05$.

[d] CTL = Control; CST = 4.5 g/ton ractopamine wk 0-6; 4,2 STP = 4.5 g/ton ractopamine wk 0-4, 9 g/ton ractopamine wk 5-6; 3,3 STP = 4.5 g/ton ractopamine wk 0-3, 9 g/ton ractopamine wk 4-6; 2,2,2 STP = 4.5 g/ton ractopamine wk 0-2, 6.75 g/ton ractopamine wk 3-4, 9 g/ton ractopamine wk 5-6.

Table 8. Real time ultrasounds of back fat and loin eye area by sex of a subset of finishing pigs fed by four different ractopamine management programs

Sex	Barrows	Gilts	SE	Probability, P <
Day 0				
Body wt., lb	157.9	155.2	0.553	0.005
10^{th} rib BF, in	0.57	0.47	0.009	0.001
Last rib BF, in	0.56	0.48	0.008	0.001
Loin eye Area, in^2	4.71	4.86	0.050	0.043
Day 14				
Body wt., lb	192.6	187.3	0.815	0.001
10^{th} rib BF, in	0.64	0.52	0.011	0.001
Last rib BF, in	0.57	0.48	0.010	0.001
Loin eye area, in^2	5.39	5.91	0.060	0.001
Day 42				
Body wt., lb	253.2	245.1	1.165	0.001
10^{th} rib BF, in	0.86	0.67	0.014	0.001
Last rib BF, in	0.82	0.63	0.013	0.001
Loin eye area, in^2	6.50	6.86	0.064	0.001
Overall				
Change in 10^{th} rib BF, in	0.29	0.20	0.012	0.001
Change in LEA, in^2	1.84	2.04	0.071	0.042