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PAYLEAN® Improves Growth and Carcass Merit of Pigs with 25% and 50% Nebraska Index Line Genes

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Summary and Implications

The Nebraska Index Line excels in reproduction and is being used in industry breeding programs. However, because it has been selected only for litter size since 1981, growth and carcass merit of pure-line pigs are below industry standards. The objectives of this experiment were 1) to compare growth and carcass traits of Index cross pigs with either 50% or 25% Line I genes in a crossbreeding system typical of how the line is used in the industry and 2) to determine the effects of feeding 18 g PAYLEAN® per ton during the last 28 days of the feeding period on Index cross pigs. Line I was crossed with Danbred® USA Landrace (L) boars and Duroc-Hampshire terminal boars to produce F_1 pigs with 50% Line I genes and terminal cross pigs with 25% Line I genes. Pigs with 25% Line I genes grew faster (2.03 vs. 1.97 lb/d) from 65 days of age to approximately 240 lb than pigs with 50% Line I genes ($P < 0.05$). They also ate more feed per day although the difference was not significant (5.82 vs 5.76 lb per d). Thus, the difference between groups in feed conversion was small and not significant. Terminal cross pigs with 25% Line I genes had only 0.02 in less backfat at the end of the experiment than F_1 pigs with 50% Line I genes, but they had significantly larger longissimus muscle area (6.42 vs 6.10 in^2) and greater percentage carcass lean (52.4 vs 51 %). Pigs of both genetic groups and both barrows and gilts responded similarly to a diet with 18 g PAYLEAN® per ton. Feeding PAYLEAN® at 18 g/ton for 28 days significantly increased growth rate (2.19 vs. 1.80 lb/d), reduced feed intake (6.49 vs. 6.81 lb/d) improved efficiency of growth (0.33 vs 0.26 gain/feed ratio, corresponding with 3.03 and 3.85 feed/gain ratios), increased carcass weight (185.4 vs 177.2 lb), increased dressing percentage (75.2 vs 74.3%), and increased carcass lean (53.6 vs 49.9%). Performance and carcass merit of pigs with 25% Line I genes were greater than for F_1 pigs with 50% Line I genes, and feeding PAYLEAN® at the rate of 18 g per ton produced similar increases in performance and carcass merit of both groups.

Introduction

The Nebraska Index Line (Line I) was established in 1981 and has been selected only for increased litter size. Line I sows produce approximately 3.5 more pigs per litter than a randomly selected control that was derived from the same base population. A cross known as GPK347 of Line I with a maternal line of DeKalb Choice Genetics was entered into the National Pork Producers Council Maternal Line Evaluation and evaluated along with five other industry lines. Total productivity through four parities per replacement gilt for GPK347 females was 33% to 51% greater than for the other lines. Females of all six lines were mated to the same terminal sires, and growth of progeny and percentage carcass lean of progeny of GPK347 sows were 94% and 98%, respectively, of the average of other crosses.

Even with slower and less efficient growth and fatter carcasses in progeny, net return on investment was estimated to be as great or greater for the GPK347 sows than for all other lines. As a result, pork producers are using crosses of Line I in breeding programs and future use of these crosses is expected to increase. In these systems, F_1 Index cross gilts are produced and crossbred gilts and sows are mated to terminal sires to produce three-way cross pigs. Two kinds of market pigs – those with 50% Line I genes, the F_1 barrows and cull gilts from F_1 gilt production, and those with 25% Line I genes, the three-way cross terminal pigs – are produced. Faster, more efficient growth and leaner carcasses in both of these groups would enhance the value of Line I cross females to commercial producers.

Ractopamine HCl is a feed ingredient that directs nutrients to increase growth, improve efficiency and increase amount of carcass lean. PAYLEAN® is a trademark of Elanco's brand of ractopamine. The objective of this experiment was to 1) determine the difference in growth and carcass traits of F_1 pigs that were 50% Line I and terminal cross pigs that were 25% Line I, and

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2) to determine the response in growth and carcass traits and the economic return in barrows and gilts of both of these groups to a diet with 18 g per ton of PAYLEAN® fed the last 28 days before slaughter.

Methods

A total of 306 pigs from 56 litters were used. Pigs with 50% Line I genes (designated F_1) were an F_1 cross produced by artificially inseminating Line I females with semen of Danbred® USA Landrace (L) boars. Pigs with 25% Line I genes (designated T) were terminal cross pigs produced by inseminating L x I females with semen of Danbred® USA Duroc-Hampshire terminal sires. The litters were a random sample of approximately 35 litters of each group and pigs were a random sample from within these litters. Equal numbers of barrows and gilts were sampled.

Pigs were moved from a nursery to finishing facilities at approximately 56 days of age. A random sample of 66 pigs, an equal number of each sex and genetic group, were placed in an environmentally controlled building with individual feeding pens (IFU), the remainder were placed in 24 pens of a naturally ventilated building (MOF) with 10 pigs of the same sex and genetic group in each pen. A corn-soybean meal based diet formulated to contain 18% crude protein, 0.95% lysine, and 1,506 kcal ME per lb was fed to all pigs throughout the experiment. A random one-half of the pigs received this diet with PAYLEAN® at the rate of 18 g per ton during the last 28 days before slaughter.

After a one-week adjustment period, each pig was weighed and individual feed intake recording of pigs in the IFU and pen feed intake recording of pigs in the MOF commenced. One pig in the MOF died during the adjustment period leaving a total of 305 pigs in the trial. At the beginning of the trial, one-half of the pigs in the IFU and one-half of the pens in the MOF were randomly assigned within each sex-genetic group subclass to receive the diet containing PAYLEAN®.

Traits

The objective was to feed pigs in the IFU to a final weight between 240 and 260 lb and to feed pens of pigs in the MOF to final average weights between 240 and 250 lb with all pigs in the pen weighing at least 215 lb. To accomplish these objectives, each pig was weighed at 21, 42 and 63 days after being placed on test. Slaughter date was designated for each pig or pen of pigs based on previous growth rate and 63-day weight. The final 28-day period for each pig began either 63, 70, or 77 days after being placed on test. Pigs were weighed again 14 days before designated slaughter date.

Individual feed intake for pigs in the IFU and pen feed intake for pigs in the MOF were recorded. Feed intake was recorded for Period 1, the first 21 days on test, Period 2, the second 21 d, Period 3, the variable period from 42 days after being placed on test to 28 days before designated slaughter date, Period 4, the first 14 days when PAYLEAN® was fed, and Period 5, the last 14 days when PAYLEAN® was fed. Feeding periods 1 and 2 were each 21 days, Period 3 averaged 22.9 days, and Periods 4 and 5 were each 14 days. Performance was recorded in each period to determine the growth pattern of pigs of each line and to determine whether the pattern was different when pigs were eating diets with and without PAYLEAN®.

Each pig was scanned for tenth rib backfat thickness and longissimus muscle area with an Aloka 500 instrument at the end of each period. Backfat and longissimus muscle area were not recorded at day 0.

After final weights and scan data were collected pigs were transported to SiouxPreme Packing Co., Sioux Center, Iowa where they were slaughtered the next morning. Carcass traits recorded were hot carcass weight, percentage carcass lean estimated by TOBEC, and 24-hour post slaughter longissimus muscle pH and Minolta l* color score.

Statistics

Average daily feed intake for each pen of pigs in the MOF was calculated for each period and this average was assigned to each pig in the pen. Feed efficiency was calculated for each pig as the ratio of its weight change during the period to actual feed intake (IFU) or pen average feed intake (MOF). Growth traits analyzed were weight at the beginning of the trial, weight, backfat and longissimus muscle area at the end of Period 3, and at the end of the trial, and average daily gain, average daily feed intake, and gain/feed ratio during each period of growth. Carcass traits analyzed were hot carcass weight, dressing percentage, percentage lean, pH, and Minolta l* score.

All traits including feed intake and gain/feed were analyzed as a trait of the pig and data for pigs in the IFU and MOF were analyzed together. A mixed-model that accounted for the random effects of litter and pig within pen and the fixed effects of building, genetic line, sex, diet (with or without PAYLEAN®) period of growth, two-factor interactions of line, sex, and diet with period, and the 3-order interactions of line by sex by period, line by diet by period, and sex by diet by period was fitted to data collected during the growing period. Period was omitted from models of carcass traits.

Results

Growth

The number of pigs, average weight at the beginning of the trial and average weight, backfat thickness, and longissimus muscle area at the end of Period 3, and at the end of the trial for pigs in each group are in Table 1. Pigs with 25% and 50% Line I genes did not differ significantly in weight or backfat thickness, but T pigs had 0.25 ± 0.093 in^2 larger longissimus muscle area after 63 days on test and 0.32 ± 0.093 in^2 larger muscle area at the end of the trial than F_1 pigs. At the end of the trial barrows were heavier than gilts and had greater backfat thickness and smaller longissi-

mus muscle area (P < 0.05). Pigs designated to be fed PAYLEAN® did not differ from controls in weight, backfat, or longissimus muscle area at the end of Period 3, before PAYLEAN® was fed. After 28 days of eating a diet with 18 g PAYLEAN® per ton, pigs weighed more (8.4± 2.12 lb), had less backfat (-0.08± 0.021 in), and had larger longissimus muscle area (0.68 ± 0.07 in^2) than controls (P < 0.01).

Average daily feed intake, average daily gain, and gain/feed ratios during each period are in Table 2. Interactions of line and sex with period of growth and with PAYLEAN® treatment generally were not significant. Terminal cross pigs gained faster than F_1 pigs in each period, although the difference was significant only in Period 5. Averaged over the test period, pigs with 25% Line I genes gained 0.068 lb/d more than pigs with 25% Line I genes (P = 0.05). Terminal cross and F_1 pigs had very similar feed intake in each period and did not differ significantly in gain/feed ratio. Barrows ate more feed and gained more rapidly in each period than gilts (P < 0.01), but the sexes did not differ significantly in gain/feed ratio.

PAYLEAN® had a dramatic effect on average daily gain during the first 14 days it was fed when pigs fed PAYLEAN® gained 0.56 ± 0.044 lb/d more than controls. Although not significant, daily feed intake was -0.20 ± 0.121 lb less; consequently gain/feed ratio exceeded that of controls by 0.09 ± .044 units during the first 14 d. The increase in daily gain for pigs fed PAYLEAN® during the second 14 days was less (0.24 ± 0.04 lb/d) because PAYLEAN® reduced daily feed intake more (-0.44± 0.121 lb) than during the first 14 days that it was fed. Gain/feed ratio for pigs fed PAYLEAN® was still significantly better during the last 14 days than for pigs fed the control diet (0.05 ± 0.007 units). These results are consistent with reports in the literature that the greatest benefit from feeding PAYLEAN® occurs during the first two weeks. Pigs can become refractory to PAYLEAN® as the length of the feeding period increases. The gain/feed ratios for pigs fed PAYLEAN® correspond with ratios of 3.03 lb feed per lb gain during the 28 days that PAYLEAN® was fed, whereas ratios for control pigs correspond with 3.85 lb feed per lb gain during this period.

Table 1. Least-squares means and contrasts for weight, backfat and longissimus muscle area

Feeding interval[a]	Line[b]			Sex[c]			Paylean[d]		
	T	F_1	P[e]	B	G	P[e]	+	-	P[e]
				Number of pigs					
	151	154		152	153		153	152	
				Weight at beginning of test (day 0), lb					
	57.8	55.1		56.0	56.9		56.4	56.4	
				Days during each interval					
1	65.1	66.2		63.9	67.4		64.9	66.3	
2	28	28		28	28		28	28	
				Weight at end of period, lb					
1	185.9	184.1	0.57	185.9	183.9	0.39	183.5	186.5	0.13
2	241.7	237.5	0.18	241.9	237.3	0.05	243.7	235.3	< 0.01
SE_D[f]	3.00			2.36			2.12		
				10th rib backfat at end of period, in					
1	0.55	0.57	0.29	0.60	0.52	< 0.01	0.55	0.57	0.11
2	0.69	0.71	0.16	0.76	0.65	< 0.01	0.66	0.74	< 0.01
SE_D	0.021			0.021			0.021		
				Longissimus muscle area at end of period, in^2					
1	5.16	4.91	< 0.01	4.94	5.15	< 0.1	5.04	5.04	0.87
2	6.42	6.10	< 0.01	6.18	6.34	0.03	6.60	5.92	< 0.01
SE_D	0.093			0.076			0.070		

[a]Feeding interval 1 includes Periods 1, 2, and 3 (see text) when PAYLEAN® was not fed and varied in length, Feeding interval 2 was the last 28 days of the trial when PAYLEAN® (18g/ton) was fed to half of the pigs.
[b]F_1 = Index x Landrace F_1 cross, T = Duroc-Hampshire (I x L) cross.
[c]G = gilt, B = barrow.
[d]- = PAYLEAN® not fed, + = PAYLEAN® fed last 28 days.
[e]P = the probability associated with tests of differences between lines, sexes, or diets.
[f]SE_D = standard error of differences between means.

Daily feed intake increased as pigs increased in age and weight. However, average daily gain was greater during Periods 2 and 3 (days 22 to 63 of the feeding period) than during all other periods. Sharp reductions in daily gain and efficiency of growth occurred during the last 28 days of the feeding period.

Carcass Traits

Pigs with 25% Line I genes had heavier carcass weights (5.1± 2.6 lb, P = 0.06; Table 3) due in part to greater live weight (Table 1) and in part to greater dressing percentage (0.5 ± 0.3 %) than pigs with 50% Line I genes. They also had 1.4 ± 0.6 % more carcass lean and paler muscle as Minolta l* values were 1.8± 0.8 units greater (P < 0.05). The two genetic groups did not differ in longissimus muscle pH.

Barrows had 2.8 ± 2.1 lb heavier carcasses than gilts (P = 0.20), due to their greater weight at the end of the test; however, some of the difference in live weight was offset by the 0.7± 0.2 % (P < 0.01) greater dressing percentage for gilts than barrows. Gilts also had carcasses with 1.2 ± 0.5 % more lean than barrows (P < 0.01), but carcasses of the sexes did not differ significantly in muscle pH or Minolta l* color score.

Pigs fed PAYLEAN® had heavier carcasses (8.2± 1.9 lb, P < 0.01) due to both greater live weight (Table 1) and to an increase of 0.9 ± 0.2% in dressing

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Table 2. Least-squares means and contrasts for average daily feed intake, average daily gain, and gain/feed ratio during each of five periods of growth.

Feeding interval[a]	Line[b]			Sex[c]			Paylean[d]		
	F_1	T	P[e]	G	B	P[e]	-	+	P[e]
				Avg. daily gain, lb					
1	1.81	1.85	0.55	1.76	1.90	< 0.01	1.83	1.83	0.67
2	2.03	2.12	0.06	1.96	2.18	< 0.01	2.07	2.07	0.72
3	2.07	2.12	0.48	2.01	2.18	< 0.01	2.12	2.07	0.30
4	2.12	2.18	0.09	2.09	2.23	< 0.01	1.87	2.43	< 0.01
5	1.79	1.90	0.03	1.79	1.92	< 0.01	1.72	1.96	< 0.01
SE_D[f]	0.044			0.044			0.044		
				Avg. daily feed intake, lb					
1	4.63	4.63	0.90	4.52	4.74	0.08	4.67	4.59	0.49
2	5.34	5.49	0.22	5.23	5.62	< 0.01	5.40	5.42	0.81
3	6.17	6.15	0.98	5.84	6.48	< 0.01	6.20	6.11	0.46
4	6.62	6.77	0.10	6.46	6.88	< 0.01	6.77	6.57	0.09
5	6.59	6.68	0.45	6.42	6.86	< 0.01	6.86	6.42	< 0.01
SE_D	0.121			0.121			0.121		
				Gain/feed ratio, lb/lb					
1	0.40	0.42	0.09	0.41	0.41	0.99	0.41	0.41	0.84
2	0.38	0.39	0.40	0.38	0.39	0.16	0.38	0.38	0.81
3	0.34	0.34	0.34	0.34	0.34	0.31	0.34	0.34	0.48
4	0.31	0.32	0.32	0.32	0.32	0.87	0.27	0.36	< 0.01
5	0.27	0.28	0.10	0.27	0.27	0.65	0.25	0.30	< 0.01
SE_D	0.008			0.007			0.007		

[a]Periods 1 and 2 were each 21 d, Period 3 was 22.9 d, and periods 4 & 5 were each 14 d.
[b]F_1 = Index x Landrace F_1 cross, 3-way = Duroc-Hampshire (I x L) cross.
[c]G = Gilt, B = barrow
[d]- = PAYLEAN® not fed, + = PAYLEAN® (18g/ton) fed last 28 d, during Periods 4 and 5.
[e]P = the probability associated with tests of differences between lines, sexes, or diets.
[f]SE_D = standard error of differences between means.

percentage (P < 0.01). Pigs fed PAYLEAN® had 3.7±0.5% more lean in carcasses than control pigs (P < 0.01). Pigs fed PAYLEAN® and controls did not differ significantly in longissimus muscle pH or Minolta l* score.

Conclusions

Pigs with 25% Line I genes and 75% genes from Danbred ® USA lines grew more rapidly, had greater carcass lean, and paler longissimus muscle than pigs with 50% of their genes from each source. Pigs of both genetic groups responded similarly to a diet with 18 g per ton PAYLEAN®. Feeding pigs a diet with 18 g per ton PAYLEAN® for 28 days before slaughter increased growth rate 22%, improved feed conversion ratio 27%, and increased carcass lean 7.4% over control pigs; however, the effect of feeding PAYLEAN® was approximately twice as great during the first 14 days that it was fed compared with the last 14 days.

[1]R. K. Johnson is professor of animal science, P. S. Miller is associate professor of animal science, and D. Petry and R. Fisher are graduate student/research technicians in the Department of Animal Science.

Table 3. Least-squares means and contrasts ± SE for carcass traits.[a]

Item		HCW, lb		Dress %		% Lean		pH		Minolta 1	
		Mean	P[e]	Mean	P[e]	Mean	P[e]	Mean	P[e]	Mean	P[e]
Line[b]	T	183.8		75.0		52.4		5.72		50.4	
	F_1	178.8		74.5		51.0		5.79		48.6	
		5.1 ± 2.6	0.06	0.5 ± .3	0.07	1.4 ± .6	0.03	-.07 ±.06	0.24	1.8 ±0 .8	0.04
Sex[c]	G	179.9		75.2		52.3		5.75		49.2	
	B	182.7		74.4		51.4		5.76		49.8	
		-2.8 ± 2.1	0.20	0.7 ± 0.2	< 0.01	1.2 ± .5	< 0.01	.01 ± .06	0.92	0.6 ± 0.8	0.44
Paylean[d]	+	185.4		75.2		53.6		5.80		48.7	
	-	177.2		74.3		49.9		5.75		50.2	
		8.2 ± 1.9	<0.01	0.9 ± 0.2	< .01	3.7 ± 0.5	< 0.01	.08 ± .06	0.16	-1.5 ± 0.8	0.07

[a]HCW = hot carcass weight, Dress % = hot carcass weight/off-test live weight; % lean = percentage of carcass lean estimated by total body electrical conductivity at SiouxPreme Packing Co.; pH = ultimate 24 h longissimus muscle pH; and Minolta 1 = Minolta 1 color score.
[b]T = DH (I x L) cross, F_1 = I x L cross.
[c]G = gilt, B = barrow
[d]+ = pigs fed PAYLEAN® (18 g/ton) during last 28 days before slaughter; - = pigs not fed PAYLEAN®.
[e]P = the probability associated with tests of differences between lines, sexes, or diets.