Amino Acid Supplements for Pigs

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Amino acids are the building blocks of protein. The various proteins in muscle, organs, bone, blood, and other body tissues consist of 20 amino acids. Ten of these, the "essential" amino acids, must be provided in the diet for pigs to synthesize body protein. The other 10, called the "nonessential" amino acids, can be produced by the pig from glucose, other metabolites, and various sources of nitrogen.

The amino acid that we commonly hear the most about is lysine for two major reasons. First, the concentration of lysine in muscle and other tissues is relatively high (about 7%); and second, many of the feedstuffs that we feed to pigs are quite low in lysine. Cereal grains are notoriously low in lysine. For example, corn and grain sorghum contain about .25% lysine -- less than one-third to one-fourth the amount of lysine that is required by the growing pig. Wheat and barley are higher in lysine than corn (.35 to .40%), but they are still well below the pig's requirement. Consequently, these feed grains must be supplemented with a protein source that is high in lysine (such as soybean meal) in order to meet the lysine requirement of pigs.

We generally hear much less about the other nine amino acids because they are normally provided in adequate amounts by the protein supplements that are used to supply lysine. In other words, if one adds sufficient amounts of a good quality protein supplement to meet the lysine requirement, the requirements for the other amino acids will be met.

Four amino acids are now being produced and sold for use in the feed industry. Lysine is produced as lysine•HCl, which contains 78% lysine, by three U.S. companies (Heartland Lysine, BioKyowa, Archer Daniel Midland), and is by far the most commonly used amino acid in swine feeds. Methionine, threonine, and tryptophan also are used to a limited extent, mainly in starter diets. They are available in relatively pure forms (98.5-99% pure), and tryptophan is also available in combination with lysine (Tryptosine®, Archer Daniel Midland).

Certain principles must be clearly understood when considering the use of supplemental lysine or the other amino acids:

First, these supplements are of no benefit unless the diet is deficient in the specific amino acid under consideration. So adding lysine HCl to a diet that is already adequate in lysine is of no benefit. However, if the diet is lower in total protein and slightly deficient in lysine, then supplemental lysine will result in increased performance.

Second, adding a second amino acid when another amino acid is first limiting is of no benefit, and may actually be detrimental. For example, adding methionine to a diet that is also deficient in lysine is useless, even if the diet is also deficient in methionine. If lysine is more deficient than methionine, the diet must first be corrected with lysine supplementation before methionine supplementation does any good. For this reason, it is important to know the order in which amino acids become deficient when the level of crude protein is reduced in the diet.

As a general rule of thumb for corn-soybean meal diets, one can delete 100 pounds of dehulled

soybean meal from a ton of feed and replace it with 3.85 pounds of lysine•HCl and 96.15 pounds of corn -- and pig performance will not be affected (Table 1). This amount of lysine•HCl supplies .15% lysine to the diet. Also, the 100 pounds per ton reduction in soybean meal is equivalent to a 2 percentage point reduction in total dietary protein. This general rule of thumb can be applied to most cereal grains and protein supplements.

Further reductions in dietary protein, even when additional lysine is supplemented, results in depressed pig performance. The reason is that other amino acids become deficient when more than 100 pounds of soybean meal is deleted from the diet. The depression in performance can be prevented by adding threonine, tryptophan, and methionine, along with additional lysine•HCl to the diet, as shown in Table 2.

One of the major advantages in using lower protein, amino acid supplemented diets is the positive impact that these programs have on the environment. Recent studies at the University of Kentucky have shown that nitrogen excretion is reduced by 15-20% when the dietary protein is decreased by 2 points and lysine added; and is reduced by 30-35% when the dietary protein is decreased by 4 points and the four amino acids added. Ammonia and other odorous emissions from manure also are substantially reduced with low protein, amino acid supplemented diets. Studies at UK have shown that ammonia emissions can be cut in half by feeding these types of diets.

Several recent studies at our university indicate that carcass leanness is decreased slightly when low protein, amino acid supplemented diets are fed to finishing pigs. This is probably due to the higher net energy in corn, as compared with soybean meal, and the greater amount of corn (and lesser amount of soybean meal) in a reduced protein, amino acid supplemented diet. We are currently investigating ways of preventing this from happening.

So what about the bottom line? Is the use of supplemental amino acids cost effective? In situations where only lysine is supplemented, the answer is yes. Lysine•HCl is competitively priced and the cost closely follows the price of soybean meal. Presently, lysine•HCl can be purchased in ton quantities at $1.20 to $1.25 per pound. When used according to the guidelines discussed previously and at present costs of corn ($4.40 per bushel) and soybean meal ($270 per ton), lysine usage reduces the feed cost by about $1.25 per ton.

However, if further reductions in dietary protein are implemented and lysine, threonine, tryptophan, and methionine are supplemented, diet cost is increased. The cost of a diet in which the protein is reduced by 4 percentage points and the diet then supplemented with adequate amounts of lysine, threonine, tryptophan, and methionine is from $7.00 to $11.00 per ton more than a conventional diet at today's prices of corn, soybean meal, and amino acids. This additional cost would have to be weighed against the benefits to the environment from reducing nitrogen in the manure and reducing ammonia and other odor emissions from the manure.

Table 1. Lysine Supplementation of Reduced Protein Diets for Pigs[a]

Protein:	Adequate[a]	Reduced[b] + Lysine[c]	Reduced[b]
Daily gain, lb	1.62	1.62	1.47
Daily feed, lb	5.01	5.02	5.10
Feed:gain	3.09	3.10	3.47

[a]Two University of Kentucky experiments, 78 pigs/treatment, 42-227 lb.

[b]Adequate = 17% protein in grower, 15% protein in developer, and 13% protein in finisher; Reduced = 15, 13, and 11% protein during the three phases, respectively (2 percentage point reduction).

[c]Lysine•HCl added to provide .15% lysine, making it equivlent to the total level in the adequate diet.

Table 2. Amino Acid Supplementation of Low Protein Diets for Pigs[a]

Protein:	Adequate[a]	Low[a] + Amino Acids[b]
Daily gain, lb	1.63	1.64
Daily feed, lb	4.99	5.03
Feed:gain	3.06	3.07

[a]Seven experiments at the University of Kentucky involving growing pigs (37-75 lb), finishing pigs (117-207 lb), and growing-finishing pigs (46-240 lb); 184 pigs per treatment.

[b]Adequate = 16-17% in grower, 14-15% in developer, and 13-14% in finisher; Low = 12-13%, 10-11%, and 9-10% during the three phases, respectively (4 percentage point reduction).

[c]Added lysine (.30%), threonine (.05-.10%), tryptophan (.03-.05%), and methionine (.05-.10%).