Amino Acid Requirements Based on Protein Deposition Rates

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Introduction

The pace of change in swine diet formulation over the past decade has been truly staggering. During the 1990’s, we successfully adopted a number of new technologies. The use of phase feeding is now almost universal. Diets are formulated on digestible rather than total amino acids, and the next step, to true digestible amino acids, appears to be just around the corner. We have a much better understanding of the relationship between whole body growth, protein/lean accretion and nutrient supply in the diet.

As important as defining nutrient requirements may be, supplying those nutrients using available ingredients must occur with the same precision. We are just beginning to understand the impact of ingredient variability, especially in energy content, on the accuracy of diet formulation; the next decade should present exciting new developments in this important area.

Finally, perhaps the most important development of the 1990’s has been the recognition that economy is as important as productivity; feeding programs are increasingly evaluated as much on the basis of cost per kg of gain, or cost per pig sold, or profit per pig space, as on days to market and average carcass index.

Defining Goals of the Feeding Program

The most important, and often most overlooked, step in diet formulation is goal setting. We used to consider goals of feeding programs in terms of maximising growth rate, or achieving the highest possible carcass index. Now, the emphasis is switching to achieving a given rate of lean tissue gain, or litter growth rate, or cost per kg gain. For example, if a given herd has the potential to achieve a protein deposition rate of 150 g/d, but is currently only achieving 135 g/d, serious discussions must take place; should the goal be to feed for 135 g/d, which at the current level of performance will result in the lowest feed cost per pig, or should the goal be to feed for 150 g/d, on the assumption that this is possible for the herd, and if achieved, would increase barn throughput (8 days or more) and perhaps improve carcass yield and thus revenues. In other words, should the feeding program be designed to meet the needs of actual, current productivity, or should it be designed to push the envelope and allow the herd to move forward in both performance and profit?

It is extremely important for everyone involved in the feeding program, from the nutritionist through to the barn staff, to be very clear on the goals of the feeding program. This may be more important in the breeding herd than in growout, but the principle is the same. For example, if the nutritionist assumes a sow lactation feed intake of 6 kg, and the herd is only achieving 5.3 kg, problems will almost definitely arise.
Determining Protein Deposition Rates

Dr. Pettigrew, in a previous talk, has already discussed the various ways of determining protein deposition rates on the farm. The most common are:
1. the use of real time ultrasound to measure it directly in a given herd
2. apply data obtained from packer kill sheets.

Both methods have their limitations, but they are an improvement over previous approaches. A third option should be considered. This requires communication with the breeding company, who can help with the third option:
3. define protein deposition targets.

Again, the question arises: should the feeding program support the current level of productivity in the herd (options 1 or 2 apply), with the goal of minimizing feed cost per pig sold, or should it be designed to recognize the inherent genetic ability of the pig, which will probably maximize gross income per pig? Of course, other management procedures must be in place to allow the pigs to perform to their genetic potential. Net income per pig and net income per pig place can be maximized under either option, depending on other circumstances in the barn, and the relationship between input costs and market prices.

Estimating Amino Acid Requirements

Lysine

The lysine required by the pig can be divided into two components: maintenance and growth. The maintenance requirement for apparent ileal digestible lysine is defined by the following equation (Wang and Fuller, 1989):

$$39 \text{ mg/kg BW}^{0.75}$$

Thus, the maintenance requirement for lysine represents a small but significant portion of the lysine required by the growing pig, as summarised in Table 1. Rarely will the maintenance requirement for lysine exceed 10% of the total requirement.

Apparent ileal digestible lysine can be converted to total lysine by multiplying by 1.22, assuming the apparent digestibility of lysine in a diet is 82%. Similarly, to convert apparent ileal digestible lysine to true ileal digestible, multiply by approximately 1.09 (NRC, 1998).

The NRC (1998) suggests that to calculate the apparent ileal digestible lysine requirement for protein deposition, merely multiply the protein deposition rate by 0.111. Thus, a very, very good 25 kg pig with a protein deposition rate of 140 g/d would require 15.5 g/d for growth, or a total of 16.2 g/d including both growth and maintenance.

Because diets must be formulated on the basis of a lysine concentration, not a daily lysine intake, the above daily lysine requirement must be converted to a percentage basis. Assuming that under normal commercial conditions, the high performing pig will eat about 95% of the daily DE predicted by NRC (1998), or 1.86 kg/d, then the apparent ileal digestible lysine content of the diet must be 0.87%.

There is increasing interest in expressing amino acid requirements as a ratio to energy content of the diet. Again, assuming the pig is eating 95% of the daily DE predicted by NRC (1998), or
6,320 kcal, then the lysine:DE ratio would be 2.6 g/Mcal DE. One reason why lysine:DE ratios are being used more frequently than in the past is the important role of energy in driving protein growth. Calculating the lysine requirement on a daily intake basis makes it easy to miss the need for adequate energy. Suggested lysine:DE ratios are presented in Table 2.

Other Amino Acids

Generally, the other amino acids required in the diet are estimated using ideal protein ratios. These are presented in Tables 3 and 4.

What About Energy

As indicated previously, there is no doubt that energy intake must be adequate in order to support optimum protein accretion. Providing sufficient lysine to support a protein deposition rate of 140 g/d, when daily energy intake is sufficient to support only 120 g/d is clearly ill advised. Research is underway to better define the pig’s response to energy concentration. Once we have the information on energy responses by the pig, diet formulation will become much easier, and more precise.

Summary

Formulation of diets to meet amino acid requirements is clearly moving to a more factorial approach, allowing definition of optimum levels under specific management conditions. However, the importance of knowing protein deposition rate on a given farm, or setting appropriate targets, is an important first step. Then, the daily feed intake must also be known, although estimates are possible. Finally, the energy content of the diet must be kept in relation to protein deposition targets, since inadequacy of daily energy intake, relative to lysine, will result in the very costly breakdown of excess amino acids for use as energy.

References


### Table 1. Lysine Requirement Based on Protein Deposition Rate

<table>
<thead>
<tr>
<th>Weight kg</th>
<th>Protein Deposition g/d</th>
<th>App. Ileal Digestible Lysine g/d</th>
<th>Total Lysine g/d</th>
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<tr>
<td></td>
<td>Maint.</td>
<td>Gain</td>
<td>Total</td>
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### Table 2. Suggested Lysine:Energy Ratios

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<th>Body weight (kg)</th>
<th>Lean Growth Potential</th>
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<td>- gram apparent digestible lysine/Mcal DE -</td>
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<td>100 to 120 kg</td>
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Source: Prairie Swine Centre Inc., 2000

NB: Lean growth potentials correspond to overall protein deposition rates of 150 g/d, 135 g/d and 120 g/d for excellent, very good and good categories, respectively. Above based on diet DE content declining from 3,400 kcal/kg to 3,250 kcal/kg from the early through to the final growout phase.
### Table 3. Ideal Pattern Of Apparent Digestible Amino Acids

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Growing Pigs</th>
<th>Adults</th>
<th>5 - 25 kg</th>
<th>25-50 kg</th>
<th>50-75 kg</th>
<th>75-120 kg</th>
<th>Gestation</th>
<th>Lactation</th>
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Source: Prairie Swine Centre Inc., 2000

### Table 4. Ideal Pattern Of Total Amino Acids

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