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Lysine source affects ractopamine diets

It does not appear that lysine source in ractopamine diets has any effect on live weight gain, but carcass weight gain is affected. However, even with high corn prices, the use of high levels of synthetic amino acids is economically justified.

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AS corn prices rise due to increased ethanol demand, it is likely that the aggressive use of synthetic amino acids will decline. There may be some circumstances, however, that may require synthetic amino acids even if least-cost formulation doesn't allow for them.

One example is early nursery diets where maximum limits are placed on soybean meal level. Another opportunity that has recently been discovered is in diets containing ractopamine (Paylean, Elanco Animal Health). Best-cost formulation during this phase will be required to facilitate maximum carcass yield.

The purpose of this article is to address the effect of lysine source (soybean meal or synthetic amino acids) in ractopamine diets, with the question being, "Does it matter?"

We have determined, through a series of experiments, that the optimum standardized ileal digestible (SID) lysine level for pigs fed 4.5-6.75 g of ractopamine per ton for 21 days is 0.95% (unpublished data), which is similar to other reported estimates (Neill et al., 2006). If pigs are fed for 28 days, the optimum SID lysine level decreases to 0.85% (Boyd et al., 2001). The fact that the lysine requirement decreases with the duration ractopamine is fed makes biological sense considering that the response to ractopamine diminishes over time (National Research Council, 1994).

Our research has defined other nutritional considerations that, if met, will allow producers to capture the benefit of ractopamine. We have shown that ractopamine diets formulated with 6-8 lb. per ton L-lysine hydrochloride result in comparable growth performance and carcass lean to diets using high levels of soybean meal (Boyd et al., 2001; Gaines et al., 2004; Ratliff et al., 2004).

Ractopamine diets formulated with 6-8 lb. per ton L-lysine hydrochloride will require supplementation with L-threonine and a methionine source. Based on two large studies, the optimum SID threonine: lysine ratio in ractopamine diets is 68% (Gaines et al., 2003; Boyd et al., 2006).

An SID sulfur amino acid ratio of 58% is recommended in the ractopamine diet, and it appears that at least 3.5-4% supplemental fat to corn/soybean meal diets (at 0.95% SID lysine) will permit optimum growth; however, further improvements in feed conversion can be realized at higher levels (Gaines et al., 2005).

Perhaps the most important finding from our research with ractopamine is that lysine source (i.e., soybean meal versus extensive synthetic amino acid supplementation) does not have an effect on live weight gain, but carcass growth responds differently. This observation first emerged in a trial by Boyd et al. (2001), when diets formulated with high levels of soybean meal resulted in a lower carcass yield than those formulated with low levels (75.2 versus 75.8%, respectively).

This difference was equivalent to 3.1 lb. of carcass, but it was unclear whether this apparent difference was real. This proved to be a consistent finding in subsequent studies; these are reported herein. Since producer payment is based on carcass weight instead of live weight, this finding is financially very important.

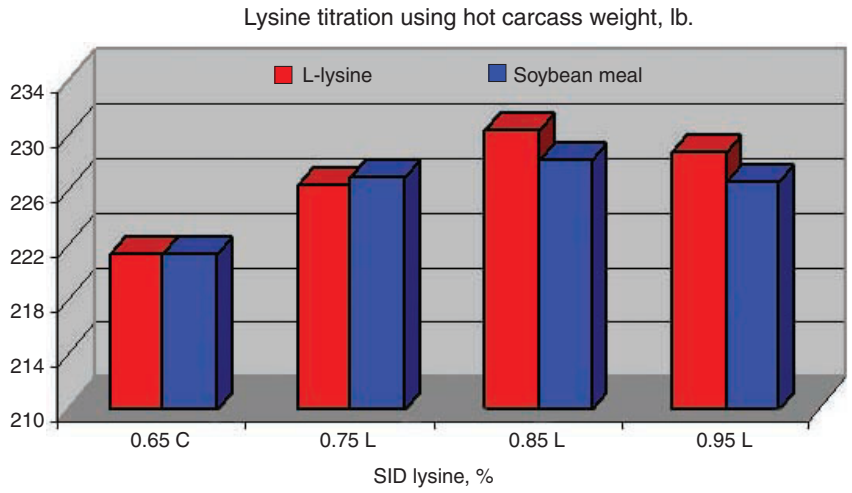
Another significant finding in this trial was the benefit of synthetic amino acid supplementation to improving carcass traits/primal cuts. Not only did lysine source affect yield ($P < 0.05$), but the pigs fed the higher synthetic lysine level had greater loin depths ($P < 0.05$) and ham weights ($P < 0.10$). There was also a numerical increase in loin weight for pigs fed the diets containing L-lysine hydrochloride. The increase in loin and ham weights did not come at the expense of belly weights.

A summary of these findings and proof of this concept are reported herein.

Experiment 1

The first trial involved the use of high or low amounts of soybean meal to re-evaluate the effect of soybean meal on whole-body versus carcass growth. A total of 336 PIC gilts with an average weight of

1. Impact of soybean meal level in ractopamine diets on carcass yield



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230.3 lb. (±1.30 lb.) were weighed by pen and assigned to two dietary treatments (eight replicate pens per treatment and 21 pigs per pen).

Dietary treatments included two sources of lysine: soybean meal and 1.5 lb. per ton L-lysine hydrochloride versus soybean meal and 6 lb. per ton L-lysine hydrochloride and synthetic amino acids.

Experimental diets were corn/soybean meal based containing 6.75 g per ton of ractopamine. Diets were formulated to a 0.95% SID lysine (2.78 g SID lysine:Mcal metabolizable energy [ME]) and fed for 21 days. Experimental diets contained 556 or 398 lb. of soybean meal per ton, respectively. At trial termination, pigs were sent to a commercial processing facility for carcass data collection.

Results are presented in Table 1. Lysine source had no effect on average daily gain (ADG), average daily feed intake (ADFI) or feed conversion ratio (FCR). Although there were no differences on live growth performance, there was an effect for carcass weight with lysine source (P = 0.03).

Carcass weight was greater (+4.3 lb.) for pigs fed high levels of synthetic amino acids, which was attributed to an improvement in carcass yield. Lysine source did not have a significant effect on back fat, loin depth or carcass percent lean.

Experiment 2

Experiment 1 was repeated in an attempt to replicate the differential effect of soybean meal level on whole-body versus carcass growth. At an average weight of 220.3 lb. (±2.04 lb.), a total of 264 PIC gilts were weighed by pen and assigned to two dietary treatments (six replicate pens per treatment and 22 pigs per pen).

Dietary treatments included two sources of lysine: soybean meal and 2 lb. per ton L-lysine hydrochloride versus soybean meal, synthetic amino acids and 6 lb. per ton L-lysine hydrochloride.

Experimental diets were corn-soybean meal based and contained 6.75 g per ton of ractopamine. Diets were formulated to 0.93% SID lysine (2.72 g SID lysine:Mcal ME) and fed for 21 days. Soybean meal levels in the experimental diets were 520 and 400 lb. per ton, respectively. At trial termination, pigs were sent to a commercial processing facility for carcass data collection.

Results are presented in Table 2. In this experiment, lysine source had no effect on ADG, ADFI or FCR. However, similar to experiment 1, carcass weight was higher (P = 0.06) for pigs fed high levels of synthetic amino acids (+3.7 lb.).

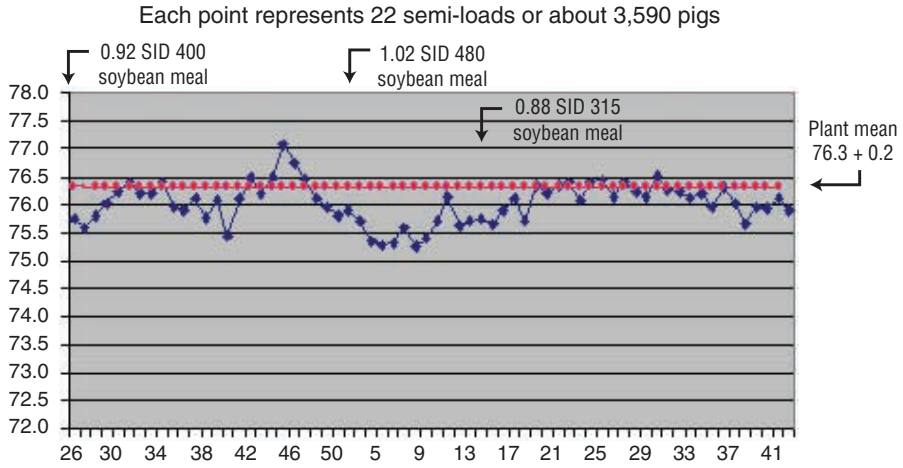
Experiment 3

Johnston et al. (2006) also conducted a study to develop response curves based on carcass yield and FCR for pigs fed ractopamine.

Two response curves were developed to achieve diets containing 0.65, 0.75, 0.85 or 0.95% SID lysine. One curve involved increasing soybean meal to meet diet specifications; the other involved holding soybean meal constant (362 lb. per ton) and meeting the diet specifications through synthetic amino acids (lysine, threonine, methionine). Ractopamine was fed at 4.5 g per ton for a period of 27 days.

Whole-body ADG, FCR and carcass

2. Illinois system process control charting of carcass yield



This chart represents a weekly comparison of carcass yield (%) for the Hanor, Ill., system (blue circles) to the desired standard (plant mean, or red circles). Each blue circle is the mean of 20-24 semi-loads of pigs and represents one week of production. SID lysine and soybean meal levels varied over the period shown and were largely driven by ractopamine trials using whole-body gain and FCR. The discovery of lysine and soybean meal that optimized carcass gain was implemented on week 17 of 2005.

1. Effect of low versus high synthetic amino acid diets for PIC gilts fed ractopamine (6.75 g/ton) for 21 days (experiment 1)[1]

Growth	--L-lysine, lb. per ton-- 1.5	6.0	Std. error of means	P-value
Bodyweight, lb.				
Day 0	229.7	230.8	1.30	0.57
Day 21	278.0	278.1	1.50	0.96
ADG, lb. per day	2.30	2.25	0.03	0.33
ADFI, lb. per day	6.20	6.08	0.08	0.32
FCR	2.70	2.70	0.04	0.96
Carcass				
Carcass weight, lb.	207.1	211.4	1.07	0.03
Back fat, in.	0.64	0.66	0.02	0.63
Yield, %	76.4	77.6	0.38	0.05
Lean, %	56.0	55.8	0.29	0.69

[1]Data represent means of eight replicate pens (21 pigs per pen). Trial conducted at PorkTech LLC (Moberly, Mo.).

2. Effect of low versus high synthetic amino acid diets for PIC gilts fed ractopamine (6.75 g/ton) for 21 days (experiment 2)[1]

Item	--L-lysine, lb. per ton-- 2	6	Std. error of means	P-value
Bodyweight, lb.				
Day 0	219.0	221.5	2.04	0.44
Day 21	268.0	270.7	1.99	0.38
ADG, lb. per day	2.31	2.34	0.04	0.51
ADFI, lb. per day	6.10	6.22	0.11	0.45
FCR	2.65	2.66	0.04	0.96
Carcass weight, lb.	205.8	209.5	1.31	0.06

[1]Data represent means of six replicate pens (22 pigs per pen). Trial conducted at PorkTech LLC.

weight were optimized at 0.85% SID lysine and were virtually identical for each lysine source. There was a numerical improvement in carcass yield (main effect, 75.8 versus 75.4%) and carcass weight (0.90 lb. per pig) for pigs fed diets with high synthetic amino acids (Figure 1).

Carcass ADG improved from 1.99 to 2.04 lb. per day by decreasing soybean meal ($P < 0.15$). Again, this confirms the concept that live weight (whole body) is not affected by soybean meal level, but carcass weight is.

It is not clear whether increased soybean meal leads to greater body shrink in transit to slaughter and/or whether organ and visceral mass is increased.

Experiment 4

Another trial was conducted to confirm the results described in experiment 3 and involved a large field test of concept.

Experimental method was applied using two finishing pig sites having 16 total barns (about 19,152 total pigs placed) and each sex housed separately. Diets were formulated to 0.88% SID lysine (corn, soybean meal, 70 lb. fat per ton) with either 2.0 or 7.0 lb. per ton of L-lysine hydrochloride. This required either 439 or 289 lb. per ton of soybean meal, respectively, to meet an 0.88% SID lysine diet specification.

Means represent closeout data and are shown in Table 3. This trial confirmed that minimizing the soybean meal content of ractopamine diets through synthetic amino acid use to achieve SID lysine levels improves carcass yield percent (+0.70%) and, thus, pounds of carcass (+1.9 lb. per pig) with no effect on liveweight ADG, FCR and carcass lean.

Each sex responded the same to soybean meal level (sex x treatment, $P > 0.10$).

3. Field validation of effect of low and high soybean meal diets on performance and carcass response of pigs fed 6.75 g/ton ractopamine (experiment 4)[1,2]

Item	--L-lysine, lb. per ton-- 2	7	Std. error of means	P-value
Number of barns	8	8	—	—
Average days on feed	23	23	—	—
Live market weight, lb.	280.9	280.9	0.8	1.00
Carcass weight, lb.	213.0	214.9	0.7	0.16
Carcass yield, %	75.8	76.75	0.4	0.26
Carcass lean, %	53.1	53.0	0.1	0.84

[1]Treatment means represent average for eight barns of pigs each (average 1,197 pigs placed per barn) from two sites. Pigs were housed by sex with sites having four barns each of barrows and gilts. Site was filled within 10-day period from single sow source. Means represent data from 110 truckloads accounting for approximately 92% of pigs within each barn. Diets were fed for a barn average of 23 days. Trial conducted at Hanor Farms Nursery-Finish system in White Hall, Ill.
[2]Sex x diet effect, $P > 0.10$ for any trait.

4. Example ractopamine diet (21 days at 4.5-6.75 g ractopamine per ton)

Ingredient	Lb. per ton
Corn	1,455
Soybean meal 48%	417
Fat	80
Monocalcium phosphate	11
Limestone	16
Salt	10
L-lysine	6.00
L-threonine	2.75
DL-methionine or Alimet	0.50
Other	1.30
Ractopamine (Paylean 9)	0.50
Total	2,000.00
Nutrients, %	
SID lysine	0.95
Crude protein	16.3
SID threonine:lysine	68
SID sulfur amino acids:lysine	58
Calcium	0.50
Available phosphorus	0.23

Field observations

Our understanding of the relationship between soybean meal level and carcass yield in pigs fed to the higher SID lysine level required with ractopamine probably explains the improvement in both yield percent and its variation (Figure 2).

Ractopamine was used for the entire period shown, with approximately 254,890 pigs represented in the process control chart (71 weeks, about 3,590 pigs per week). The variation in carcass yield between week 26 (2004) and week 18 (2005) is expected to be due to diet changes that were made to improve feed conversion with ractopamine without regard to the soybean meal level involved (least costing of soybean meal, synthetic amino acids).

Beginning at week 18 (2005), an 0.88% SID lysine diet was implemented with no less than 7.0 lb. L-lysine hydrochloride and held constant. An improvement in carcass yield percentage and decrease in the coefficient of variation ensued. This is consistent with the concept that soybean meal in some way adversely affects the percentage of whole body that results in carcass.

Economics

At minimum, a 2 lb. reduction in hot carcass weight could be expected when using high levels of soybean meal with ractopamine. If one assumes a carcass price of $60/cwt., this equates to a $1.20-per-head loss for the last 45 lb. of weight gain. Based on FCR of 2.70 during the ractopamine phase, one could still afford to pay up to $20 per ton more for ractopamine diets with high synthetic amino acids. Thus, even with high corn prices, the use of high levels of synthetic amino acids is economically justified, especially for pork production systems marketing on a fixed time basis.

Summary

It does not appear that lysine source in ractopamine diets has any effect on live weight gain, but carcass weight gain is affected.

Based on the significant evidence presented, it appears that if ractopamine diets are formulated with high levels of soybean meal (i.e., more than 400 lb. per ton), there is a reduction in carcass weight.

We estimate that a 2 lb. reduction in hot carcass weight could be expected when using high soybean meal levels. To circumvent this potential loss in hot carcass weight, ractopamine diet formulations having 6-8 lb. L-lysine hydrochloride should be used.

Thus, the Food & Drug Administration-approved crude protein minimum of 16% limits the ability to maximize carcass gain. The mechanism involved in the adverse effect of high levels of soybean meal in the ractopamine diet on carcass weight is unclear and cannot be determined from this research. Similar reductions in carcass weight have been observed when exceeding the lysine requirement of the genotype and with high levels of other feedstuffs such as dried distillers grains with solubles. An example ractopamine diet to optimize carcass traits/primal cuts is shown in Table 4.

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