High Pressure Jet Processing in Ice Cream Manufacture

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1. **Introduction**

2. **HPJ Processing Ice Cream Mix**

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4. **Conclusion and Future Directions**
Introduction: Ice Cream Emulsifiers and Stabilizers
Introduction- Emulsifiers
Overview

• Enhance fat destabilization
  • Resist icy/coarse textures

• Improve whipping quality of mix

Goff, 2016
Introduction-Stabilizers
Overview

• Variable in structure and function
• Increase mix viscosity
• Retard ice/lactose crystal growth during storage
Can we use high pressure jet processing instead of adding these ingredients?

Peanut Butter Cup Ice Cream
Ingredients: Milk, cream, sugar, peanut butter, corn syrup solids, cocoa processed with alkali, stabilizer (propylene glycol monoesters, mono & diglycerides, cellulose gum, guar gum, carrageenan), vanilla extract
Introduction: High Pressure Jet (HPJ)
The High Pressure Jet (HPJ)
Skim milk - casein micelle disruption

Control

300MPa

400MPa

500MPa

In 400 MPa-treated skim milk...
↑ viscosity
↑ foam stability
↑ emulsion stability

Hettiarachchi et al. 2018
Can we use HPJ-processing instead of adding emulsifiers and stabilizers?
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Research Title: Effect of high pressure jet processing on the physiochemical properties of low fat ice cream mix

Hypothesis:

• Changes in micellar structure induced by a 400 MPa high pressure jet treatment will increase functional properties of ice cream mix.

• This will allow for physiochemical properties identical to polysorbate 80-containing formulations.
Procedure: HPJ-Treated Mix Processing

Skim milk → Butter* → Mix → Pasteurize 165°F for 30 min → Homogenize 2500psi → Mix Aging (24 h)

SMP* Sugar*

PS80**  

C-0 = homogenized mix without PS80  
C-P80 = homogenized mix with PS80  
HPJ-mix-200 = 200 MPa-treated mix  
HPJ-mix-400 = 400 MPa-treated mix

*Added at 110°F  
**Added at only to C-P80 sample

HPI-treated C-0 and C-P80

Analyze
Results
Results - Apparent Viscosity

Voronin et al., 2020
Hettiarachchi et al. 2018
Results - CSLM Microscopy

Red = Fat (Nile Red)
Green = Protein (FITC)

Control

Control with Poly 80

400MPa Mix

Voronin et al., 2020
Results - Crystallization

Cycle 1
Cycle 2
Cycle 3
Melted

Control

400MPa Mix

Voronin et al., 2020
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Project Outline

**Research Title:** Freezing high pressure jet-treated ice cream mix: a study of the kinetics and microstructure

**Hypothesis:**

- Many of the physical properties seen in HPJ-treated ice cream mix are retained during dynamic freezing
- The retention of these properties lead to increased hardness and reduced melting rate in a frozen low fat ice cream
Procedure: HPJ-Treated Mix Processing

1. **Mix**
   - Skim milk
   - Butter*
   - SMP*
   - Sugar*

2. **Pasteurize**
   - **SMP***
   - **Sugar***
   - **PS80***
   - *Added at 110°F
   - **Added at only to C-P80 sample
   - **Pasteurize 165°F for 30 min

3. **Homogenize**
   - **2500 psi

4. **Mix Aging**
   - **(24 h)

5. **Analyze**
   - C-0 and C-P80

6. **HPJ**
   - **(100-500 MPa)**

*Additional information:
- **HPJ-treated**
- **UW River Falls**
- **DAIRY INNOVATION HUB**
Procedure: Freezing

- Density
- Particle Size
- Rheology

Freeze to -5°C

- Density
- Particle Size
- Rheology

- Density
- Particle Size
- Rheology

- Density
- Particle Size
- Rheology

- Hardness
- Drip-through Rate

UW River Falls

- TEM
Results
C-P80

Control

Voronin et al., 2021
CSLM

400MPa

Mix

5µm

12 min

5µm

500MPa

Mix

5µm

12 min

5µm

Voronin et al., 2021
Hardness and Melting Rate

Voronin et al., 2021
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Conclusions

- HPJ processing (> 300 MPa) creates novel fat-protein complexes with unique functionality
- These complexes break down during freezing
  - Hard, viscous low fat ice cream formed
- Optimization needs to be completed…
  - Alter formulation (full fat, high protein)
  - Freeze for less time
- Investigate quiescently frozen confections
Future Directions

• Optimize freezing of HPJ-treated ice cream mix

• Look at potential for non-dairy frozen dessert applications

• Vary ice cream mix composition (high protein formulations)
  • Shrinkage?
Future Directions – Non-Dairy

Solubility and foaming properties of three different pea protein isolates with HPJ treatment
Acknowledgements

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Dr. John Coupland
Questions?

Thank you!
References


TEM- Comparing C-0 to other samples

- Control
- 300MPa