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NUTRITIONAL CONSIDERATIONS FOR IMPROVED LEAN VALUE

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Summary

The swine industry is in a transitional period as it gears up to produce the lean meat required by the consumer. In fact, pork processors are increasing the production of lean products (boneless loins, 95% fat-free hams) because consumers are willing to pay premiums for low-fat products. New methods of measuring the amount of lean pork (fat-o-meter, etc.) are being developed rapidly, in order to allow the packer to offer price differentials for lean compared to fat pigs. Pork producers, in my opinion, will adjust production systems to meet consumer demands for lean pork when monetary differentials are offered by the packer for high lean-value carcasses.

(Key Words: Split-sex Feeding, Genotype, Lean Growth, Biotechnology.)

Introduction

In the past, the swine industry has defined pork production as the quantity of live weight produced, with little emphasis on pork quality. For this reason, progress in carcass leanness during the past decade has been extremely slow. In the future, growing-finishing swine diet formulation should consider the nutrient utilization and growth performance list below to ensure competitiveness of our industry.

Present	Future
Average daily gain	Lean gain per day
Feed efficiency	Feed per lb of lean gain
Feed cost per lb	Feed cost per lb of lean gain

Feeding diets that allow optimum lean tissue growth will become more important, as the pork packing industry moves toward marketing boneless retail cuts. "Lean value" packer pricing programs will merit a greater economic advantage for producing a carcass with a high percentage of lean tissue. Daily amino acid intake and energy density of the diet will be important nutritional factors affecting lean tissue growth in growing-finishing swine.

Recent studies have shown that there are different dietary amino acid concentrations necessary to achieve various production goals, as illustrated in Figure 1. Lysine is one of the most important nutrients in swine diet formulation. Diet formulations low in lysine may limit daily lysine intake (g/d) and reduce lean tissue growth in finishing pigs. Amino acid levels currently recommended by the NRC (1988) may not be adequate for optimum lean tissue growth.

Nutritional manipulation of lean growth in pigs is not difficult. The basic principles of lean growth have been summarized and are outlined below:

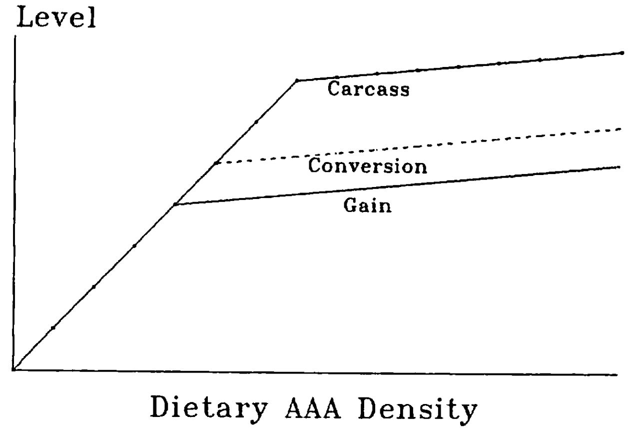

Figure 1. Dietary Amino Acid Concentrations – Influence on Performance

1. Maximum lean tissue growth can occur only when the daily intakes of all essential nutrients are sufficient, particularly amino acids and energy.
2. Shortages of protein intake will reduce daily live weight gain, feed conversion efficiency, and carcass lean content.
3. An oversupply of dietary protein may improve the percentage lean in the carcass but may result in slightly poorer feed efficiency.
4. Insufficient daily energy supply to pigs may improve carcass leanness but growth rate will deteriorate.
5. Energy supplied over and above that needed for maintenance and maximum lean tissue gain will be used for fat deposition.

The commercial swine industry currently pens barrows and gilts together and they are fed one grower diet (16% CP) and are changed to a 14% CP finishing diet at about 120 lb live weight. In the future, sexes may be penned separately and fed a series of diets to optimize lean growth based on the environment in which pigs are housed.

Split-sex Feeding

It has been known for several years that there are large differences in lean gain potential between barrows and gilts. Although difficult to accomplish on the farm, split-sex feeding may offer some feeding as well as marketing alternatives. Split-sex feeding involves sorting gilts from barrows and feeding each a separate diet. Since gilts typically consume .4 to .5 lb less feed per d than barrows, gilts will require higher concentrations of dietary amino acids to fully meet their lean growth requirements. Also, gilts could be fed higher levels of other nutrients (calcium and phosphorus) if they will be retained for the breeding herd.

Penning barrows separately also allows the producer to take advantage of the relatively high feed intake of barrows compared to gilts. Research experiments have shown that barrows eat 10 to 14% more feed and have faster growth rates than gilts. Thus, less dietary nutrient density will be needed for barrows, resulting in more economical diets.

Split-sex feeding may offer tremendous opportunities at marketing in the future. In fact, producers should be able to demand considerable premiums for gilts on a "lean value"

marketing system, because of less backfat and larger loin-eyes compared to barrows. Also, I believe that gilts fed to heavier weights (≥250 lb) have some advantages in production efficiency (feed utilization, etc.) compared to barrows that must be considered in future swine production practices.

Genotype Differences

Many producers think that genotype differences in lean growth are due to breed differences alone. However, within-breed differences because of the source of breeding stock are greater for lean growth potential than the between-breed differences. In fact, little if any improvement in lean growth performance of some genetic lines has been made during the last decade, whereas tremendous progress has been made with other genetic lines. Thus, in the swine industry, we currently have great variation in genetic lines for lean growth *potential*.

The option to formulate diets differently for various genetic lines may be available in the future. A recent experiment was conducted at the University of Kentucky evaluating the effects of changing lysine levels in diets for growing-finishing pigs of different genotypes. Based on genotype, pigs were placed in high or low lean-tissue growth potential groups. Pigs were fed ad libitum a corn-soybean meal diet from 44 to 235 lb. Littermate barrows were randomly allotted to four dietary lysine levels (.50, .65, .80, or .95%). Daily gain and lean tissue gain were maximized with a dietary lysine level of .65% in the low lean genotype (Table 1). However, the "high lean" genotype required a much higher lysine level (.80 to .95%) to maximize daily gain and carcass leanness.

Table 1. Effect of Various Dietary Lysine Levels for Low and High Lean Genotypes

		Lysine level, %			
Item	Genotype	.50	.65	.80	.95
Lean gain[abc]	High lean	.63	.85	.88	.90
(lb/d)	Low lean	.61	.69	.69	.68

[a]Lysine effect ($P<.05$).
[b]Genotype effect ($P<.05$).
[c]Lysine × genotype interaction ($P<.05$).

Lean growth rate and lean tissue feed can be improved through consistent performance testing and selection. Pigs with low lean-gain potential only require low amino acid inputs to achieve their maximum daily lean deposition. Pigs with high lean-gain potential respond to higher nutrient inputs by increasing lean growth rate. In fact, with the higher lysine levels, the high-lean genotypes had larger loin eye areas, less backfat, and greater lean gain than the low-lean genotypes in the Kentucky experiment. This research indicates that the relatively unimproved pig will not respond to increases in protein or lysine levels and, therefore, will

perform satisfactorily on conventional grain-soybean meal diets containing 16% CP during the growing phase and 14% CP during the finishing phase.

Feed Intake and Lean Growth

The nutritional program needed to achieve the genetic capacity for maximum lean growth of pigs depends on feed intake, as well as digestibility and efficiency of nutrient use. As the pig grows, changes in voluntary feed intake and changes in maintenance requirement reduce energy efficiency in conversion of feed to tissue or product. Pigs that have high lean-growth potential possess a higher maintenance requirement but efficiently utilize energy for body protein accretion up to ad libitum feeding. In fact, in pigs selected for high lean-tissue accretion, feed intake may be the upper ceiling limiting further improvements in lean growth.

The growing-finishing pig is generally considered to regulate feed intake within the environmental "comfort zone" to maintain a constant daily intake of energy. The amount of feed that is consumed is determined by the energy density of the diet fed. As the energy density of the diet increases (fat addition), the amount of feed consumed decreases to maintain a constant energy intake. Diets that do not adequately provide the required amounts (mg, g) of essential nutrients (i.e., amino acids) fail to allow maximum lean growth.

Feed intake and maintenance requirement of finishing pigs are greatly influenced by effective temperature of the environment. Table 2 illustrates the influence of air temperature on feed intake, gain, and feed efficiency. Feed intake is greatly influenced at temperatures above and below the comfort zone. Pigs exposed to freezing temperatures consume excessive quantities of feed to offset heat loss demands. At the other extreme, heat stress, feed intake is extremely low. During heat stress, nutrient intake is a major production problem. Formulation of swine diets should be adjusted to account for variation in feed intake as related to environmental temperature (i.e., season) changes.

Table 2. Effect of Temperature on Finishing Pig Performance

Temperature, °F	Daily intake, lb	Daily gain, lb	F/G
32	11.16	1.18	9.45
41	8.27	1.17	7.10
50	7.70	1.76	4.34
59	6.93	1.74	3.99
68	7.09	1.87	3.79
77	5.78	1.58	3.65
86	4.87	.98	4.91
95	3.33	.68	4.87

Biotechnology and Lean Growth

Biotechnology has developed a number of compounds that partition nutrients away from fat tissue deposition and toward lean (muscle) tissue accretion in swine. Two compounds that have received considerable research attention are porcine somatotropin (growth hormone) and beta agonists. Somatotropin is a naturally occurring protein found in the blood of all mammals. Beta agonists are compounds commonly used in human medicine. Somatotropin and beta agonists can dramatically influence carcass leanness and ultimately pork product quality. Research has shown that porcine somatotropin can increase daily gains up to 19%, improve feed efficiency up to 28%, and reduce backfat thickness up to 33%.

Feed intake is often reduced when somatotropin is administered to finishing pigs. In addition, improvements in carcass leanness may increase dietary amino acid needs. A recent trial conducted at Kansas State evaluated the influence of dietary lysine on growth performance and carcass characteristics of finishing swine. Treatments included either a daily injection of 4 mg of porcine somatotropin or placebo, in combination with a diet containing .6% lysine (NRC requirement) or diets containing .8, 1.0, 1.2, or 1.4% lysine provided by synthetic lysine. Average daily gain was maximized at the 1.2% dietary lysine level, with those pigs gaining approximately 35% faster than control or somatotropin-treated pigs receiving the .6% lysine diet (Table 3). Porcine somatotropin-treated pigs fed either a 1.2 or 1.4% lysine diet were 33% more efficient than control or somatotropin-treated pigs fed the .6% lysine diet. It would appear that the lysine requirement of porcine somatotropin-treated pigs is at least double the present recommendations for finishing swine.

Conclusions

Goals of the swine industry must be to optimize lean accretion and to improve the efficiency of lean production to meet future packer and consumer demands for pork. Diets that do not adequately provide the requirement of essential nutrients fail to allow maximum lean tissue growth. Many factors influence the nutrient requirements of pigs, including sex, genotype, feed intake, housing, etc.

Finishing pigs may need to be fed diets with higher lysine and increased energy density (2 to 3% added fat) to optimize lean tissue growth. Improved genetic lines will need increased daily nutrient intakes to maximize lean growth. Also, environmental temperature should be considered in formulating swine diets to prevent nutrient deficiencies. Listed in Table 4 are recommendations that producers could use in formulating diets in the future for optimizing lean tissue growth in swine.

Biotechnology has been developed that will greatly increase lean efficiency for the swine industry in the future. Feed intake is often reduced with the application of biotechnology. Recent data indicate that finishing pigs treated with porcine somatotropin have a relatively high dietary lysine requirement. Growth performance and carcass traits of finishing pigs were optimized at dietary lysine levels of 1.2 to 1.4%, which corresponds to lysine intakes of 30 to 36 g/d. Other nutrients should be increased to take advantage of maximizing lean tissue accretion in pigs treated with porcine somatotropin. Currently, porcine somatotropin or beta agonists are <u>not available</u> to the swine industry, except for research purposes.

Table 3. Effect of pST and Dietary Lysine on Growth Performance[a]

Item	Control .6% lysine	pST-treated, % lysine .6	.8	1.0	1.2	1.4
Daily gain, lb						
Day 28[bc]	1.87	1.57	1.94	2.56	2.73	2.62
Overall[bc]	1.98	1.65	2.14	2.56	2.65	2.56
Daily feed intake, lb						
Day 28[d]	5.47	4.78	4.87	5.20	5.34	5.14
Overall[d]	6.11	4.98	5.42	5.53	5.45	5.29
Feed conversion (F/G)						
Day 28[bc]	2.91	3.13	2.52	2.04	1.96	1.98
Overall[bc]	3.07	3.03	2.54	2.18	2.07	2.08

[a]A total of 72 finishing pigs with an avg initial wt of 130 lb and avg final wt of 230 lb. Overall trial duration ranged from 42 to 66 d. Linear and quadratic comparisons correspond to only pST treatments.
[b]Linear effect of lysine ($P<.01$).
[c]Quadratic effect of lysine ($P<.01$).
[d]Quadratic effect of lysine ($P<.10$).

Table 4. Dietary Lysine Recommendations[a]

Phase (wt, lb)	Winter Gilts	Winter Barrows	Summer Gilts	Summer Barrows
~~50~~ 80 to 120	.90	.80	1.00	.90
120 to 170	.85	.75	.90	.80
170 to market	.75	.65	.85	.75

[a]These recommended nutrient allowances are only useful if the pork producer first adopts split-sex feeding as a management practice.