Increasing the Shelf-Life of Cheese

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Center for Dairy Research “Solution Based Research Backed by Experience, Passion and Tradition”
Introduction

• Potential for the US to become a more significant exporter of cheese to markets in:
  – Asia
  – South America
  – North Africa
Introduction

• Challenges:
  – Cheese will require longer shelf life.
Extending Shelf-life

• Freezing
  – Affects texture of cheese
    • Crumbly
    • Grainy
    • Mushy
  – Affects functionality of cheese
    • Shredding
    • Slicing
    • Spreading (for soft cheeses)
DMI/DRI Funded Projects

1. Increasing the shelf-life of export cheese by prolonged low-temperature storage.

2. Investigating the textural changes when cream cheese and mascarpone are super chilled.
Overarching Objective

- Extend shelf-life
Low Temperature Storage: Super Chilling

- Lowering temperature to just above freezing point.

- Potential benefits:
  - Low functional damage
  - Extended shelf life
  - No thawing
  - No need to label as ‘frozen’
High Pressure Processing (HPP)

• High hydrostatic pressures to cold pasteurize cheese.

0.101 MPa (1 atm)
High Pressure Processing (HPP)

- Hydrostatic pressures

0.101 MPa (1 atm)
High Pressure Processing (HPP)

- Hydrostatic pressures

0.103 MPa
(1 atm)
High Pressure Processing (HPP)

- Marianas Trench
  ~11 Km

- Hydrostatic pressures

110 MPa (1,085 atm)

~7 mi
High Pressure Processing (HPP)

- Hydrostatic pressures

110 MPa (1,085 atm)
600 MPa (~6,000 atm)
High Pressure Processing (HPP)

• Previous research (9 mo):
  – Reduced microbial activity.
    • Decreased starter numbers.
  – Decreased enzymatic activity.
    • Reduced proteolysis.
  – Disrupted protein structure.
    • Affected textural & rheological properties.


Ozturk et al. 2015. Low-sodium Cheddar cheese: Effect of fortification of cheese milk with ultrafiltration retentate and high-hydrostatic pressure treatment of cheese. J. Dairy Sci. 98. 6713-6726
PROJECT 1

INCREASING SHELF LIFE OF EXPORT CHEESES BY PROLONGED LOW TEMPERATURE STORAGE
Specific Objective

- Extend shelf life of cheese (LMPS Mozzarella, Cheddar, Gouda) for domestic and export markets without the need to freeze cheese.

- Explore the effect of HPP and low temperature storage on cheese texture, flavor, and functionality.
Hypotheses

• The use of a less proteolytic coagulant, HPP, and low storage temperatures can extend the performance and texture shelf life of Cheddar, Gouda, and reduced sodium cheeses like LMPS Mozzarella, without need for freezing.
Mozzarella Cheese Manufacture

1% Na

Less Proteolytic Coagulant

LMPS Mozzarella

Ripen at 5°C, 2 wk

High Pressure Treatment (600MPa, 3min)
Control Cheeses – without HPP treatment

Cheddar Cheese Manufacture

For processed cheese

Cheddar

Ripen at 5°C, 1 mo

Gouda Cheese Manufacture

Ripen at 5°C, 1 mo

Low temperature storage for up to 12 months

-20°C  0°C  4°C
Parameters

- Samples stored at 3 different temperatures
  - -20°C (freezing)
  - 0°C (super chilled)
  - 4°C (refrigeration)

- Evaluation time points
  - 2 weeks
  - 3 months
  - 5 months
  - 7 months
  - 9 months
  - 12 months

Frozen samples are thawed at 4°C for 7 days
Analyses

- Compositional
  - Moisture / Protein / Fat / Salt / pH
  - Lactose
  - Total calcium, soluble/insoluble calcium

- Microbiological
  - Starter / NSLAB

- Proteolysis
  - pH 4.6 soluble nitrogen
  - UREA-PAGE electrophoresis

- Differential Scanning Calorimetry (DSC)
Analyses

• Differential Scanning Calorimetry (DSC)
  – Freezing point
    • Moisture
    • Salts
    • Lipids
Analyses

Gouda Rep 1

Freezing Temperature: -22.28°C

End = -23.53 °C
Onset = -21.24 °C
Analyses

• Rheological
  – Dynamic low-amplitude oscillatory rheology

• Textural
  – Texture Profile Analysis (TPA)

• Sensory
  – Trained panel (QDA / Spectrum®)
    • Cheese
    • Functionality (for LMPS Mozzarella)
    • Shreds (for LMPS Mozzarella)
Project Underway

- Reduced sodium LMPS Mozzarella has been manufactured on four different dates.
Project Underway

• High pressure treatment.
  – 600MPa, 3 min
Results

• Cheeses are in low temperature storage

• Only 2 week time point reached so far.
  – Results match previous study
Results at 2 weeks

- Microbiological analyses

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>HPP-treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter (log)</td>
<td>9.30</td>
<td>4.62</td>
</tr>
<tr>
<td>NSLAB (log)</td>
<td>2.19</td>
<td>1.45</td>
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</tbody>
</table>
Results at 2 weeks

- Compositional analyses

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>HPP-treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.20 ± 0.04</td>
<td>5.37 ± 0.05</td>
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</table>
Results at 2 weeks

- Rheological properties

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<tr>
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<th>Control</th>
<th>HPP-treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meltability Indicator</td>
<td>2.96 ± 0.21</td>
<td>3.68 ± 0.17</td>
</tr>
<tr>
<td>Melting Point</td>
<td></td>
<td></td>
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</table>
Future

• Continue evaluating changes in reduced sodium LMPS Mozzarella at 3, 5, 7, 9, and 12 months.

• Manufacture cheddar and gouda.
PROJECT 2.

INVESTIGATING THE TEXTURAL CHANGES WHEN CREAM CHEESE AND MASCARPONE ARE SUPER CHILLED INSTEAD OF FREEZING.
Specific Objectives

• Increase shelf life of Cream cheese and Mascarpone
  – For export and domestic markets
  – Retain the required texture, flavor, and performance.
Hypothesis

• Freezing high moisture and high fat cheese causes textural changes.

• The use of low storage temperatures and HPP can help extend the shelf life of cream cheese and mascarpone, and their incorporation into other food ingredients (e.g. in cheesecake and tiramisu).
Cream Cheese

Supplied by industry partners

Mascarpone

High Pressure Treatment (HPP, 600MPa, 3min),
Control Cheeses – without HPP treatment

1 week

Low temperature storage for up to 15 months

-20° C  0° C  4° C
Parameters

• Samples stored at 3 different temperatures
  – -20°C (freezing)
  – 0°C (super chilled)
  – 4°C (refrigeration)

• Evaluation time points
  – 1 week
  – 3 months
  – 6 months
  – 9 months
  – 12 months
  – 15 months

Frozen samples are thawed at 4°C for 7 days
Analyses

• Compositional
  – Moisture / Protein / Fat / Salt / pH
  – Lactose
  – Total calcium

• Microbiological
  – Starter / NSLAB
  – Yeast and mold
Analyses

• Proteolysis
  – pH 4.6 soluble nitrogen
  – UREA-PAGE electrophoresis

• Differential Scanning Calorimetry (DSC)

• Particle size analysis
  – Cheese mix
Analyses

- Rheological
  - Dynamic low-amplitude oscillatory rheology

- Textural
  - Texture Profile Analysis (TPA)
    - Penetration
    - Spreadability

- Sensory
  - Trained panel (QDA / Spectrum®)
    - Cheese
Analyses

- Functionality in Cheesecake (Cream cheese) and Tiramisu (Mascarpone)
  - Cheesecake / Tiramisu
    - Ease of use / incorporation
    - Texture (cracking, splits, graininess/smoothness)
    - Moisture loss on storage

- Batters
  - Specific gravity
  - Viscosity
  - Lump straining
  - Whipability (for Mascarpone)
Current Efforts

• Industry partners identified and ready to begin supplying samples this month.

• Panelist training underway
  – Texture and functionality evaluation
    • Cream cheese
    • Mascarpone
Current Efforts

• Preliminary HPP treatment.
  – Evaluate cream cheese tolerance for HPP.
  – Concerns of the aluminum foil wrapper seals breaking -> vacuum sealing.
Current Efforts
Current Efforts

Freezing Temperature: -22.57° C

Melting Temperature: -0.27° C

Cream Cheese Rep 1

End = -23.37 °C
Onset = -21.84 °C
Current Efforts

Freezing Temperature: -17.67° C

Melting Temperature: 1.43° C
Future

• Beginning this month, cream cheese trials begin.

• January, mascarpone trials begin.
Acknowledgements

• American Pasteurization Company and our industry partners.

• Wisconsin Center for Dairy Research Analytical, Cheese Research, Applications, and Sensory staff.

• Program funding provided by Wisconsin Milk Marketing Board and Dairy Management Inc., as administered by DRI.
Questions?