Maximising productivity in cheese manufacture:
How to exceed expectations and get maximum value from your cheesemaking process with BioSolutions.
With 100+ years of innovation as our foundation, we will keep delivering transformative solutions
Content

1. Challenges in cheese production
2. Role of cultures and enzymes in cheese production process
3. Process optimisation & real-life field data
4. Q&A
Challenges in Cheese Production from multiple factors

- High focus on sustainability / environmental impact.
- Increasing regulatory compliance in more detail than ever before.
- Changing consumer preferences.
- Competitive landscape.
- Implementing the best technological advances.
- Managing the cost of production and maintaining cheese yield all year around.
Become more productive by increasing yield and speed

INCREASED YIELD
Create more cheese with the same amounts of milk due to a higher level of moisture / fat / protein retention into cheese.

INCREASED SPEED
Be more productive with an increased acidification / coagulation speed to reduce overall recipe time.
Role of Cultures & Enzymes in Cheese
The Cheesemaking Triangle

Technology

Coagulant

Cultures / Adjuncts

The combination of process parameters and choice of coagulant, starter and ripening adjuncts is unique for each cheese.
Cheese Production Technology

- Milk
- Heat treatment
- Adding cultures
- Adding enzymes
- Cutting
- Scalding and stirring
- Whey draining

- Cheddaring
- Milling
- Salting
- Molding / Cooling
- Storage
- Conversion
- Stretching
- Molding
- Brining
### Primary cultures for Pasta Filata cheese

<table>
<thead>
<tr>
<th>Culture</th>
<th>Function Description</th>
<th>Optimum Temperature</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STREPTOCOCCUS THERMOPHILUS</strong></td>
<td>Primarily for acidification</td>
<td>38-42°C</td>
<td>Very low proteolysis</td>
</tr>
<tr>
<td><strong>LACTOBACILLUS BULGARICUS</strong></td>
<td>Contribute to flavor, texture and acidification</td>
<td>40-45°C</td>
<td>Medium proteolysis</td>
</tr>
<tr>
<td><strong>LACTOBACILLUS HELVETICUS</strong></td>
<td>Added for flavor, texture and its ability to utilize galactose (browning)</td>
<td>40-45°C</td>
<td>Very proteolytic - Quick deterioration of cheese texture if overused</td>
</tr>
</tbody>
</table>
Drive acidification consistency and yield in Mozzarella

➢ In any continuous cheese process the culture needs to achieve a target pH / TA range in a specified time or point in the process.

➢ In Mozzarella, optimum mill pH is 5.05 – 5.25 to achieve the correct stretch / demineralization level.

➢ Slow cultures or variation in acidification will result in production stoppages and yield loss.

➢ A faster culture will allow process optimization.
The effect of acidification rate

- Insufficient acidification
- Excessive acidification
- Perfection
Coagulant selection is application specific, and yield is affected by C/P ratio

<table>
<thead>
<tr>
<th>THE C/P RATIO</th>
<th>CASEIN SUBSTRATE</th>
<th>EFFECT</th>
<th>IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>C: Clotting activity</td>
<td>K: Kappa Casein</td>
<td>Higher clotting activity enables more precise cutting of Kappa Casein and an enhanced ability to form strong casein network</td>
<td>• Use of a coagulant with a high C/P ratio results in a stronger casein network, where fat and proteins are kept in the cheese</td>
</tr>
<tr>
<td>P: General proteolytic activity</td>
<td>α, β: α, β Casein</td>
<td>The proteolytic activity affects the speed of breakdown of casein in bigger and smaller peptides (fast speed gives bitter taste)</td>
<td>• Cheese yield is directly correlated to the C/P ratio of the coagulants</td>
</tr>
</tbody>
</table>

1 C/P is the ratio between the specific clotting activity and general proteolytic activity.
2 C: Clotting activity by international standard. Analysis method = 50 IMCU/L Milk, pH 6.5.
3 P: Proteolytic activity, Chr. Hansen method. Analysis method = Curd simulation & peptides extraction.
A more specific coagulant enables precise cutting of the kappa casein and allow strong network formation.

**INSTABILITY**
- **SPECIFIC CLEAVING**
  - Coagulant is added, CMP released after cleaving Kappa casein

**COAGULATION**
- Casein network formed as destabilized micelles aggregate into curd

**LOW C/P RATIO**
- Broken proteins
- Lost fat
- Casein network is weaker due to unintended cleaving, losing fat and bits of broken protein to the whey

**HIGH C/P RATIO**
- Casein network is strong and captures optimal levels of fat with minimal protein breakdown
Cultures and Enzymes work together to maximise yield

- Each data point relates to one production run.
- Milling pH is correlated to yield.
- Fat recovery % correlated to yield and milling pH.
- Optimal pH at mill (cooker / stretcher) aids moisture reabsorption.
- Sub-optimal pH at mill will result in the need to overwork the curd and loss of fat.
Process Optimisation Case
Cheese Process and Ingredient Dosage Optimisation Project

- Large dairy producing Mozzarella for pizza cheese
- Cheese vats: 18,000L
- Coagulant: Chymax Supreme
- Dose: Control & Trial (+24%)
- Coagulation temperature: Control & Trial (-1.5°C)
- Scalding: 44°C
- Coagulation time: -5 minutes
- Culture dose: Control -500U/Vat & Trial - 1000U/Vat
- Pre-ripening time: Reduced ripening time
- AoM Mixers Adjusted

- Data Collected in 3 ways (treatment).
  1. Control – Baseline production before any changes made
  2. Optimised 1 – Change for culture dose only.
  3. Optimised 2 – Change for both Culture and Coagulant
Cheese Moisture by Treatment

- **Black** – Control
- **Red** – Optimised 1
- **Green** – Optimised 2

- Times series plot of all data from control and Optimised 1 & 2.
- There is an obvious moisture increase for both Optimised 1 & 2 versus the control.
- Data was processed to remove outliers from runs with known production issues.
Histogram of Cheese Moisture % by Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
<th>StDev</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>45.17</td>
<td>0.871</td>
<td>251</td>
</tr>
<tr>
<td>Optimised 1</td>
<td>46.00</td>
<td>0.727</td>
<td>209</td>
</tr>
<tr>
<td>Optimised 2</td>
<td>46.35</td>
<td>0.686</td>
<td>177</td>
</tr>
</tbody>
</table>

Black – Control
Red – Optimised 1
Green – Optimised 2

1. Control – Baseline production before any changes made
2. Optimised 1 – Change for culture dose only.
3. Optimised 2 – Change for both Culture and Coagulant

– Overall, a 1.18% increase in moisture.
– 0.185% reduction in StDev.
– The reduction in moisture variation enabled the increase in moisture without production OOS product.
Reducing process variation enables yield increase
Thank you.