Dietary Protein

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Some slides adapted from Dairy Nutrition & Management (ANSCI 200/492), University of Illinois at Urbana-Champaign, Dr. Mike Hutjens & Jimmy Clark

Protein is Required for:

Supply nitrogen to microbial protein synthesis (i.e., microbial growth)
  - Ammonia
  - Amino acids
  - Peptides

Supply amino acids for synthesis of:
  - Milk protein
  - Tissue protein
  - Enzymes, hormones, etc.

Supply carbon skeletons for glucose synthesis (minor role)
Crude Protein Requirement

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<table>
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<tbody>
<tr>
<td>pregnant, nonlactating</td>
<td>1.1 kg/day</td>
</tr>
<tr>
<td>lactating, nonpregnant</td>
<td>4.4 kg/day</td>
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<td>Increase for lactation</td>
<td>3.3 kg/day</td>
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<td>or</td>
<td>300% increase</td>
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600 kg cow; milk yield of 88#/d of 3.5% FCM

Rumen Degradable Protein (RDP)

1. Rapidly degraded in rumen (NRC, 1989)
   - Alfalfa Silage 77%
   - Barley 73%
   - Soybean meal 65%

2. RDP in diet should be:
   - 10 - 12% of dry matter
   - 60 - 66% of CP
**Soluble Protein**

1. Crude protein that goes into solution
   - NPN
   - Peptides
   - Protein

2. Protein that is readily available

3. Examples of feeds high in soluble CP
   - Urea 100%
   - Wet Silage 45%
   - Raw Soybeans 40%

4. Soluble CP & degradable CP are not the same

5. Soluble CP in diet should be (Cornell Model)
   - 1/2 of RDP
   - 5 - 6% of Dry Matter
   - 28 - 32% of CP

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**Rumen Undegradable Protein (RUP)**

1. Protein not degraded in rumen

2. Examples of feeds with high RUP
   (NRC, 1989)
   - Blood meal 82%
   - Fish meal 60%
   - Corn gluten meal 55%
   - Corn grain 52%
   - Protected amino acids 100%?

3. Feed protein digested in small intestine

4. RUP in diet should be:
   - 5 to 7% of dry matter
   - 34 to 40% of CP
General Recommendations for Concentrations of Protein in Dairy Cow Rations

- 16-18% CP, % DM
- 56-64% RDP, % CP
  - 28-32% Soluble CP, % CP (50% RDP)
- 36-44% RUP, % CP

CP Fraction Analysis

Roe et al. (1990), Sniffen et al. (1992)
Feed protein

- RDP → AA
- NPN → NH₃ → bacteria
- RUP → SI → peptides → AA for cow

AA=amino acid; SI=small intestine
**Microbial CP**

- ~50% CP, of which 80% is AA
- ~60% of non-ammonia N reaching the SI
- very high quality (resembles casein)
- diet has little influence on quality (AA profile) of microbial CP
- ∴ RUP sources are important in protein quality reaching SI

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**EAA Profiles of Milk and Feeds**

Clark et al. (1992)
Goals of Protein Nutrition

- Maximize microbial protein synthesis
- Provide RUP to small intestine
- Assure high absorption of protein reaching small intestine
- Absorbed protein should be high quality (AA profile)
What drives microbial protein synthesis?

- NRC estimates daily microbial protein using energy intake
  
  \[\text{MCP(g)} = 6.25 \times [-30.93 + (11.45 \times \text{Mcal/d})]\]
  
  - ex) 1.7 Mcal/kg, 18% CP diet, 26 kg/d DMI
    - 1.7 Mcal * 26 kg = 44.2 Mcal/d intake
  
  \[6.25 \times [-30.93 + (11.45 \times 44.2)] = 2970 \text{ g} = 6.5 \#\]

Lack of beneficial production responses when rumen undegradable proteins (RUP) or protected amino acids are fed may be attributed to:

1. Feeding larger amounts of dietary CP than required by the cows.
2. Supplemental protein supplies only a small proportion of the total dietary protein that escapes ruminal degradation.
3. A shortage of degradable protein in the diet.
4. Decreased microbial protein synthesis because of low ruminal availability of N, energy, or other factors.
Lack of beneficial production responses may be attributed to:

5. Not supplying the limiting amino acids to the absorption sites in the intestine.
6. Low digestibility of protein passing to the small intestine.
7. Feeding only one protein supplement that creates an amino acid imbalance.
8. Energy, rather than protein & amino acids, was limiting milk & milk protein synthesis.
9. Feeding rumen undegradable protein at an improper stage of lactation.
10. Mobilization or utilization of nutrients from body tissue, which prevents a nutrient deficiency.

Advantages for ruminally protected amino acids

1. RPAA can substitute for ruminally undegradable protein
2. More space in ration for other nutrients
3. Opportunity to balance supply of absorbable amino acids
4. Environmentally friendly (reduce N pollution of surface and ground water)
Disadvantages for ruminally protected amino acids

1. Cannot accurately predict response
2. Cost