Cheesemaking with Sheep Milk

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- Steps in cheesemaking
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Cheesemaking Terminology
Cheesemaking terminology

- Ash
- Culture/starter culture
- Chymosin
- Casein
- Whey
- TA
- pH
Culture/starter culture

- **Starter cultures** are lactic acid bacteria that
  - “start” the fermentation
  - convert lactose to lactic acid and other products
  - contribute to flavor, body and texture of cheese

- **Mesophiles**
  - “like” middle temperatures (68-111°F)
  - used for Cheddar, Jack, Cottage, Gouda and Blue

- **Thermophiles**
  - “like” high temperatures (111-140°F)
  - used for Italian style cheeses
Culture/starter culture

- **Adjunct cultures**
  - are added intentionally to cheese milk
  - work later in the process
  - contribute to flavor, body and texture of cheese

- **Adventitious bacteria** (nonstarter lactic acid bacteria)
  - enter the cheesemaking process at various points and contribute to (positively or negatively) cheese quality
Cheesemaking terminology

- **Titratable acidity (TA)** measures the **AMOUNT** of acid in a volume
  - A base (NaOH) is used to titrate to an end point (pink color change)
  - **Apparent acidity** measures fresh milk citrates, phosphates, proteins
  - **Developed acidity** measures lactic acid (fermentation)

- **pH** measures the **CONCENTRATION** of hydrogen ions (H+) in a solution
  - Acid/acidic conditions are below 7
  - 7 = neutral
  - Base/basic conditions are above 7
### Milk proteins

#### During cheesemaking  >>>>>>  Whey

<table>
<thead>
<tr>
<th>Caseins</th>
<th>Whey Proteins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make up ~ 80% of protein</td>
<td>About 20% of milk protein</td>
</tr>
<tr>
<td>Sensitive to acid/stable to heat</td>
<td>Sensitive to heat/stable to acid</td>
</tr>
<tr>
<td>$\alpha_{s1}$-casein</td>
<td>$\beta$–lactoglobulin</td>
</tr>
<tr>
<td>$\alpha_{s2}$-casein</td>
<td>$\alpha$–lactalbumin</td>
</tr>
<tr>
<td>&quot;sensitive&quot; to Ca++</td>
<td>Other more minor ones</td>
</tr>
<tr>
<td>$\beta$-casein</td>
<td></td>
</tr>
<tr>
<td>Kappa-casein</td>
<td></td>
</tr>
<tr>
<td>stable to Ca++</td>
<td></td>
</tr>
</tbody>
</table>
Chemistry and microbiology of cheese milk
High quality cheese making

- **Begins with high quality milk**
  - From healthy animals
  - No inhibitory substances (antibiotics)
  - Cooled to less than 45°F (7°C) within 2 h of collection
  - Fresh (stored < 48 h)
  - Low bacteria levels
  - Normal somatic cell counts
  - Stainless steel equipment, pipes and fittings
  - Heat treatment??
Heat treatment of cheese milk?

- **Raw?**
  - Cheeses will likely have native flavors
  - Native microflora may include pathogens
  - Must be aged a minimum of 60 days at or above 35°F

- **Heat treated?**
  - Inactivates some pathogens, enzymes and spoilage microorganisms
  - Treated the same way (legally) as raw milk
Heat treatment of cheese milk?

- **Pasteurized?**
  - Flavors result from starter cultures and adventitious bacteria
  - Not required for aged cheeses
  - Required by law for sale of fresh cheeses
  - *Note: Do not homogenize cheese milk*

**KEY POINT:**

Every step of the process, from animal to consumer, influences the safety and quality of the end product.
High quality cheese making

- **Requires hygiene and sanitation**
  - Properly trained employees
    - Hair nets and beard nets
    - Clean and sanitized hands (gloves)
    - Foot baths
  - Appropriate chemicals and usage
    - Chlorinated alkaline cleansers
    - Acid cleaners
    - Sanitizers (sodium hypochlorite, etc.)
    - Time, temperature, concentration and agitation
High quality cheese making

- **Proceeds with high quality ingredients and supplies**
  - Starter culture
  - Coagulating enzyme (chymosin)
  - Molds (both microbial and physical)
  - Salt
  - Other inclusions (herbs, fruits, nuts)

- **Involves good record-keeping**
  - Keep track of failures along with successes
The Steps in Cheesemaking
The steps in cheese making

- Place high quality milk into recently cleaned and sanitized vat
  - Gradually raise temperature to target for culture

- Gently agitate and add culture
  - Note time and pH or TA
  - Ripen (for recommended time)
The steps in cheese making

What’s happening, chemically, in the cheese vat?
Milk Protein Chemistry

Casein sub-micelle
Ca\(^{2+}\) phosphate
Kappa casein

\(\alpha_{s1}\)-casein
\(\alpha_{s2}\)-casein
\(\beta\)-casein

Casein Micelle

- Casein sub-micelle
- Calcium phosphate
- Kappa casein
Milk Protein Chemistry

Casein Micelle

Native pH of milk (~6.7)
Lactose Fermentation Chemistry

pH 4.6
Coagulation Chemistry
The steps in cheese making

- **Add coagulating enzyme and stop agitation**
  - Note time

- **Check curd**
  - Cut curd (size depends on cheese type)
    - note time
  - Heal (rest recommended time)
But cheese makers are sometimes impatient...
Lactose Fermentation PLUS Coagulating Enzyme Chemistry

pH 6.5

Chymosin
Coagulation Enzyme Chemistry
The steps in cheese making

- **Begin gentle agitation of curd**
  - Note time and pH/TA
  - Heat/cook/stir curd (depends on cheese type)
  - Turn off heat at target temperature and agitate until target time (note time and pH/TA)
The steps in cheese making

- **Drain whey**
  - May be incremental
  - May include wash step

- Subsequent steps vary according to cheese type
Defining steps in cheese making

- **Feta**
  - Mold/hoop
  - Salt/brine

- **Cottage**
  - Rinse curds with acidified, chlorinated water 3X
  - Add cream dressing to curd (about 50:50)
Defining steps in cheese making

- **Blue-veined mold-ripened varieties**
  - Inoculate with mold spores
  - Mold/hoop
  - Aerate with needles
  - Age in high relative humidity environment

- **Camembert-style mold-ripened varieties**
  - Mold/hoop
  - Spray surfaces with mold spores
  - Age in high relative humidity environment
Defining steps in cheese making

- **Cheddar and Jack types**
  - Cheddar
  - Mill (if cheddared)
  - Salt
  - Mold/hoop
  - Press
  - Age
Defining steps in cheese making

- Mozzarella and Provolone styles
  - Stretch
  - Brine
The steps in cheese making

- **Package**
  - May include plastic, wax, etc.

- **Age/ripen**
  - All raw milk cheeses must be aged at least 60 days at 35°F or greater
  - Fresh cheese (pasteurized milk) may be sold right away
Sheep Milk Chemistry
# Sheep Milk Chemistry

Milk chemistry compared among species

<table>
<thead>
<tr>
<th></th>
<th>Water (%)</th>
<th>Lactose (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Ash (%)</th>
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</thead>
<tbody>
<tr>
<td>Cow milk</td>
<td>87.5</td>
<td>4.9</td>
<td>3.6</td>
<td>3.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Goat milk</td>
<td>87.0</td>
<td>4.5</td>
<td>4.1</td>
<td>3.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Sheep milk</td>
<td>80.9</td>
<td>5.3</td>
<td>7.0</td>
<td>5.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>
Milk Fatty Acid Chemistry of Species Compared

<table>
<thead>
<tr>
<th></th>
<th>Cow</th>
<th>Goat</th>
<th>Sheep</th>
<th>Buffalo</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Saturated total</strong></td>
<td>2.08</td>
<td>2.67</td>
<td>4.60</td>
<td>4.60</td>
<td>2.01</td>
</tr>
<tr>
<td>4:0</td>
<td>0.11</td>
<td>0.13</td>
<td>0.20</td>
<td>0.28</td>
<td>-</td>
</tr>
<tr>
<td>6:0</td>
<td>0.06</td>
<td>0.09</td>
<td>0.14</td>
<td>0.15</td>
<td>-</td>
</tr>
<tr>
<td>8:0</td>
<td>0.04</td>
<td>0.10</td>
<td>0.14</td>
<td>0.07</td>
<td>-</td>
</tr>
<tr>
<td>10:0</td>
<td>0.08</td>
<td>0.26</td>
<td>0.40</td>
<td>0.14</td>
<td>0.06</td>
</tr>
<tr>
<td>12:0</td>
<td>0.09</td>
<td>0.12</td>
<td>0.24</td>
<td>0.17</td>
<td>0.26</td>
</tr>
<tr>
<td>14:0</td>
<td>0.34</td>
<td>0.32</td>
<td>0.66</td>
<td>0.70</td>
<td>0.32</td>
</tr>
<tr>
<td>16:0</td>
<td>0.88</td>
<td>0.91</td>
<td>1.62</td>
<td>2.00</td>
<td>0.92</td>
</tr>
<tr>
<td>18:0</td>
<td>0.40</td>
<td>0.44</td>
<td>0.90</td>
<td>0.68</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Monounsaturated total</strong></td>
<td>0.96</td>
<td>1.11</td>
<td>1.72</td>
<td>1.79</td>
<td>1.66</td>
</tr>
<tr>
<td>16:1</td>
<td>0.08</td>
<td>0.08</td>
<td>0.13</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>18:1</td>
<td>0.84</td>
<td>0.98</td>
<td>1.56</td>
<td>1.57</td>
<td>1.48</td>
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<td>20:1</td>
<td>trace</td>
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<td>-</td>
<td>-</td>
<td>0.04</td>
</tr>
<tr>
<td>22:1</td>
<td>trace</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>trace</td>
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<tr>
<td><strong>Polyunsaturated total</strong></td>
<td>0.12</td>
<td>0.15</td>
<td>0.31</td>
<td>0.15</td>
<td>0.50</td>
</tr>
<tr>
<td>18:2</td>
<td>0.08</td>
<td>0.11</td>
<td>0.18</td>
<td>0.07</td>
<td>0.37</td>
</tr>
<tr>
<td>18:3</td>
<td>0.05</td>
<td>0.04</td>
<td>0.13</td>
<td>0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>18:4</td>
<td>trace</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20:4</td>
<td>trace</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>20:5</td>
<td>trace</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>trace</td>
</tr>
<tr>
<td>22:5</td>
<td>trace</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>trace</td>
</tr>
<tr>
<td>22:6</td>
<td>trace</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>trace</td>
</tr>
</tbody>
</table>

Higher total fat
Sheep Milk Chemistry

- Compared to cow milk, sheep milk
  - Has lower water content
  - Has higher lactose, fat, protein and ash
  - Has more overall flavor
    - Higher proportion of short chain volatile fatty acids
  - Yields more cheese per pound of milk
    - Yields less whey
  - Cheese is more white
    - Beta-carotene converted to Vitamin A
Cheesemaking
with Sheep Milk
Cheese Making
with Sheep Milk

• Just about any cheese made out of cow or goat milk can be made out of sheep milk.

• Unique properties of sheep milk will be more pronounced in cheese.
Cheese Making
with Sheep Milk

- **Always remember the priorities**
  - Sanitation
  - Safety
  - Quality

- **Experiment**
  - Keep records
  - Set yourself apart

- **Enjoy!**
Questions?

Cheesemaking with Sheep Milk

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Sheep Milk Production

Comparative Performance of Breeds for Commercial Milk Production

<table>
<thead>
<tr>
<th>Rank</th>
<th>Breed</th>
<th>Average Milk Production, lb.</th>
<th>Milk production relative to E. Friesian</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>East Friesian</td>
<td>658</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>Lacaune</td>
<td>627</td>
<td>0.95</td>
</tr>
<tr>
<td>3</td>
<td>Dorset</td>
<td>409</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Unpublished data from the University of Wisconsin-Madison