Models to Predict the Response of Pigs to Increasing Levels of Ractopamine

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Introduction

The Food and Drug Administration approved Paylean® with research completed with pigs in the late 1980's and early 1990's that had lower percent lean, lower lean accretion, higher feed intakes and poorer feed efficiency compared to today's pigs. Also, recent data conducted at Purdue University indicates that a four-week duration of feeding with high lysine diets result in the most profitable use of Paylean. The objective of these analyses was to model the response of current U.S. high lean gain terminal cross pigs to alternative approved levels of Paylean (4.5 to 18 g/ton; 5 to 20 ppm). The details of the research trial are presented by Herr et al. (2001.)

Three hundred gilts, with an average weight of 184 lbs., were allotted to 60 pens by weight in a 3×4 factorial arrangement of treatments in a randomized complete block design (n = 5) with three genotypes (g) and four ractopamine levels (RL): 1) control, 0 ppm; 2) 5 ppm; 3) 10 ppm; and 4) 20 ppm ractopamine (RAC). All pigs were fed an 18.6% CP, 1.1% lysine diet for the four-week trial. The weekly pen data were fitted to numerous linear, nonlinear and biphasic equations of ractopamine level (RL), and either duration of time (DRAC, midweek days on RAC), or weight gain on ractopamine (WTGRAC.) The values of DRAC and WTGRAC were set to zero for the control treatment. The RAC response was also divided into two phases: (1) RL1, 0 for control and 5 for all other RAC treatments, and (2) RL2, (RL-RL1) for RAC treatments 2, 3, and 4. For ADG (kg/d), the equations included the fixed effects of block G and week on test ($P < .01$) and either a biphasic nonlinear [$.0410\ RL1 + .05996\ (RL2)^{.007}$] or asymptotic nonlinear function {$.2491\ [1 - \exp(-.713\ RL)]$} of RL level. For gain:feed (G:F), the models included the fixed effects of week ($P < .01$) and either a biphasic linear ($.0084\ RL1 + .0013\ RL2$) or asymptotic nonlinear function {$.0513\ [1 - \exp(-.717\ RL)]$}. The partial sums of squares accounted for by the biphasic functions were 4.4 and 8.9% greater than the nonlinear functions for ADG and G:F, respectively. For daily feed intake (ADFI, kg/d), the equation with the lowest RSD included the fixed effects of block, G, week, and $-.0150\ RL2$ ($P < .01$); RL1, the change from 0 to 5 ppm ractopamine was non-significant ($P > .40$). The change in the RAC response with weight gain on ractopamine was not significant ($P > .10$) for any variable. The predicted linear change in RAC response to DRAC were small for ADG (-.008, P = .19), G:F (-.0008, P = .49), and ADFI (-.0057, P = .31).

Discussion

These regression analyses indicated that the three performance variables respond differently to increasing levels of Paylean. The biphasic and nonlinear functions of Paylean level resulted in different predicted RAC responses (Table 2). The biphasic functions predicted 77 and 68% of the maximal (20 ppm) ADG and G:F response at the 5 ppm RL, while the nonlinear functions predicted 97% of the 20 ppm RL response at 5 ppm for both ADG and F:G.

The biphasic functions provided the best fit to the data. The response to Paylean for the first 4.5 g/ton (5 ppm) is substantial, especially per gram of Paylean fed. Above 4.5 g/ton the marginal response of Paylean with each additional g/ton to increase average daily gain and feed efficiency is substantially less. For example, the first 4.5 g/ton or 5 ppm of Paylean increases ADG at the rate of .041 lbs. per day per ppm in the diet. At the 9 g/ton (10 ppm) level, the marginal increase in ADG per ppm increase in Paylean is only .0021 times as great. For feed

efficiency, the bi-phasic model predicts that the marginal response to Paylean levels above 4.5 g/ton are constant from 4.5 to 18 g/ton but only 15.5% as large at the marginal improvement for the first 4.5 g/ton. The most profitable level of Paylean is determined by identifying the point at which the marginal return equals the marginal cost of the Paylean and required additional essential amino acids to achieve the optimal Paylean response.

If only growth performance and feed efficiency are considered, based on this data, the optimal level is at or just above 4.5 g/ton. Only based on increased carcass weights (dressing percent) and payment for percent lean would producers consider feeding Paylean above the 4.5 g/ton level. In this trial, no significant differences in dressing percent were found for the 5, 10 and 20 ppm levels of ractopamine. The RAC response did not significantly change over the duration of the 28-day feeding trial.

Implications

Based on the improved performance in average daily gain and feed efficiency, the optimal level of ractopamine is at or just above 4.5 g/ton. Increased carcass weight and payment for percent lean is needed to make the higher levels of Paylean more profitable.

Table 1. Effect of Paylean and genetic line on weekly ADG, ADFI, and F:G in late finishing pigs

	Control	4.5 g/ton Paylean	9 g/ton Paylean	18 g/ton Paylean	Std. Error
# of Pigs, hd.	74	76	74	76	
Initial Wt, lbs	183.8	184.2	184.2	184.4	1.41
Week 1					
ADG	2.03[a]	2.30[b]	2.44[b]	2.36[b]	.080
ADFI	5.31[ab]	5.52[ab]	5.65[b]	5.08[a]	.181
F:G	2.65[c]	2.44[bc]	2.34[ab]	2.17[a]	.094
Week 2					
ADG	2.11[a]	2.24[ab]	2.41[b]	2.35[b]	.075
ADFI	5.76[b]	5.37[a]	5.65[ab]	5.45[ab]	.131
F:G	2.80[b]	2.45[a]	2.38[a]	2.34[a]	.099
Week 3					
ADG	1.92[a]	2.25[b]	2.21[b]	2.27[b]	.078
ADFI	5.84[a]	5.64[a]	5.77[a]	5.57[a]	.128
F:G	3.08[b]	2.54[a]	2.68[a]	2.48[a]	.103
Week 4					
ADG	1.76[a]	1.94[b]	2.00[b]	1.95[b]	.069
ADFI	6.11[b]	5.92[ab]	6.07[ab]	5.73[a]	.137
F:G	3.57[b]	3.13[a]	3.14[a]	3.00[a]	.151
Overall					
ADG	1.95[a]	2.19[b]	2.26[b]	2.25[b]	.028
ADFI	5.75[b]	5.61[ab]	5.79[b]	5.46[a]	.102
F:G	2.95[a]	2.56[b]	2.57[b]	2.43[b]	.046
Final Wt, lbs	238.3[a]	244.9[b]	247.3[b]	246.3[b]	1.70
Slaughter Wt, lbs	245.8[a]	253.7[b]	254.2[b]	255.05[b]	1.75
% Yield (farm)	73.31[a]	74.27[b]	73.85[b]	74.41[b]	.212

[a,b,c] Means in a row with different superscript differ P < .05 (pdiff)

Table 2. Predicted response to ractopamine as predicted by different functions of ractopamine levels (ppm)

	5 ppm	% maximal response	10 ppm	% maximal response	20 ppm
ADG, lb/day					
Biphasic	.2050	77.0	.2658	99.9	.2661
Nonlinear	.2421	97.2	.2489	97.9	.2491
Gain to Feed					
Biphasic	.0420	68.3	.0485	78.8	.06150
Nonlinear	.0498	97.1	.05126	99.9	.05130
Feed intake lb/day					
Linear of RL2[a]	.00	.00	-.075	33.3	-.225

[a] RL2 is the level of ractopamine above 5 ppm