Fat Feeding

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

Use Supplemental Fats

1. Increase diet energy density while maintaining adequate fiber content
2. Improve energetic efficiency
3. Improve energy balance
4. Improve reproduction

<table>
<thead>
<tr>
<th></th>
<th>Ground Corn</th>
<th>Fat</th>
<th>Fat/Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross energy</td>
<td>1.90</td>
<td>4.30</td>
<td>2.25</td>
</tr>
<tr>
<td>Digestible energy</td>
<td>1.70</td>
<td>3.31</td>
<td>1.95</td>
</tr>
<tr>
<td>Metabolizable energy</td>
<td>1.52</td>
<td>3.31</td>
<td>2.18</td>
</tr>
<tr>
<td>Net energy</td>
<td>0.89</td>
<td>2.70</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Production Responses to Supplemental Fat

DIETARY FAT AND MILK COMPOSITION

• Milk fat:
  – Dietary fat may increase 0.1 to 0.3%
    • (If rumen fermentation is not disrupted)
    – Yield often increased
• Milk protein:
  – Dietary fat may decrease 0.1%
  – Yield usually unchanged
  • Dilution of protein production as milk yield increases
Sources of Fat in Diets for Dairy Cows

1. Basal ingredients (forages, grains)
2. High-fat by-product feeds
3. Oilseeds
4. Animal fats
5. Granular (inert) fats

Properties of Fat that Need to be Considered

- Digestibility
  - Post-ruminal digestion and absorption
- Palatability and effects on intake
- Ruminal inertness
  - Saturated vs. unsaturated

Dietary Lipids

- Triglycerides
- Glycolipids
- Phospholipids

Lipolysis

- Esterified Plant Lipid
  + $3\text{H}_2\text{O}$
  → Free Fatty Acids

Biohydrogenation

- Reduction of double bonds
- Result: fatty acids that are more saturated with hydrogen

Biohydrogenation

(adapted from Harfoot et al., 1973)
Saturated Hydrogenated Fats

Tallow
Grease

Unsaturated Vegetable Oils
(Corn, Soybeans)

Fatty Acid Content
- High energy component of fat
- 5 – 8 common fatty acids
- Energy content is ~9.4 kcal/g
- Amount of fatty acids in fat supplement is important in determining energy value of supplement

Diet

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>Alfalfa hay</th>
<th>Grass pasture</th>
<th>Soybean (seed)</th>
<th>Corn (seed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myristic</td>
<td>C_{14:0}</td>
<td>0.9</td>
<td>1.1</td>
<td>...</td>
</tr>
<tr>
<td>Palmitic</td>
<td>C_{16:0}</td>
<td>33.9</td>
<td>15.9</td>
<td>12.4</td>
</tr>
<tr>
<td>Palmitoleic</td>
<td>C_{16:1}</td>
<td>1.2</td>
<td>2.5</td>
<td>...</td>
</tr>
<tr>
<td>Stearic</td>
<td>C_{18:0}</td>
<td>3.8</td>
<td>2.0</td>
<td>3.7</td>
</tr>
<tr>
<td>Oleic</td>
<td>C_{18:1}</td>
<td>3.0</td>
<td>3.4</td>
<td>25.4</td>
</tr>
<tr>
<td>Linoleic</td>
<td>C_{18:2}</td>
<td>24.0</td>
<td>13.2</td>
<td>50.6</td>
</tr>
<tr>
<td>Linolenic</td>
<td>C_{18:3}</td>
<td>31.0</td>
<td>61.3</td>
<td>7.9</td>
</tr>
</tbody>
</table>

(Palmquist and Jenkins, 1980)

Fat Supplements

Advantages of Oilseeds

1. Provide other key nutrients (protein, digestible fiber)
2. Economical
3. Ease of handling (except cottonseed)
4. Slow release of oil in rumen

Fat Content and Feeding Rates of Oilseeds

<table>
<thead>
<tr>
<th>Type</th>
<th>Fat content</th>
<th>Maximum lb to feed daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed</td>
<td>18 - 20%</td>
<td>4 to 6</td>
</tr>
<tr>
<td>Soybeans</td>
<td>18 - 20%</td>
<td>3 to 5</td>
</tr>
<tr>
<td>Canola</td>
<td>40 - 55%</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Sunflower</td>
<td>38 - 50%</td>
<td>2 to 3</td>
</tr>
<tr>
<td>High oil corn</td>
<td>6.5 - 10%</td>
<td>------</td>
</tr>
</tbody>
</table>
### Types of Feed-Grade Fats

- Tallow
- Choice white grease
- Yellow grease
- Blended animal and vegetable fats

### Feed-grade Commodity Fats

**Advantages:**
1. Generally lower cost
2. High-quality fats are acceptably inert in rumen and are highly digestible

**Disadvantages:**
1. Handling and mixing difficult
2. Quality control - variable
3. Low-quality fats can disrupt fiber digestion, decrease intake, decrease milk fat percentage

### Quality Standards for Tallow

- The more saturated, the better
  - Iodine value (IV) < 50
    - prefer 38 to 45

<table>
<thead>
<tr>
<th>Fat Source</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tallow</td>
<td>38-50</td>
</tr>
<tr>
<td>Partially hydrogenated tallow</td>
<td>14-31</td>
</tr>
<tr>
<td>Yellow grease</td>
<td>72</td>
</tr>
<tr>
<td>Corn oil</td>
<td>126</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>131</td>
</tr>
</tbody>
</table>

- Free fatty acids < 5%

### Commercial Granular Fats

**Advantages:**
1. Easy to handle and mix
2. Quality control
3. Few effects in rumen

**Disadvantages:**
1. Higher cost
2. Some are less digestible

### Relative Digestibility of Commercial Fats (Highest to lowest)

<table>
<thead>
<tr>
<th>Type of fat</th>
<th>Product names</th>
<th>Percent fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium salts of fatty acids</td>
<td>Megalac, EnerGI</td>
<td>80</td>
</tr>
<tr>
<td>Saturated free fatty acid prills</td>
<td>Energy Booster</td>
<td>99</td>
</tr>
<tr>
<td>Palm fatty acid distillates</td>
<td>Biopass</td>
<td>95</td>
</tr>
</tbody>
</table>

72-78% digestible

### Choose Fat Sources on the Basis of:

1. Cost
2. Convenience
3. Characteristics of fat
How Much Fat Should Be Fed?

Thumb rule #1:
Total fat fed = milk fat produced

Example:
90 lbs milk, 3.5% fat = 3.15 lbs fat
50 lbs feed DM, 3% fat = 1.5 lbs basal fat

So, could supplement 1.5 to 1.65 lbs fat

How Much Fat Should Be Fed?

Added fat (% of ration DM) =
\[(6 \times \text{ADF})/\text{UFA} \text{ (e.g., } 6 \times 21/85 = 1.5\% \text{ soybean)}\]
or
\[(4 \times \text{NDF})/\text{UFA} \text{ (e.g., } 4 \times 37/45 = 3.3\% \text{ tallow)}\]

Where ADF and NDF are expressed as a percent of ration DM and UFA is unsaturated fatty acids (18:1 + 18:2 + 18:3) 

Jenkins, 1993

<table>
<thead>
<tr>
<th>Fat</th>
<th>18:1</th>
<th>18:2</th>
<th>18:3</th>
<th>UFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tallow</td>
<td>42</td>
<td>3</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Animal-veg blend</td>
<td>34</td>
<td>16</td>
<td>2</td>
<td>52</td>
</tr>
<tr>
<td>Palm</td>
<td>43</td>
<td>10</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Grease</td>
<td>48</td>
<td>20</td>
<td>3</td>
<td>71</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>19</td>
<td>53</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>25</td>
<td>53</td>
<td>7</td>
<td>85</td>
</tr>
<tr>
<td>Corn</td>
<td>29</td>
<td>55</td>
<td>1</td>
<td>85</td>
</tr>
<tr>
<td>Canola</td>
<td>60</td>
<td>20</td>
<td>10</td>
<td>90</td>
</tr>
</tbody>
</table>

What is an Economical Amount of Fat to Feed?

- Up to 3% of total diet DM or 1.5 pounds per cow daily
- If high corn silage, up to 2.5% of total DM or 1.25 pounds

Other Considerations

- Reproduction
- Milk fat depression
- Consumer health

Reproduction

- Provide specific omega-6 and omega-3 fatty acids to ↑ conception and pregnancy rates
- ↓ days open
- Provide additional energy?
- Energy independent response
  - PUFA used in prostaglandin synthesis
Milk Fat Depression

- Linoleic acid
  - trans-10, cis-12 CLA
  - cis-9, trans-11 CLA
  - trans-11 C18:1
  - C18:0

Need change in rumen fermentation (lower pH) and PUFA

Effect of CLA isomers on milk fat %

Day

-2 -1 1 2 3 4 5 6 7 8

Milk Fat percentage

Infusion
c/t 10,12 CLA
cl 9,11 CLA
Control

Baumgard et al. (2000)

Human Health

- Milk fatty acids
  - ~70% saturated, ~30% unsaturated
  - Oleic acid makes up ~70% of unsaturated fatty acids

Human Health

- CLA
  - Anticarcinogen
  - Antioxidant
  - Antiatherosclerosis

Human Health


Control


Beef Extract
Human Health

- CLA content of milk can be enhanced through dietary means
- Increase in CLA arises from inhibition of trans-11 18:1 reduction
- Enriched CLA milk associated with increased trans fatty acid content
  – Might not be advantageous for the industry
- CLA could be a management tool