



High Pressure Jet Processing in Ice Cream Manufacture

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INNOVATION HUB

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3.	Freezing HPJ-treated Ice Cream Mix
4.	Conclusion and Future Directions

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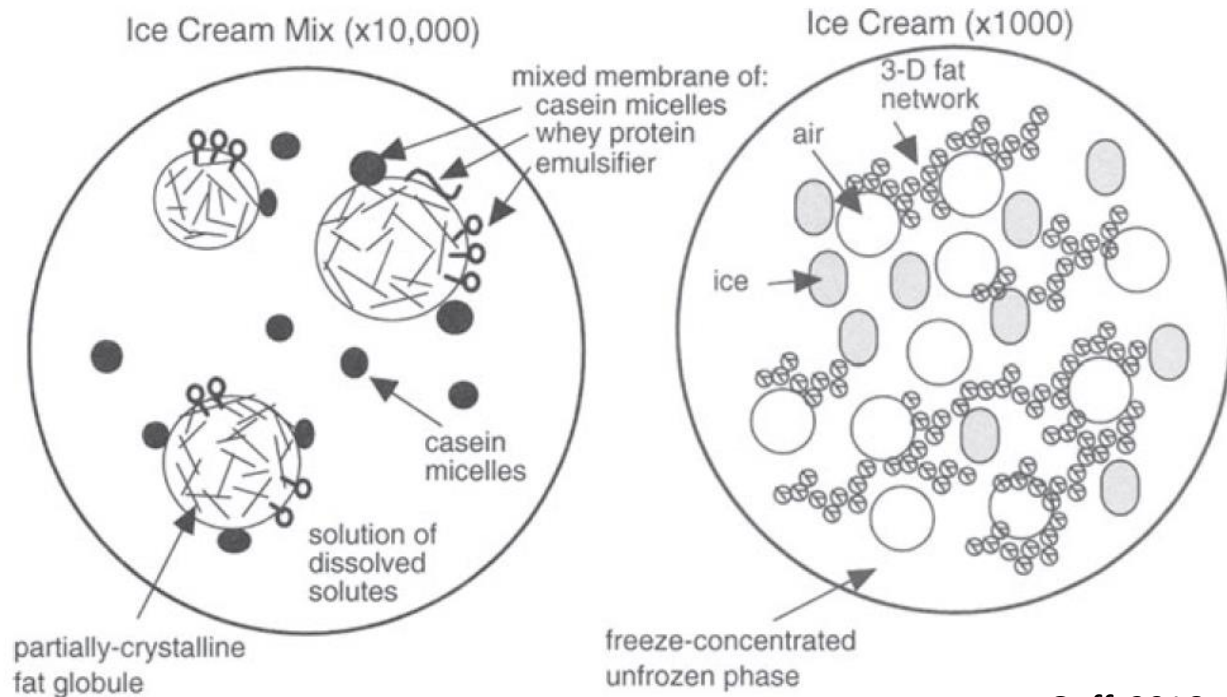
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Introduction: Ice Cream Emulsifiers and Stabilizers

Introduction- Emulsifiers

Overview

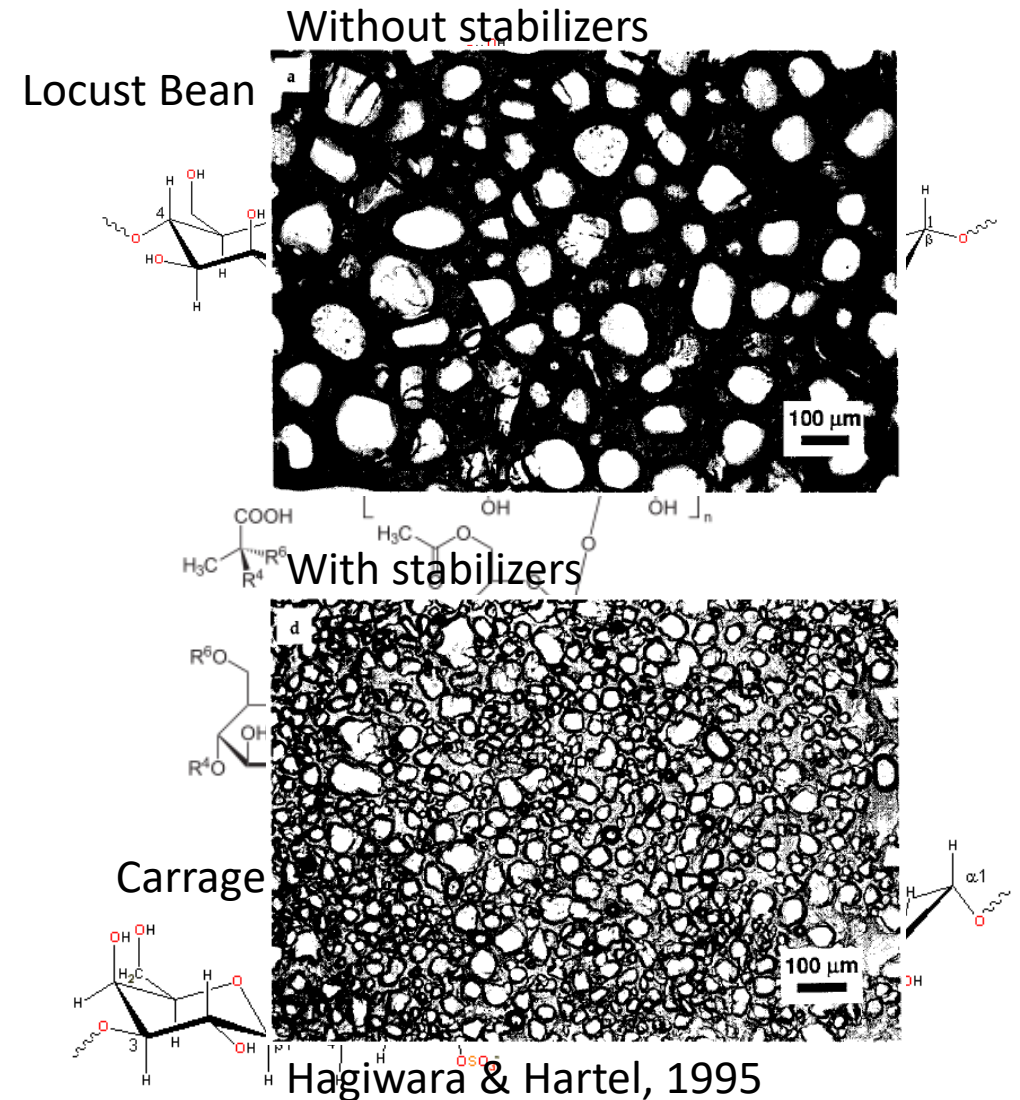
- Enhance fat destabilization
 - Resist icy/coarse textures
- Improve whipping quality of mix



Goff, 2016

Introduction-Stabilizers Overview

- Variable in structure and function
- Increase mix viscosity
- Retard ice/lactose crystal growth during storage





PennState

Berkey Creamery



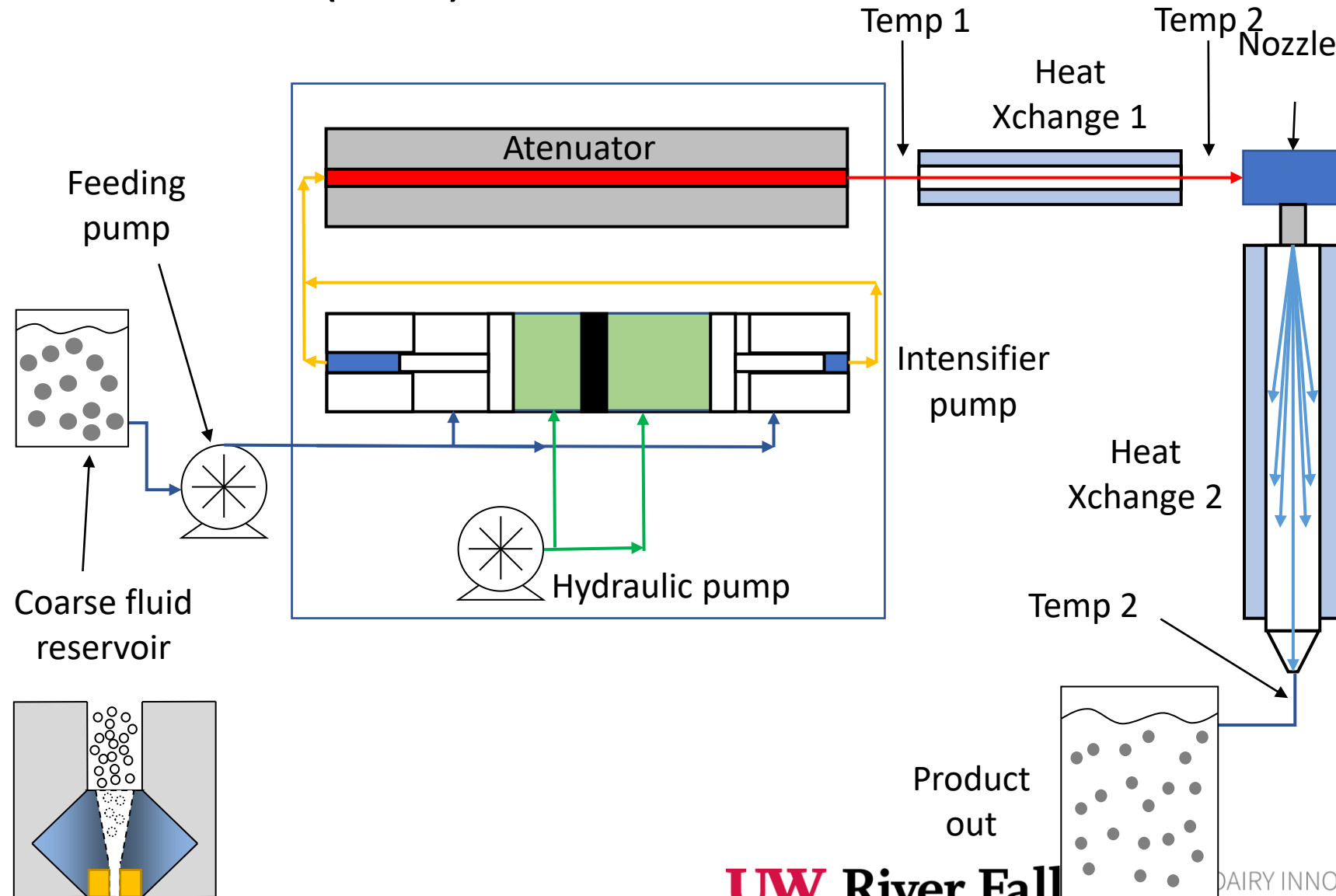
Peanut Butter Cup Ice Cream

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

Can we use high pressure jet processing instead of adding these ingredients?

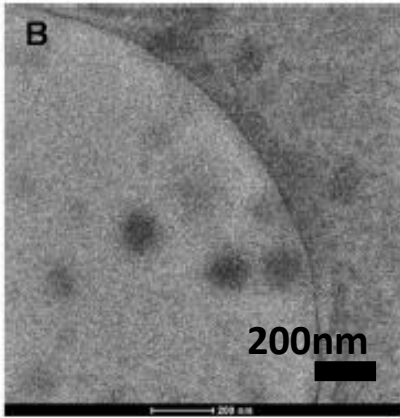
Introduction: High Pressure Jet (HPJ)

The High Pressure Jet (HPJ)

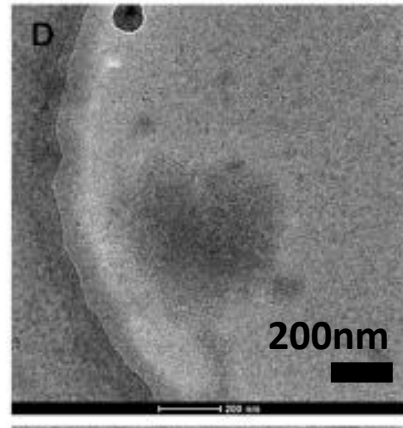


Skim milk- casein micelle disruption

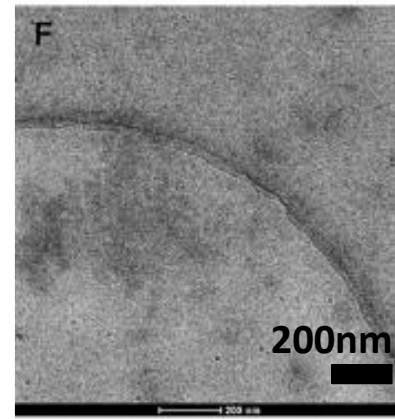
Control



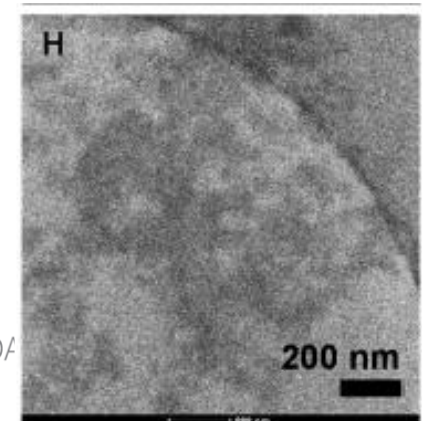
300MPa



400MPa



500MPa



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

Can we use HPJ-processing instead of adding emulsifiers and stabilizers?

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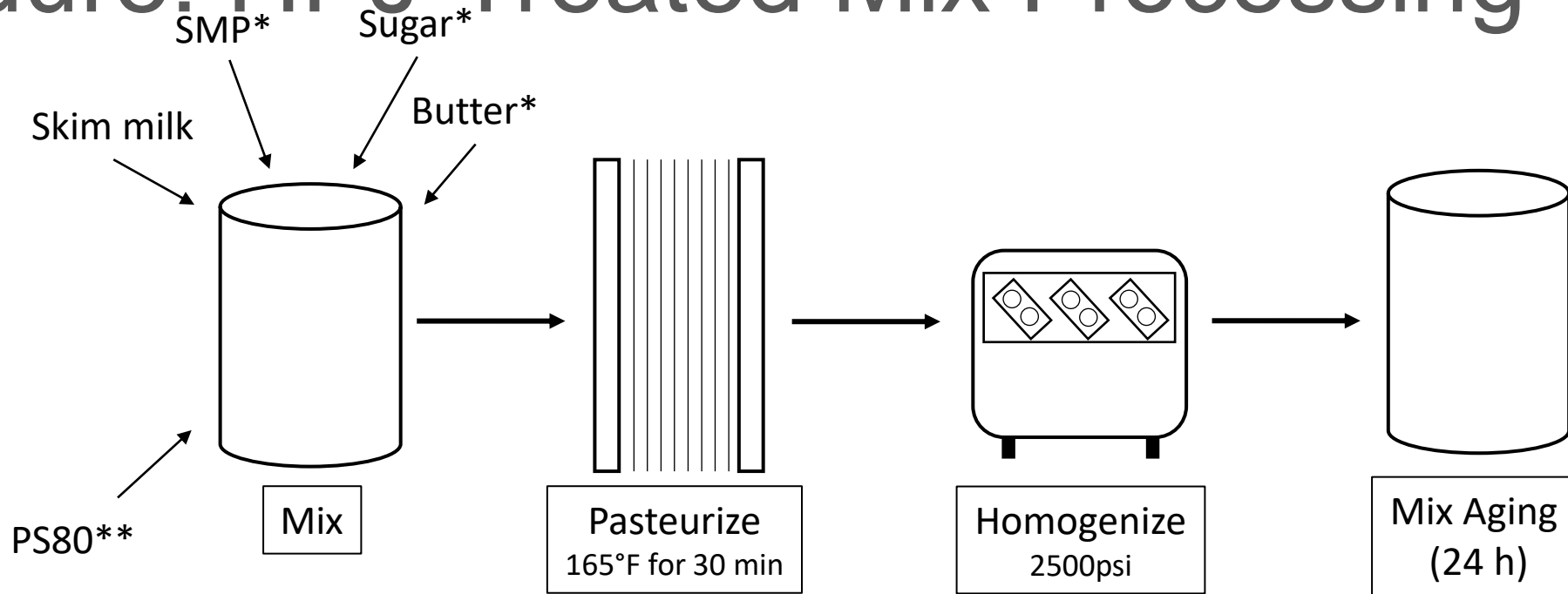
Research project Outline

Research Title: Effect of high pressure jet processing on the physiochemical properties of low fat ice cream **mix**

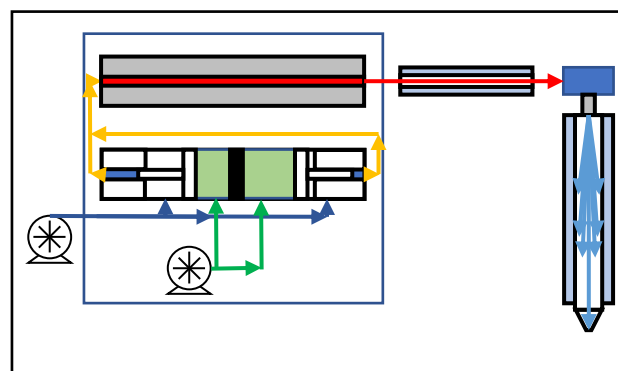
Hypothesis:

- 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.

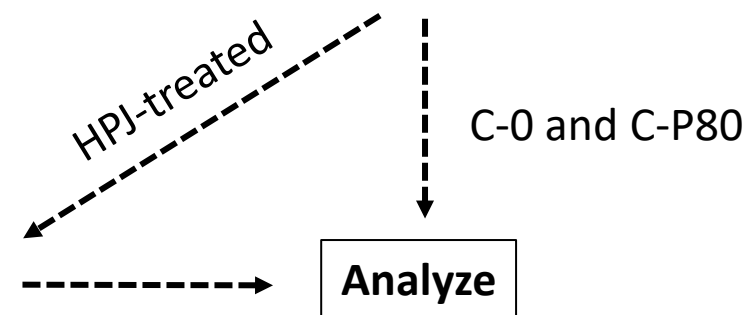
Procedure: HPJ-Treated Mix Processing



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



HPJ
(200 or 400 MPa)

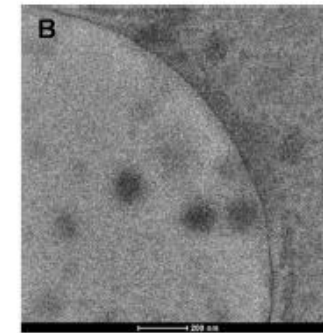
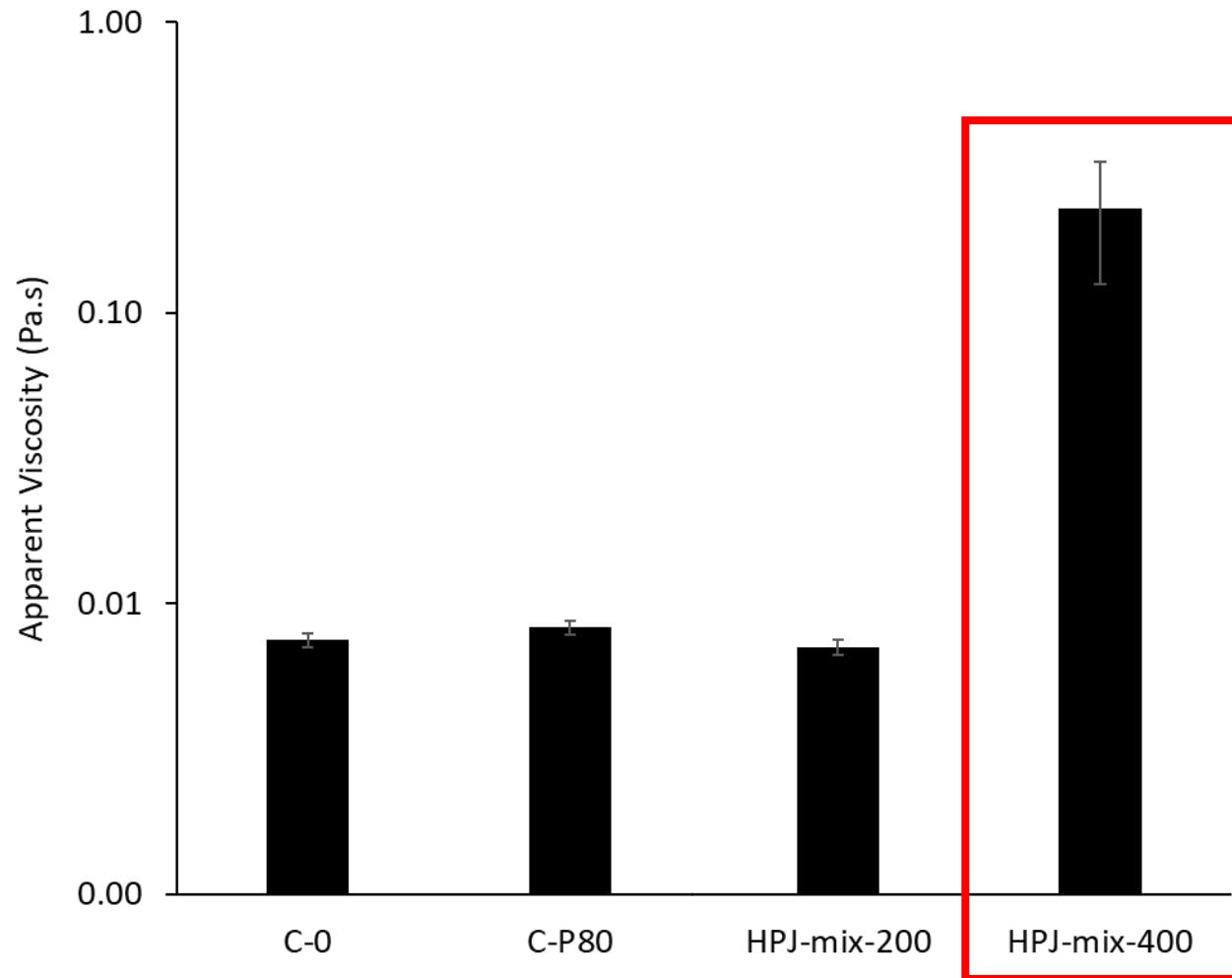


*Added at 110°F

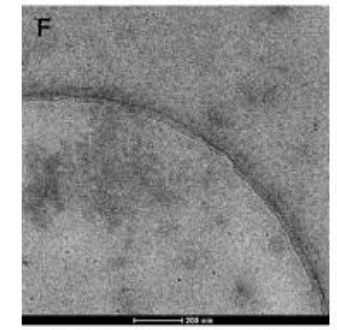
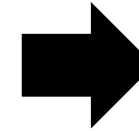
**Added at only to C-P80 sample

Results

Results- Apparent Viscosity



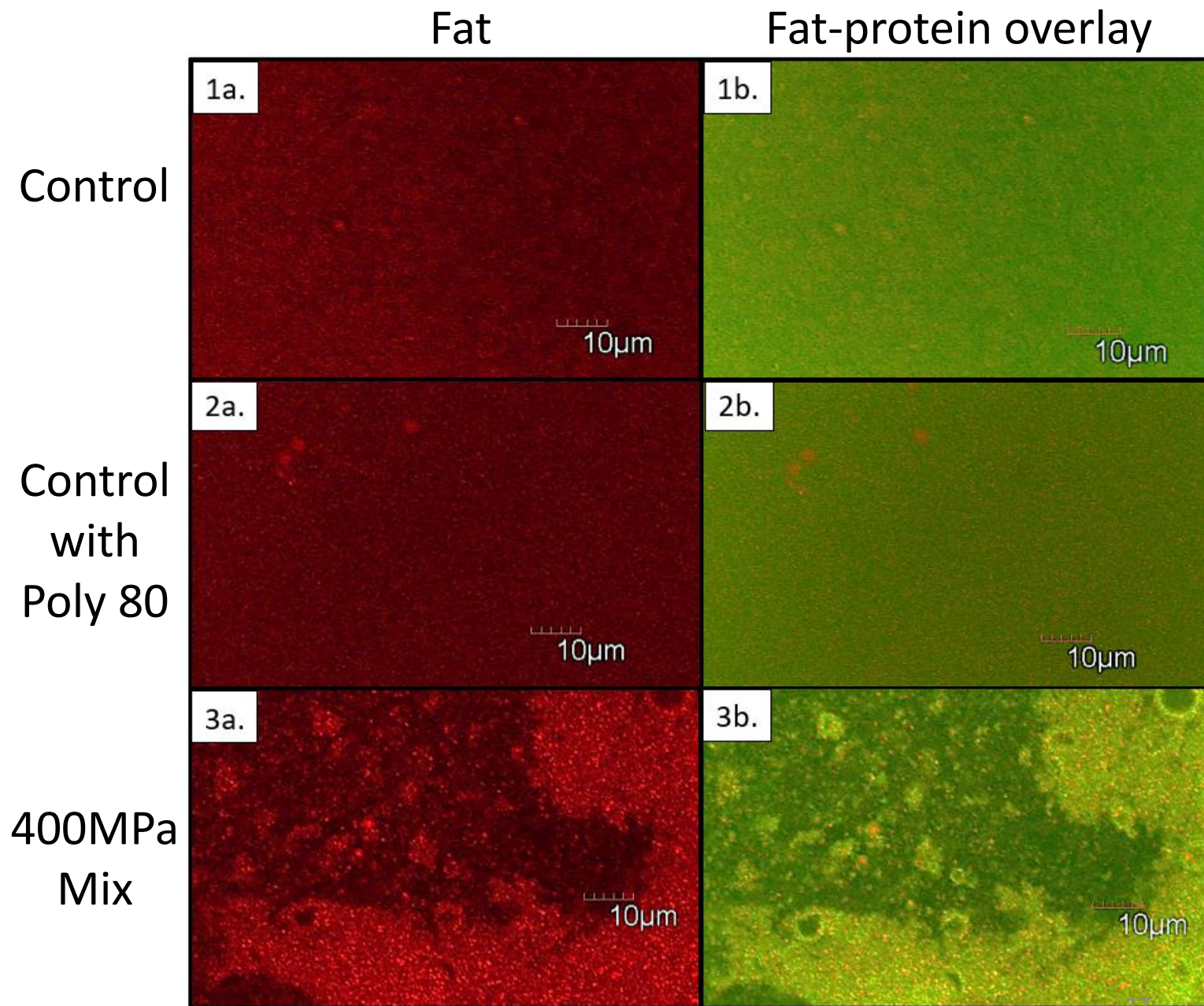
Control



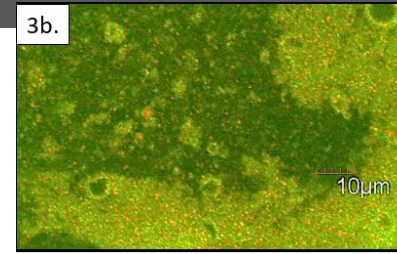
400 MPa

Results- CSLM Microscopy

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



Results- Crystallization



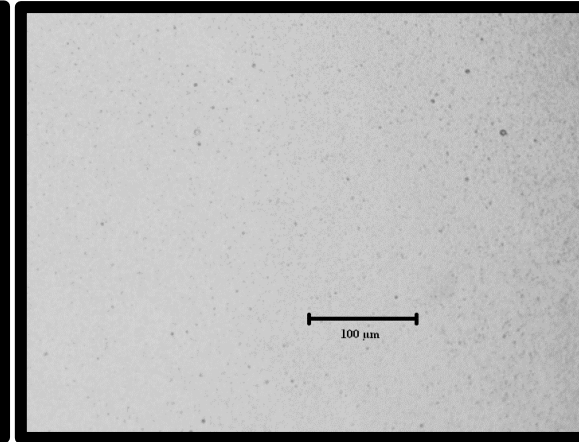
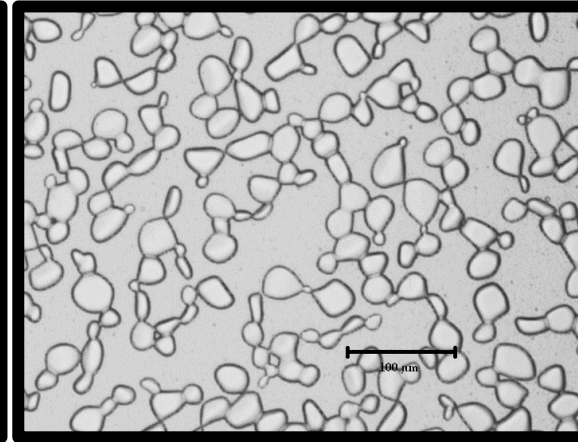
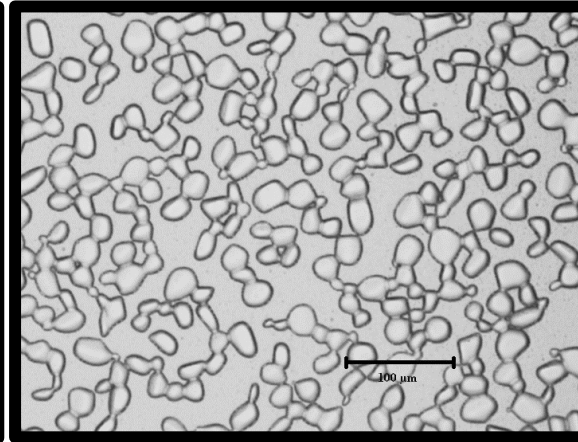
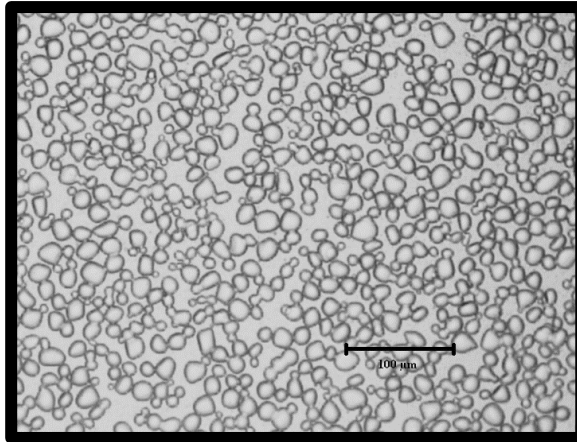
Cycle 1

Cycle 2

Cycle 3

Melted

Control



400MPa
Mix

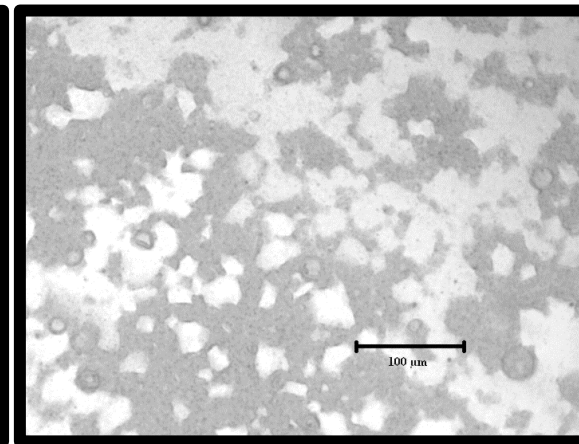
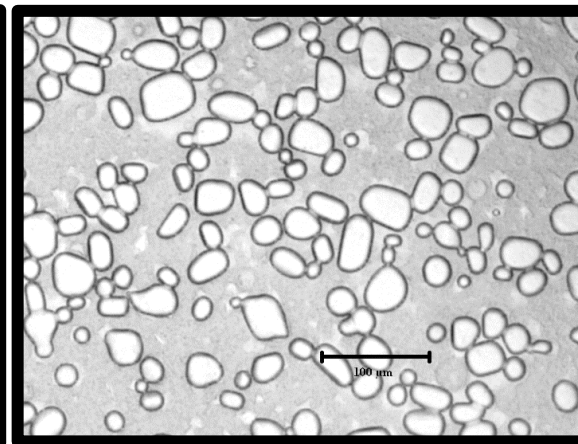
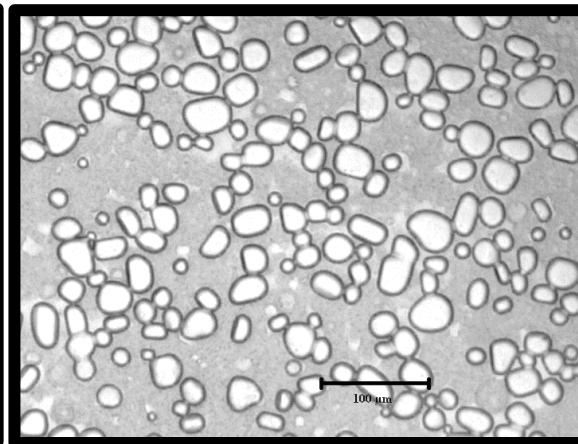
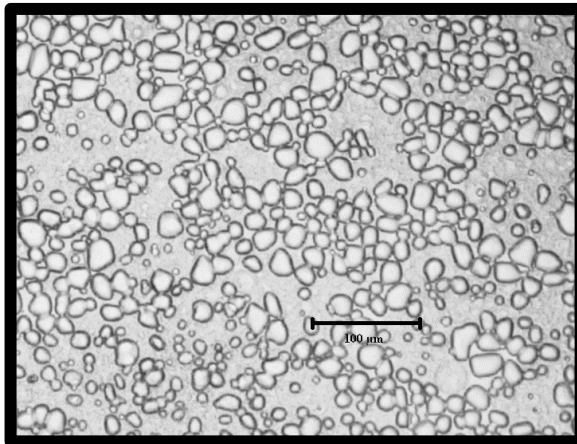


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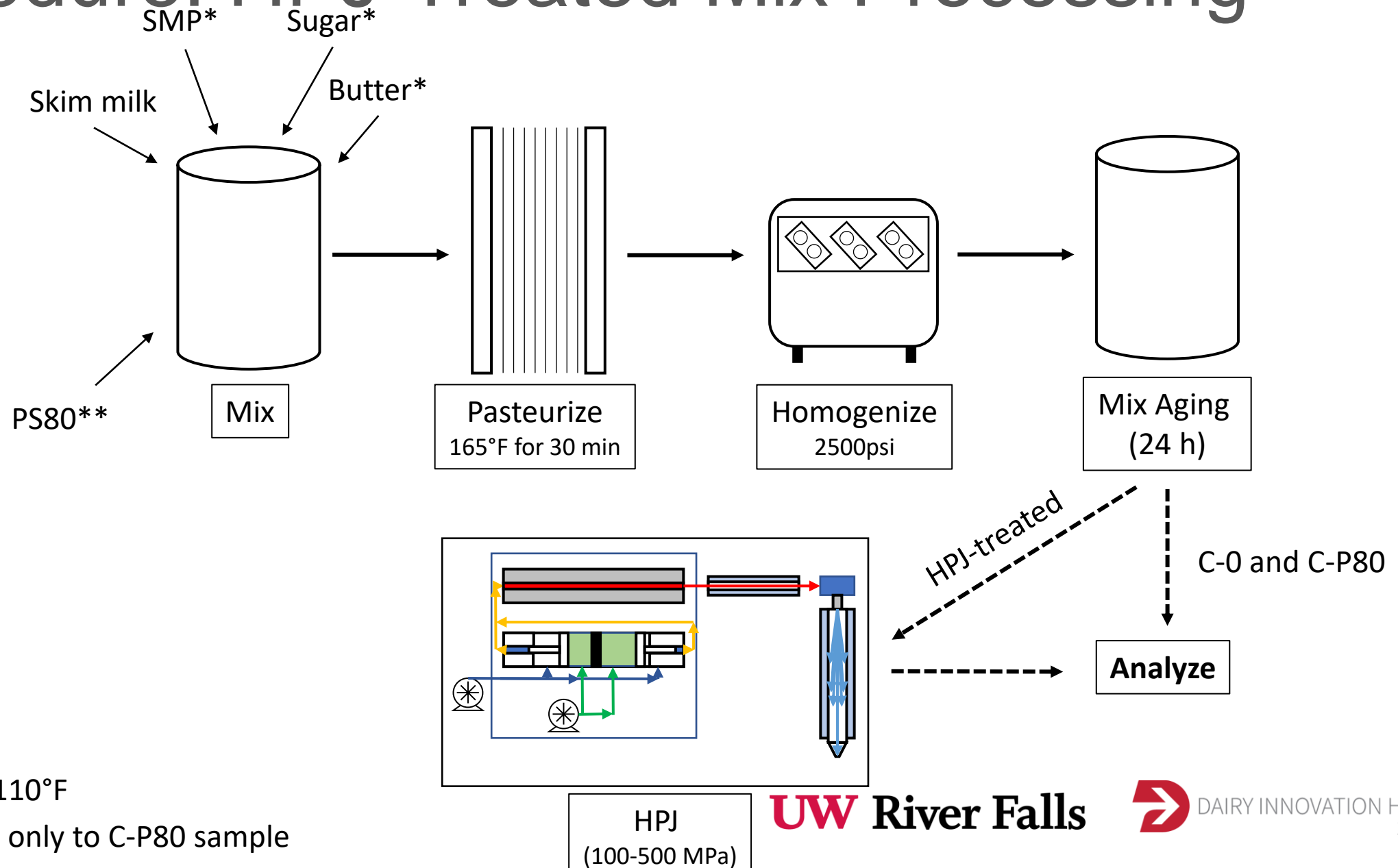
Project Outline

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

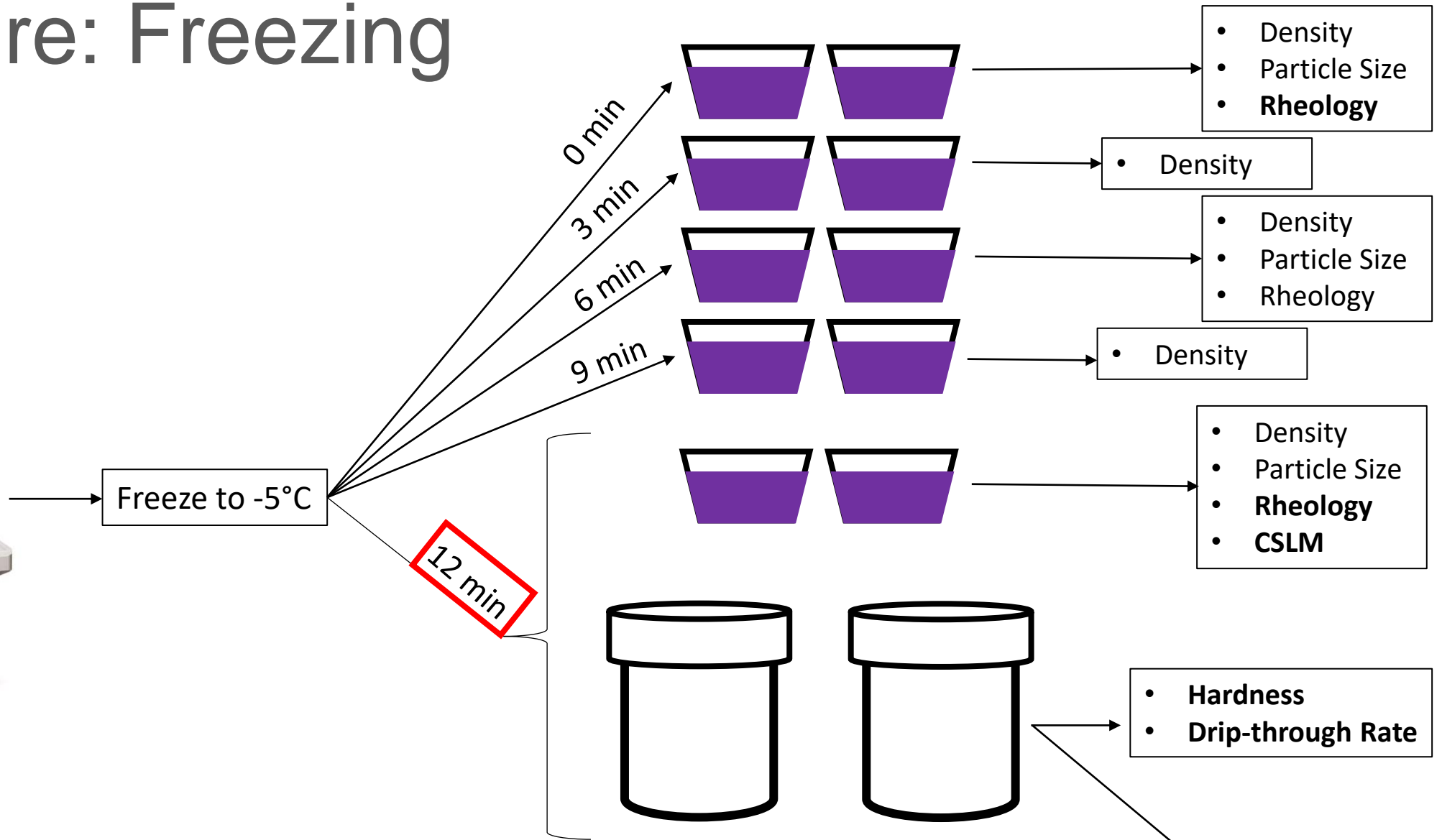
Procedure: HPJ-Treated Mix Processing



*Added at 110°F

**Added at only to C-P80 sample

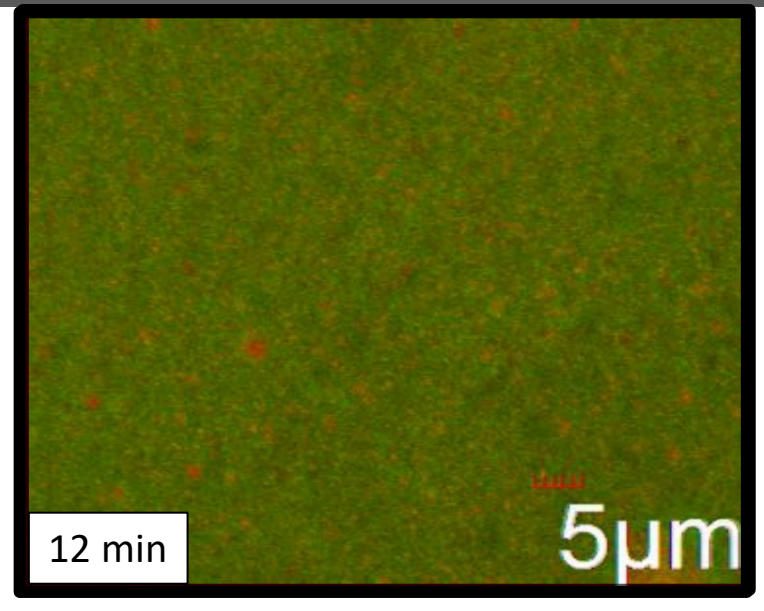
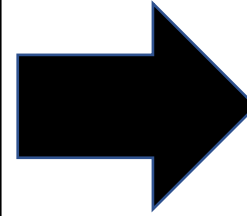
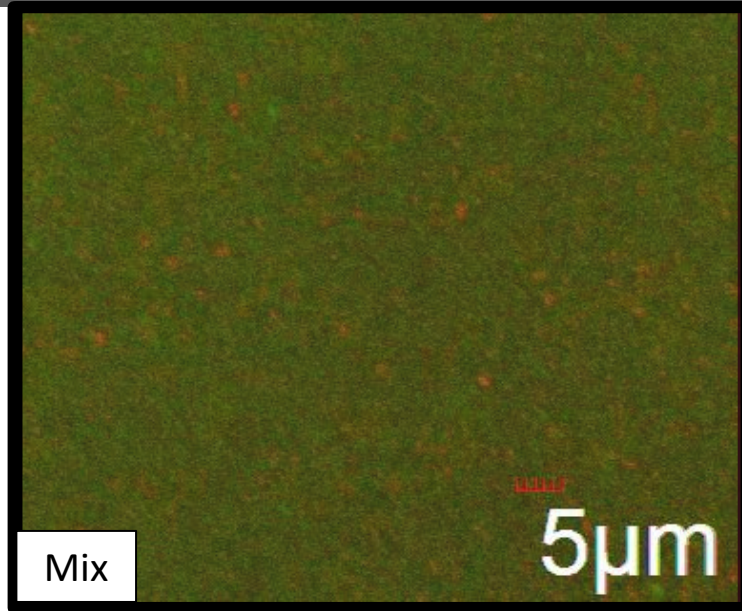
Procedure: Freezing



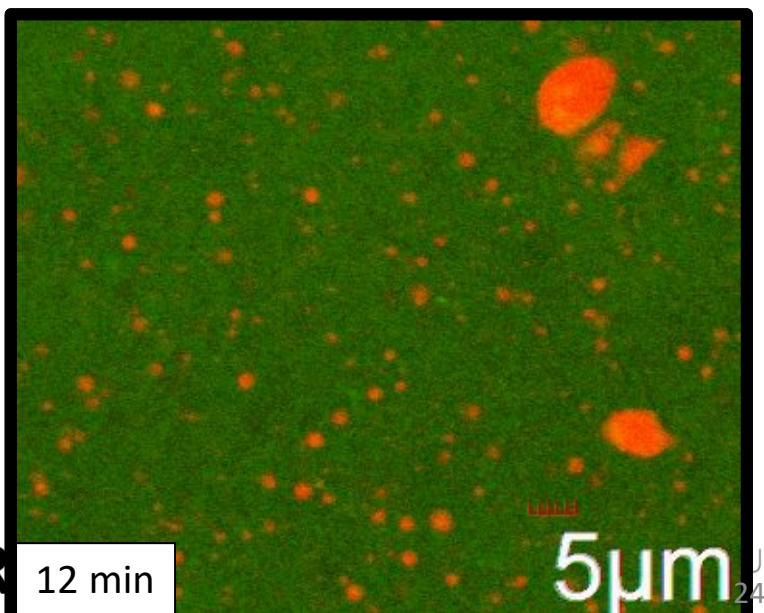
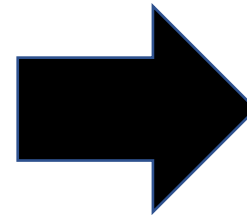
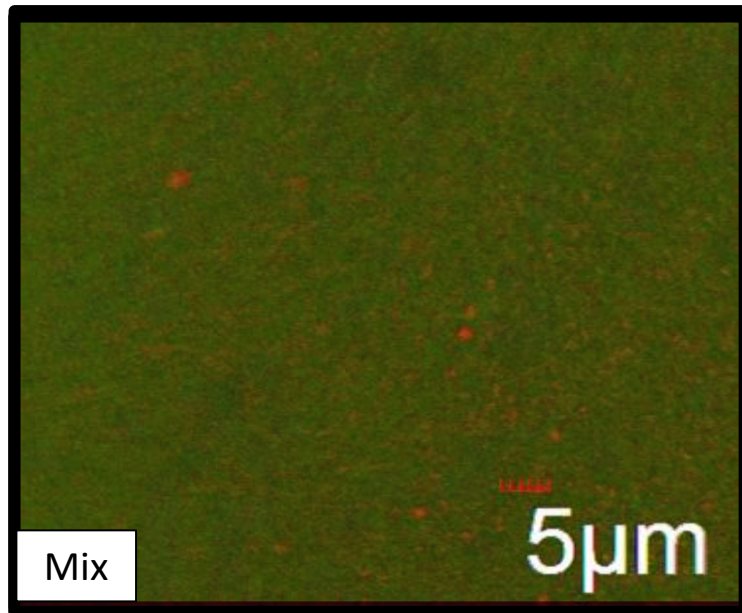
Results

CSLM

Control



C-P80

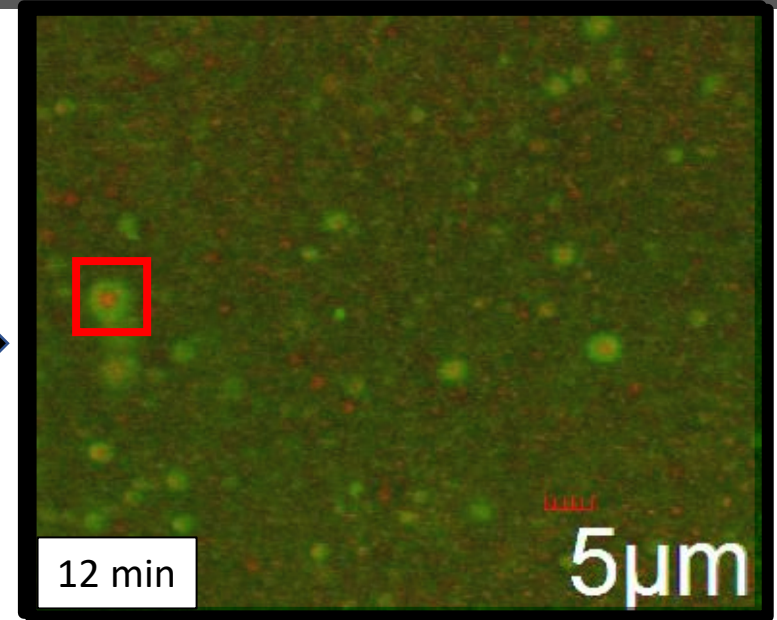
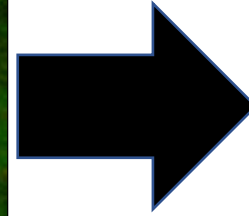
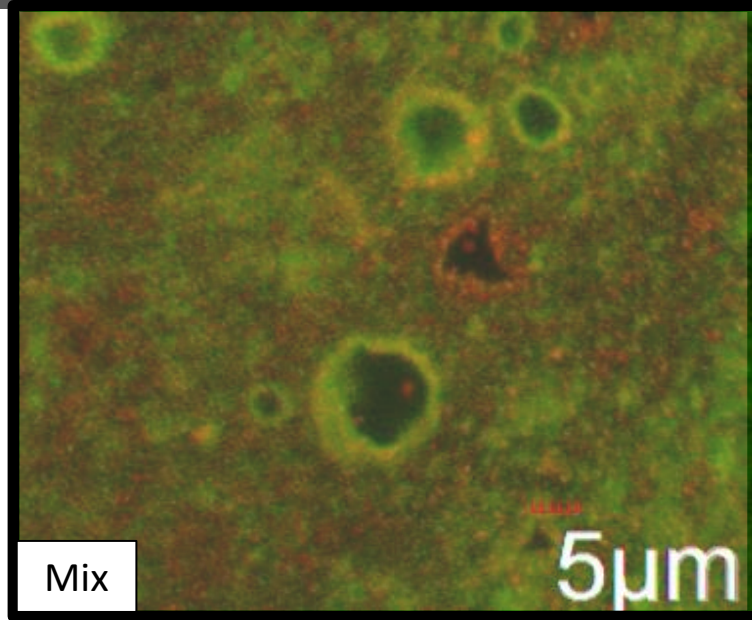


UW R

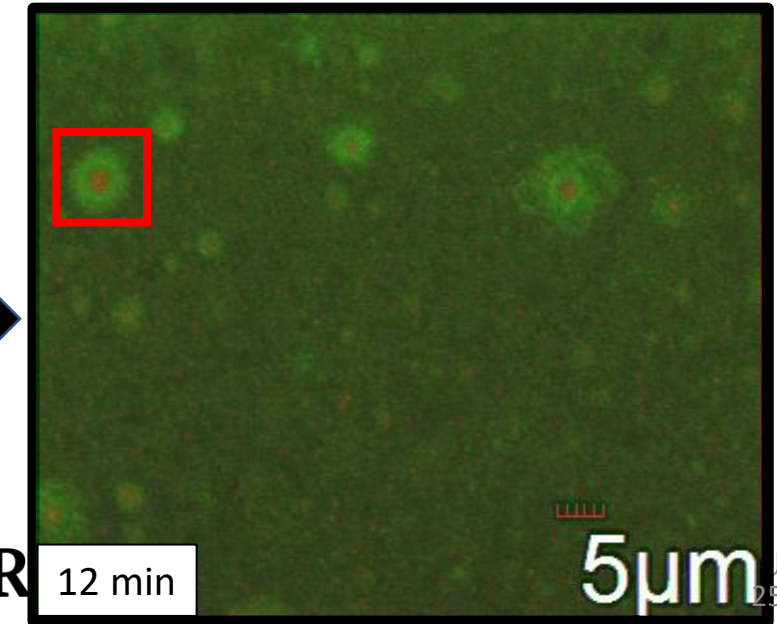
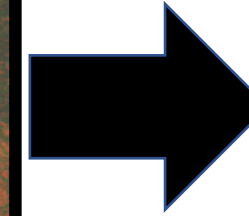
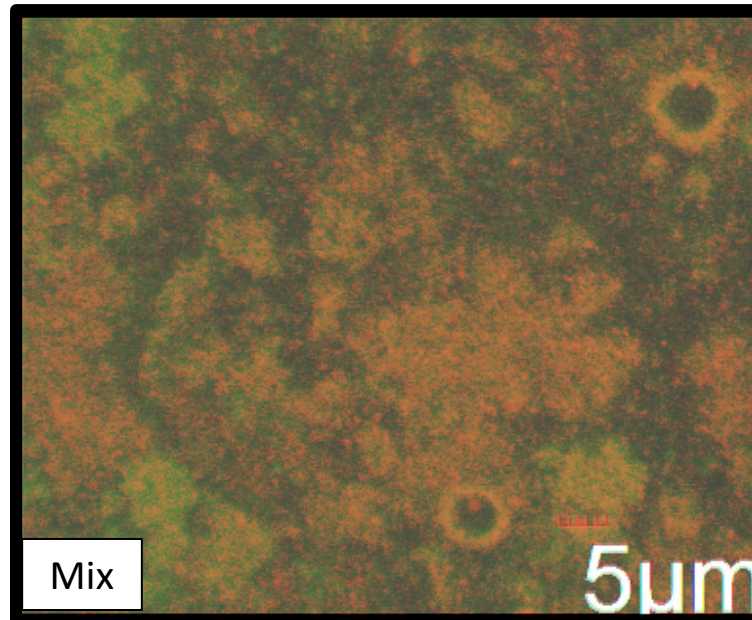
JB
24

CSLM

400MPa



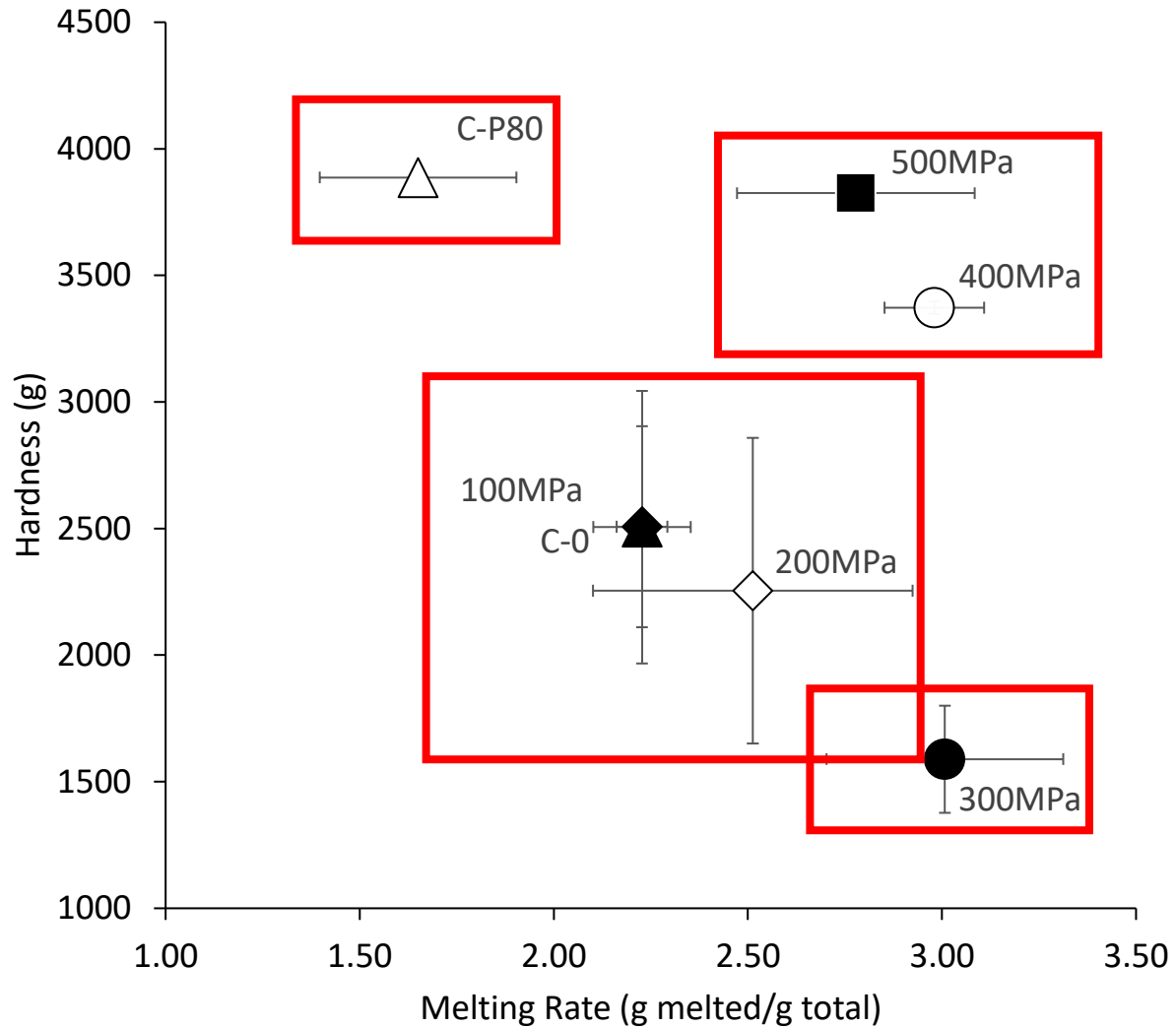
500MPa



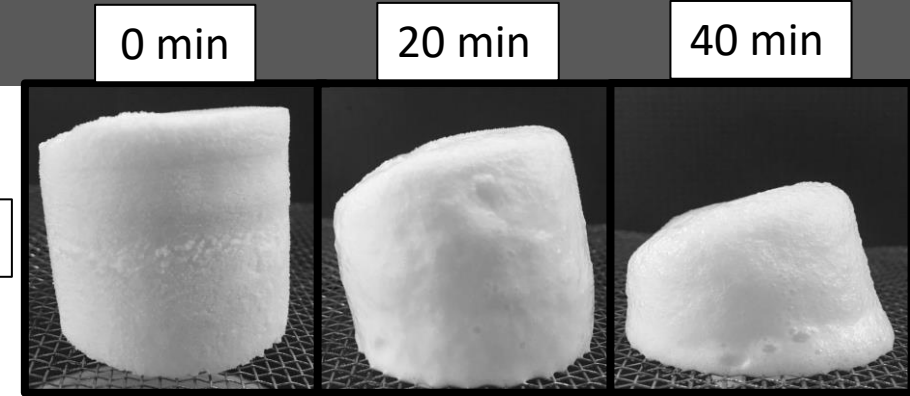
UW R

JB
25

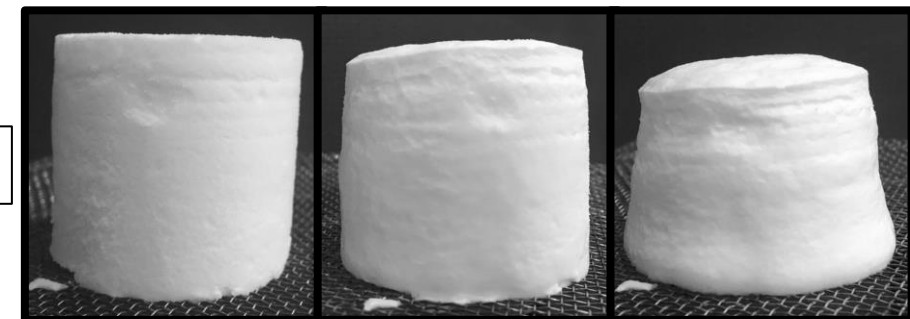
Hardness and Melting Rate



C-0



C-P80



400MPa



500MPa



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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

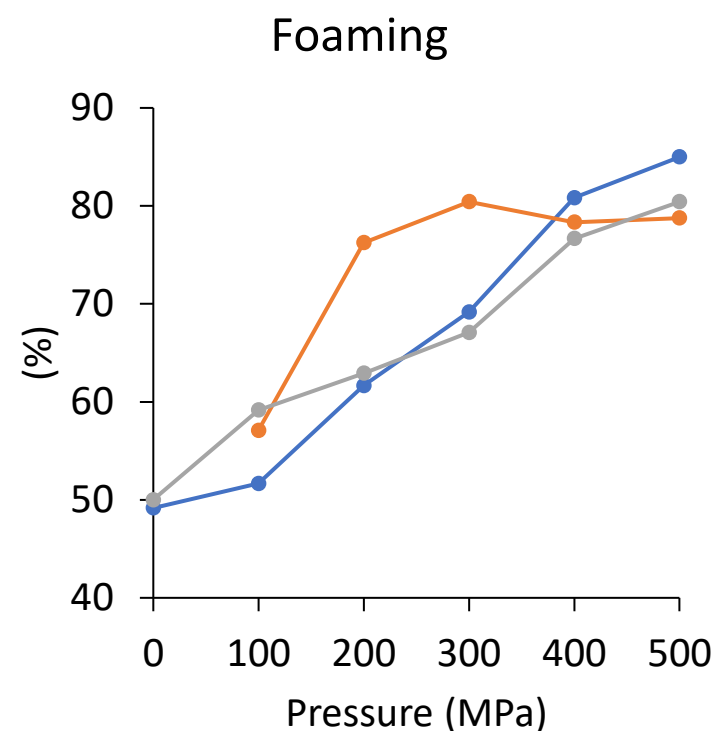
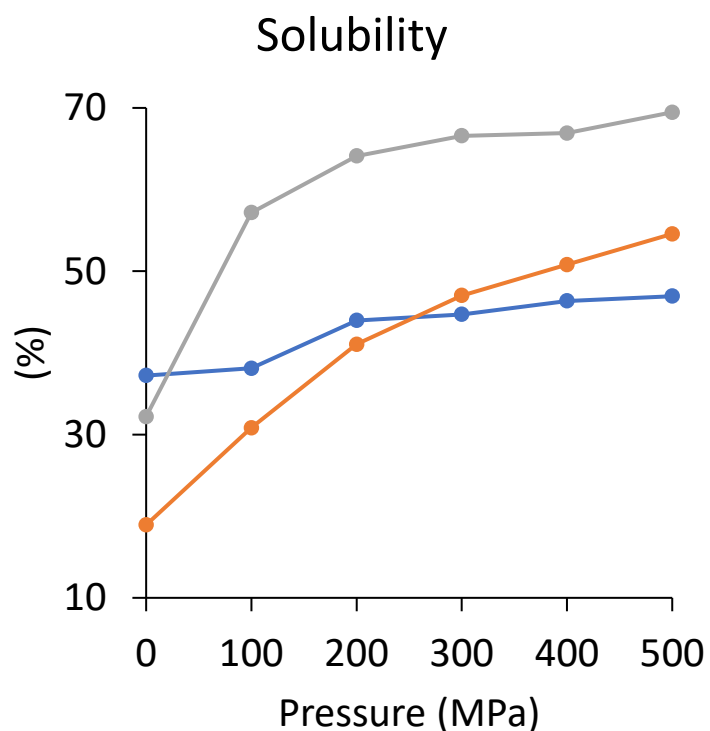
- Optimize freezing of HPJ-treated ice cream mix
- Look at potential for non-dairy frozen dessert applications
- Vary ice cream mix composition (high protein formulations)
 - Shrinkage?



Future Directions – Non-Dairy



United States Department of Agriculture
National Institute of Food and Agriculture



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

Acknowledgements



Dr. Federico Harte



Dr. John Coupland

Questions?

Thank you!

References

Goff, H. D. and R. W. Hartel. 2013. Ice Cream Structure. Pages 313-352 in Ice Cream. Springer US, Boston, MA.

Hagiwara, T. and R. W. Hartel. 1996. Effect of Sweetener, Stabilizer, and Storage Temperature on Ice Recrystallization in Ice Cream. *Journal of Dairy Science* 79(5):735-744.

Hettiarachchi, C. A., M. Corzo-Martínez, M. S. Mohan, and F. M. Harte. 2018. Enhanced foaming and emulsifying properties of high-pressure-jet-processed skim milk. *International Dairy Journal* 87:60-66.

Voronin, G. L., R. Roberts, T. L. Felix, J. N. Coupland, F. M. Harte. 2020. Effect of high-pressure-jet processing on the physiochemical properties of low-fat ice cream mix. *Journal of Dairy Science* 103(7): 6003-6014.

Voronin, G. L., G. Ning, J. N. Coupland, R. Roberts, F. M. Harte. 2021. Freezing kinetics and microstructure of ice cream from high-pressure-jet processing of ice cream mix. *Journal of Dairy Science* 104(3): 2843-2854.

TEM- Comparing C-0 to other samples

