Proteins and Amino Acids

Review...

- Proteins are composed of amino acids
- Amino acids are the essential nutrients
- The dietary provision of amino acids in correct amount and provisions determines the adequacy of the protein in the diet

Review....

Most limiting amino acid concept....

- Def.- the amino acid found in the diet at the lowest concentration relative to the animals requirements
- Finishing diet formulated to contain 13.2% CP would contain:
  - .61 Lys
  - .22 Met
  - .54 Thr
  - .16 Trp

Finishing diet formulated to contain 13.2% CP would contain:

- .61 Lys (req. 0.60)→.61/.60*100 = 102%
- .22 Met (req. 0.16)→.22/.16*100 = 140%
- .54 Thr (req 0.41)→.54/.41*100 = 130%
- .16 Trp (req.11)→ .16/.11*100 = 145%

- Which AA is most limiting?
  - 1st limiting = Lys
  - 2nd limiting = Thr
  - 3rd limiting = Met
  - 4th limiting = Trp

Therefore, if you formulated the diet on a Lys basis, the diet would be sufficient in all AA.

If the diet was formulated on a Thr basis, it would be deficient in Lys.

Nutrient Requirements...

- AA requirements for the growing pig are related to the rate of protein accretion, energy intake, and dietray energy density
- Growing pigs
  - Daily Lys requirement =
    - $Lys_{Maintenance}$ + $Lys_{Protein\ accretion}$

Protein:Energy Relationship

- Protein accretion requires energy
- Up to a point, protein accretion is linearly correlated with energy intake
- Animals usually consume enough feed to meet their energy requirements if given ad libitum access to feed

Lys Requirement...

- The Lys requirement can be expressed as a ratio of Lys:Energy
- The Lys requirement (% or g/kg_{diet}) increases with increasing energy concentration in the diet
- $\uparrow[ME]_{diet} \rightarrow \downarrow$Feed Intake

AA Requirements...

- Amino acid requirements can be listed as a ratio of the AA to Lys

How much Lys should be in the diet?

Body Weight (kg),	3–5	5–10	10–20	20–50	50–80	80–120
ME (kcal/kg)	3,265	3,265	3,265	3,265	3,265	3,265
Lysine (%)	1.50	1.35	1.15	0.95	0.75	0.60

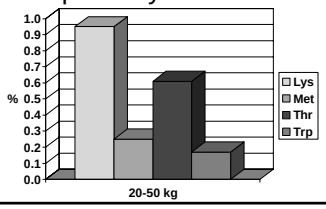
What if we increase the dietary ME level?

Amino acid ratios relative to Lys?

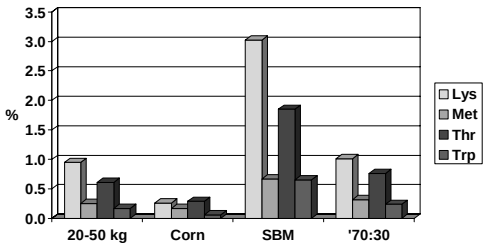
- Can we adjust other amino acid levels?
- If so, how, and to what level?

Protein Quality....

- "Protein Quality" increases as the ratio of amino acids in the feedstuffs more closely resembles the ratio of amino acids required by the animal



Amino Acid Ratios...



Converting to a Lys basis...

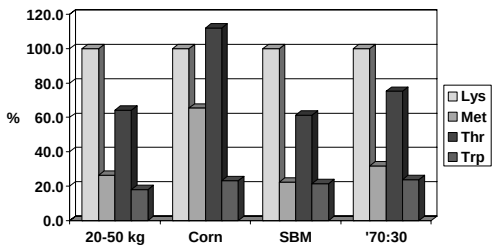
	%	% of Lys
Lys	3.02	100
Met	.67	22.2
Thr	1.85	61.3
Trp	.65	21.5

Maintaining the Lys:ME?

Converting to a Lys basis...

	%	% of Lys
Lys		
Met		
Thr		
Trp		

Amino Acid Ratios Relative to Lys



The Concept of an "Ideal" Protein

⇨ Must contain all EAA, and in the correct ratios.

Proteins and Amino Acids

⇨ The closer the amino acid profile of the dietary protein to that of the tissue or product being produced, the better the biological value and efficiency of utilization.

⇨ There is a high correlation between AA requirements for growth and the amino acid composition of the carcass.

Proteins and Amino Acids

Diet | **Metabolism** | **Cell & Tissue Proteins**

EAA → Muscle
100 units lys
114 units arg
32 units his
46 units met
66 units phe
56 units tyr

Proteins and Amino Acids

Diet | **Metabolism** | **Animal Cells & Tissue**

EAA
100 units lys
114 units arg
32 units his
46 units met
66 units phe
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→ **Muscle**
100 units lysine
114 units arg
32 units hist
46 units meth
66 units phen
56 units tyr

Proteins and Amino Acids

V. The Concept of an "Ideal" Protein

A. Practical application: The requirements for EAA can be calculated if the **lysine** requirement is known.

B. Examples from the NRC Table

1. Maintenance
2. Protein Accretion
3. Lactation

Converting to a Lys basis...

	%	% of Lys
Lys	.95	100
Met	.25	26.3
Thr	.61	64.2
Trp	.17	17.9

Ideal protein concept...

Proteins and Amino Acids

VI. Feed ingredients contain various proteins that are digested to provide amino acids.

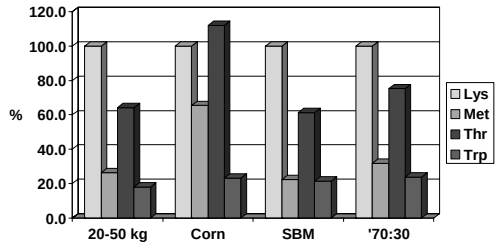
A. Soybean meal - 44 or 48% crude protein

1. Low in sulfur amino acids, but a good source of other amino acids.

B. Corn gluten meal

1. A good source of sulfur amino acids.

Amino Acid Ratios Relative to Lys



Proteins and Amino Acids

⇨ Deficits can be covered by blending complimentary ingredients together, or by providing synthetic amino acids.

Concept of Bioavailability....

- Bioavailability- the availability of a given nutrient for absorption by the animal
- A given feed ingredient may contain 2 g of Lys/kg, but only 1.5 g may be available to the animal for absorption

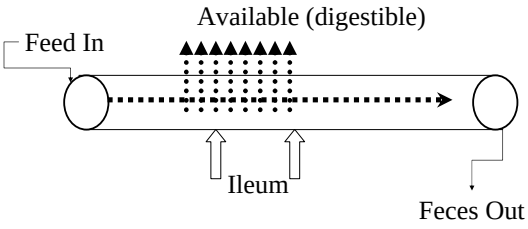
Digestibility...

$$\frac{\text{(Amt. of Nutrient in Feed- Amt of Nutrient in Feces)}}{\text{Amt. of Nutrient in Feed}} \times 100$$

However, digestibility based on fecal amino acid excretion does not accurately represent the the amount or proportion of amino acids digested by the animal.

Why not???

Nutrient Requirements



⇨ ***A more accurate estimate of the amino acid <u>availability</u> to the animal.***

Ileal digestibility...

$$\frac{\text{(Amt. of Nutrient in Feed- Amt of Nutrient in Ileal digesta)}}{\text{Amt. of Nutrient in Feed}} \times 100$$

Apparent ileal digestibility...

$$\frac{[AA]_{feed} - [AA]_{digesta}}{[AA]_{feed}} \times 100$$

Ileal digesta contains amino acids from two sources:

1. Unabsorbed feed amino acids
2. Amino acids from endogenous origin
   - Sloughed cells
   - Non reabsorbed digestive enzymes

True AA digestibility...

- Apparent AA digestibility is adjusted to account for endogenous losses

$$\frac{[AA]_{feed} - [AA]_{digesta} + [\text{Endogenous AA}]_{digesta}}{[AA]_{feed}} \times 100$$

True AA digestibility...

- Difficulty in determining True AA digestibility lies in the difficulties associated with determining endogenous AA losses

Problem:

10.0 g lysine consumed in
1000 g feed (1% of diet)
2.1 g ileal lysine remaining,
7.9 g absorbed
0.3 g endogenous ileal lysine

Apparent: 1. (10-2.1)/10 = 79% *(0.79%)*

True: 2. [10 - (2.1 -.3)]/10 = 82% *(.82%)*