Soft Ripened White Mold Cheeses
The Science and the Art

Dairy Australia Webinar 2017

Gianaclis Caldwell
Summary

• The three core cheesemaking technologies for bloomies
  ─ Lactic
  ─ Rennet
  ─ Stabilized
• Food Safety Reminder
• The key factors to remember during production
• Buffering review
• pH goal benchmarks
• Starter culture options
• Surface molds and yeasts
• The influence of rennet
• Moisture and pH at hooping/forming
• The role of salt
• Affinage
The Three White Mold Technologies

• Lactic
  – Examples: Most French soft ripened goat cheeses
  – Characteristics: Firm paste, thin rind with some softening around rind. Crumbly. Small format

• Make in Nutshell:
  – Little to no rennet
  – Long coagulation to low pH, about 4.4-4.6
  – Wet, acidic curd drained in bags or open meshed small forms
  – Bag drained curd is often reformed into wheels
The Three White Mold Technologies

• Rennet Traditional—softened paste
  – Traditional Camembert and Brie
  – Soft, runny paste when ripe

• Make in a Nutshell:
  – Quick rennet coagulation (relatively)
  – Little to no stirring
  – Large wet curds at hooping
  – pH at dehooping <5.0
The Three White Mold Technologies

• Rennet – stabilized paste
  – Exported and mass produced Camembert and Brie
  – Characteristics: Soft paste with long shelf stability.
  – Artisans can use stabilization techniques too!

• Make in a Nutshell:
  – Quick rennet coagulation
  – More stirring of curds and smaller curd size
  – Possible other stabilization techniques
    • Washing curd
    • Adding fat
Don’t forget these are “High Risk” Cheeses!

- Both pasteurized and raw versions are considered high risk.
- Post contamination potential
- High surface pH – sometimes 8.0!
- Keep in mind when designing production flow
- Address in food safety plans
The Keys to All Bloomies

• Buffering
  – Milk’s natural buffering
  – How you manipulate it through pH development
• Surface de-acidification – raising the pH
  – How you manipulate it with yeasts
  – How you manipulate it with molds
  – How salt manipulates the yeasts and molds
• Softening of the paste
  – How the surface flora change the interior
  – How the environment helps
It’s all about Buffering

• Buffer Basics
  – Compounds that have the ability to resist changes in pH (free hydrogen ions)
  – Buffering Capacity of milk
    • The only reason we can make cheese
    • The better the milk’s buffering capacity the more time you have to make all cheeses
Milk’s Powerful Buffering Ability

The Casein Micelle

- Caseins  the major buffer in milk
- Calcium Phosphate  as Colloidal Calcium Phosphate (CCP) – Insoluble
  - Pre-bound ionic calcium
  - Usually 2/3 of the total CP in milk
  - Exists in milk in greater quantity in milk than would be normal in another solution of the same pH
  - Combines with lactic acid to form calcium lactate
## Comparison of Benchmarks

<table>
<thead>
<tr>
<th></th>
<th>Lactic</th>
<th>Traditional Rennet</th>
<th>Stabilized</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH at renneting</td>
<td>6.00 – 6.30</td>
<td>6.10-6.30</td>
<td>6.40-6.55</td>
</tr>
<tr>
<td>pH at unmolding</td>
<td>&lt; 4.45</td>
<td>4.65-4.85</td>
<td>4.95-5.20</td>
</tr>
<tr>
<td>Ca/FFDM (mineralization)</td>
<td>&lt;0.4%</td>
<td>0.8-1.7%</td>
<td>1.8-2.3%</td>
</tr>
<tr>
<td>Best Before</td>
<td>2-9 weeks</td>
<td>6-10 weeks</td>
<td>7-15 weeks</td>
</tr>
</tbody>
</table>
Starter Culture Choices

- **Mesophiles**
  - Produces more acid by hooping time
    - Less minerals in curd
    - Less buffering
  - Aroma

- **Thermophiles – TA 50**
  - Keeps the pH higher at hooping
    - More minerals in curd
    - More buffering
  - Exopolysaccharides
    - Texture
# Comparison of Cultures and Rennet Used

<table>
<thead>
<tr>
<th></th>
<th>Lactic</th>
<th>Traditional Rennet</th>
<th>Stabilized</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Starter</strong></td>
<td>Mesophilic</td>
<td>Mesophilic and Thermophilic</td>
<td>Thermophilic</td>
</tr>
<tr>
<td><strong>Rennet (ml/100L, 26 gal)</strong></td>
<td>4-12</td>
<td>16-25</td>
<td>25-40</td>
</tr>
<tr>
<td><strong>Geotrichum</strong></td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>P. camemberti</strong></td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
</tbody>
</table>
Yeast’s Role

• Deacidification
  – Vary in rate of surface deacidification
  – Vary on salt tolerance

• Gas Production Inside
  – Vary on whether gas is produced
  – Eyes inside are helpful for many traditional bloomy types

• Fat and Protein breakdown
  – Vary on ability to help soften the cheese
  – Vary on ability to produce other flavors
## Comparison of Yeast Options

<table>
<thead>
<tr>
<th>Yeast Option</th>
<th>Ferments on surface</th>
<th>Ferments inside plus gas</th>
<th>Neutralizing surface pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>KL- <em>Kluyveromyces lactis</em></td>
<td>Yes</td>
<td>Yes</td>
<td>+</td>
</tr>
<tr>
<td>CUM – <em>Candida utilis mesophile</em></td>
<td>Yes</td>
<td>Yes, glucose only</td>
<td>+++</td>
</tr>
<tr>
<td>DH – <em>Debaryomyces hansenii</em></td>
<td>Yes</td>
<td>No</td>
<td>++</td>
</tr>
</tbody>
</table>
Geotrichum’s Role

- Further de-acidification of rind
- Aroma
- Rind thickness
Comparison of Geotrichum Options

<table>
<thead>
<tr>
<th></th>
<th>Appearance</th>
<th>Growth Rate</th>
<th>Salt tolerance</th>
<th>Flavor</th>
<th>Lipolysis Proteolysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geo 15</td>
<td>Yeast like, cream</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>4x &lt; PC</td>
</tr>
<tr>
<td>Geo 13</td>
<td>Intermediate</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>“</td>
</tr>
<tr>
<td>Geo 17</td>
<td>Mold like, white</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>“</td>
</tr>
</tbody>
</table>
Penicillium camemberti’s Role

• Rind texture
  – Choice of PC influences texture

• Rind thickness
  – Each PC grows at a different thickness and height

• Rind aroma and paste flavor
  – Different aroma compounds produced
  – Different flavor compounds produced

• Paste texture
  – Draws lactate from paste to deacidify and allow for softening
## Comparison of PC (Choozit 10d)

<table>
<thead>
<tr>
<th></th>
<th>Whiteness</th>
<th>Growth Rate</th>
<th>Thickness</th>
<th>Proteolysis</th>
<th>Lipolysis</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP 6</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Neige</td>
<td>++</td>
<td>+</td>
<td>++++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>PC VB</td>
<td>++</td>
<td>+</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>SAM 3</td>
<td>++</td>
<td>+</td>
<td>+++</td>
<td>++</td>
<td>++</td>
<td>Anti mucor</td>
</tr>
</tbody>
</table>
### Rates of Dosing PC to Geo

<table>
<thead>
<tr>
<th>Yeasts</th>
<th>LACTIC SOFT CHEESE</th>
<th>MIXED SOFT CHEESE</th>
<th>STABILIZED SOFT CHEESE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHOOZIT® DH</td>
<td></td>
<td>1 dose* for 1000L of milk</td>
<td></td>
</tr>
<tr>
<td>CHOOZIT® KL 71 - CUM</td>
<td></td>
<td>2 doses for 1000L of milk</td>
<td></td>
</tr>
<tr>
<td><strong>Geotrichum candidum</strong></td>
<td>CHOOZIT® GEO 13 - 15 - 17</td>
<td>1-2 dose(s)** for 1000L of milk</td>
<td>2 doses* for 1000L of milk</td>
</tr>
<tr>
<td><strong>Penicillium camemberti</strong></td>
<td>CHOOZIT® PC 02 - 12 - 22 - HP 6 - NEIGE - SAM 3 - VS - VB</td>
<td>2 to 5 doses*** for 1000L of milk</td>
<td></td>
</tr>
</tbody>
</table>
Ratio of Dosing PC to Geo

Graph showing the ratio of dosing PC to Geo with categories such as 100% PC, 70/30 PC/GEO, 50/50 PC/GEO, 30/70 PC/GEO, and 100% GEO.
How Rennet Affects Bloomies

• More rennet
  – More stirring
  – More loss of whey early
  – More minerals retained

• During aging
  – Small role in proteolysis

• The Type of Rennet
Resolubilization Review

• Several key pH/acid goals MUST be achieved if a soft texture is desired by the end of aging
  – High moisture at drainage means....
    • Loss of minerals during draining which means...
    • Loss of buffering capacity of curd
  – Low pH of 4.7-ish means...
    • Presence of lots of lactate (lactic acid) to feed yeasts first then white molds which means...
    • Consumption of lactic acid by white mold raises the pH by both acid consumption and ammonia production which means...
    • Casein returns to the point (above about 5.1) when it “likes” water again
Moisture at Hooping - Lactic

- Lactic
  - Tremendous loss of minerals before hooping
  - Low buffering capacity
  - Low pH
  - High lactate content
  - Crumbly texture
Moisture at Hooping – Rennet Trad.

• Rennet Traditional
  – Wet curd at hooping = loss of minerals during draining = loss of buffering capacity
  – Slightly higher pH = faster time to surface flora development
  – Texture can resolubilize
Moisture at Hooping – Stabilized

- Curd drier at hooping, higher pH
  - Higher buffering capacity
  - Sweeter curd
  - Faster rind growth
  - Firmer paste
  - Longer aging
The Role of Salt in Bloomies

- **Drainage**
  - Helps draw moisture from curd
- **Rind Growth**
  - Influences PC vs Geo
  - Limits other molds
- **Flavor**
- **Preservation**
- **Goal Salt Amounts**
  - 1.7 – 1.8% of weight of curd
  - Or brine 30 – 60 min.
Aging Needs

• Drying phase
  – Yeasts, Geo
  – 24-48 hours
  – 54-64 F
  – Room humidity about 80%
  – Small fan helpful
Aging Needs

- Aging phase I
  - 45-60F
  - 85 - 95 % RH
  - Turn daily
  - Lots of air exchange
Aging Needs

• Aging phase II
  – Wrap when mold growth is even and not too thick
  – Continue to age at 45-55F
  – Same humidity
Surface Invaders

- Historical perspective – is it contaminated or is it traditional?
- Sources of unwanted fungi:
  - Dairy farm
  - Make room
  - Aging room
- Petri-film yeast and mold plates to monitor milk
- Worker cleanliness
  - Hair
  - Street clothes
- Surface cleaning
- Air cleaning
  - Ozone
  - UV
Sources


Use of ozone to reduce molds in a cheese ripening room.
Serra R¹, Abrunhosa L, Kozakiewicz Z, Venâncio A, Lima N.

Microorganisms 2017, 5(3), 42; doi:10.3390/microorganisms5030042

Review

Diversity and Control of Spoilage Fungi in Dairy Products: An Update
Lucille Garnier 1,2Orcid, Florence Valence 2 and Jérôme Mounier 1,*
• gianaclis@gmail.com
• www.gianacliscaldwell.com
• www.pholiafarm.com
• Facebook, YouTube