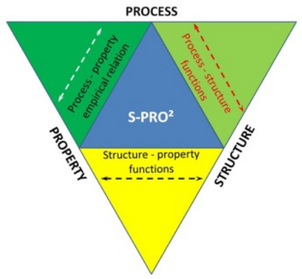
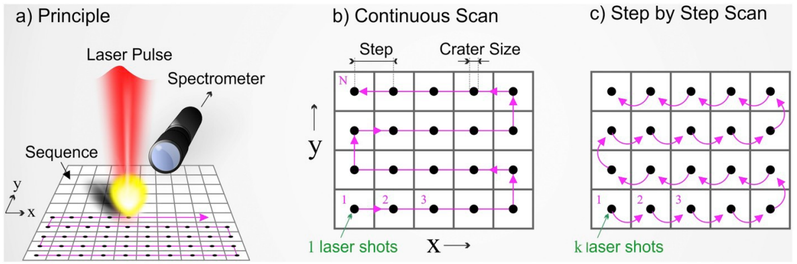
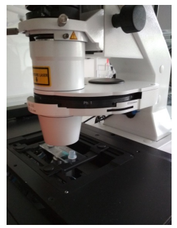
# Dairy research and program capabilities at Utah State University

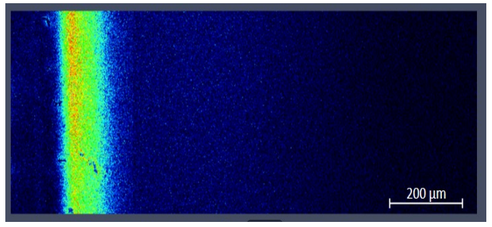
**Prateek Sharma, PhD**
Nutrition Dietetics and Food Science Department, Utah State University, Logan, USA

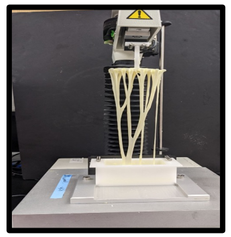
**Oregon Dairy Industry Conference, April 19, 2023**





# Outline

- About myself
- NDFS department-Food Science program
- Western Dairy Centre/BUILD Dairy
- Student product development competitions
- Aggie Creamery/Dairy Production lab capabilities
- My research program
- Other research programs

# About myself- Prateek Sharma


## Professional experience

Assistant Professor, Utah State University (2020-present)

Marie Curie Career-FIT Fellow, Ireland (2019)

Post-Doc, Teagasc/DPTC, Ireland (2017-2018)

PhD Scholar, Riddet Institute/Fonterra Research and Development Centre, New Zealand (2012-16)

Scientist (Dairy Processing), National Dairy Research Institute, Karnal (2010-12; 2016-17).

Senior Innovation Scientist, Dairygold Food Ingredients, Ireland. (2008-2010)

R&D Technologist, Glanbia Food Ingredients, Ireland (2007-08)

QA Executive, Amul, India (2004-05)

Graduate Intern, Schreiber Dynamix, India (2002)

## Education

PhD: Massey University through PGP funding (2016)

EU MS: Food Science, Technology & Nutrition (2008)

DIT (Ireland), KaHO Sint Lieven (Belgium), Hochschule Anhalt (Germany), UCP (Portugal)

MTech: Dairy Technology (2004)

National Dairy Research Institute, Karnal (India)

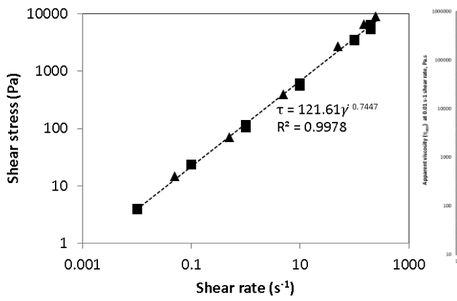
BTech: Dairy Technology (2002)

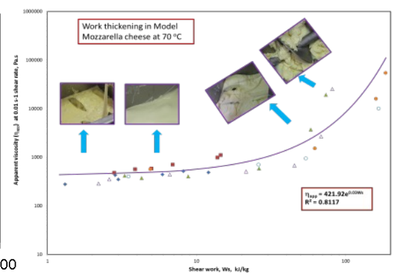
Maharana Pratap University of Agriculture & Technology (India)


About My research
Ready to reconstitute dairy products
Process development for indigenous dairy products
Emulsion based delivery systems
Directly acidified milk drinks
Demineralisation of whey and isolation of whey proteins
Cheese structure, rheology and functionality
Diffusion of small solutes in model cheese matrices

# Rheology landscape

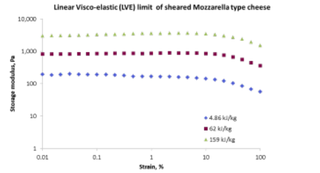
## Steady Shear rheology

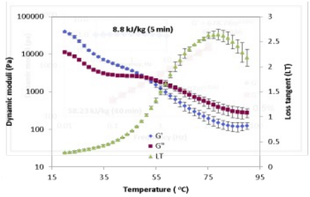


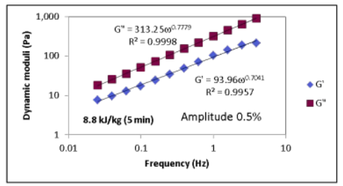



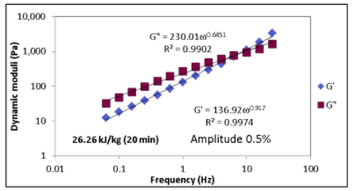

Sharma, et al. 2015. *International Dairy Journal,* 47, 102-108

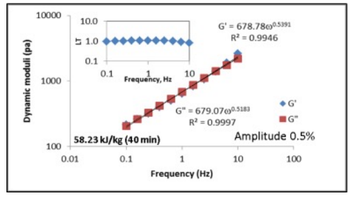
## Small Amplitude Oscillatory Shear rheology

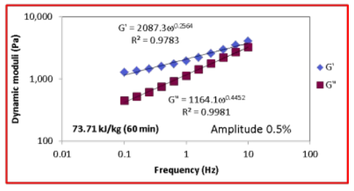


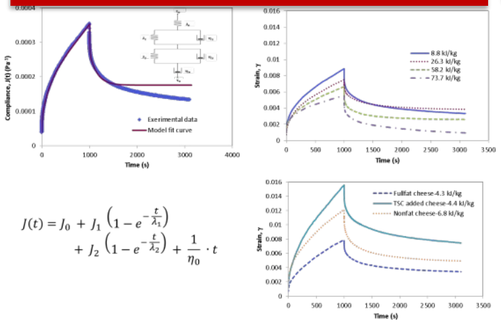




Sharma et al. 2016. *Food Hydrocolloids*, 54, 266-277

Sharma et al. 2016. *International Dairy Journal*, 56, 108-118

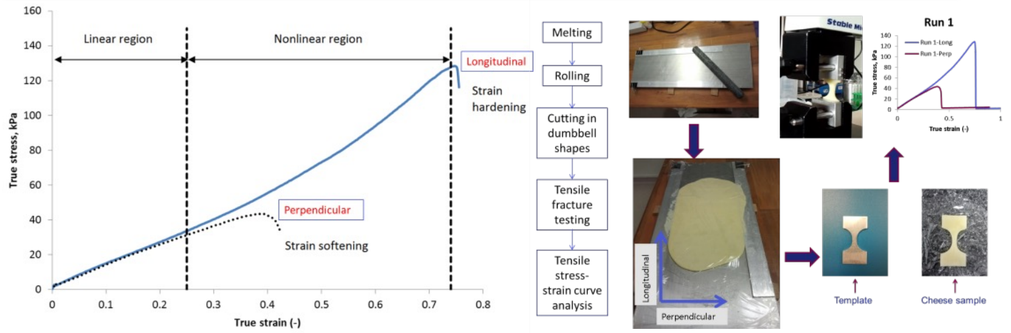
## Creep behaviour-transient viscoelasticity




$$J(t) = J_0 + J_1\left(1 - e^{-\frac{t}{\lambda_1}}\right) + J_2\left(1 - e^{-\frac{t}{\lambda_2}}\right) + \frac{1}{\eta_0}\cdot t$$

Sharma et al. 2017. *LWT-Food Science and Technology*, 87, 108-118

## Tensile fracture and strain hardening







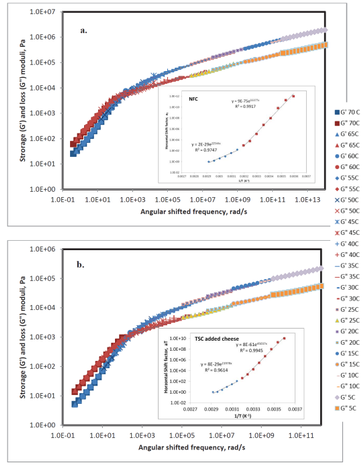




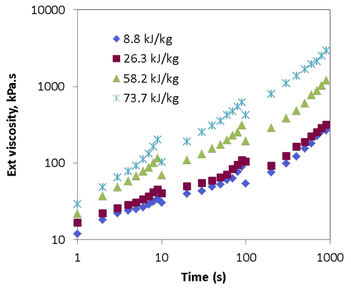


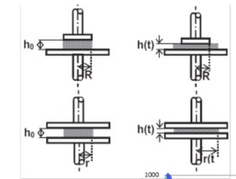
Sharma et al. 2018. *Journal of Dairy Science*, 101, 1-12; Bast, Sharma, et al., 2015. *International Dairy Journal*, *44*, 6-14

## Time-temperature superposition

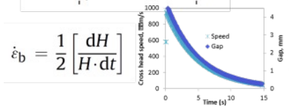


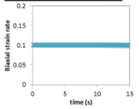

## Lubricated squeezing flow and extensional viscosity



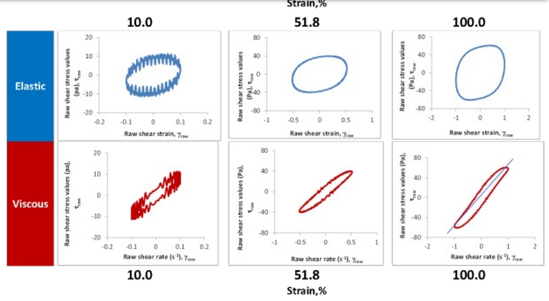




$$\dot{\varepsilon}_b = \frac{1}{2}\left[\frac{dH}{H \cdot dt}\right]$$



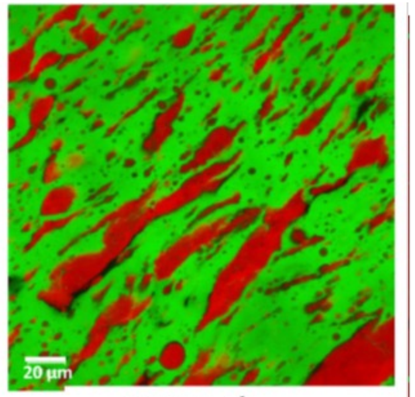

## Non-linear oscillatory shear rheology- Lissajous plots



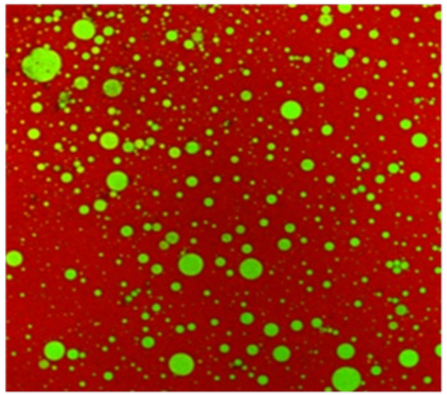

Sharma 2017. *Shear work induced changes in the rheology of model Mozzarella cheeses (Doctoral dissertation)*. Palmerton North, New Zealand: Massey University.

UtahState University

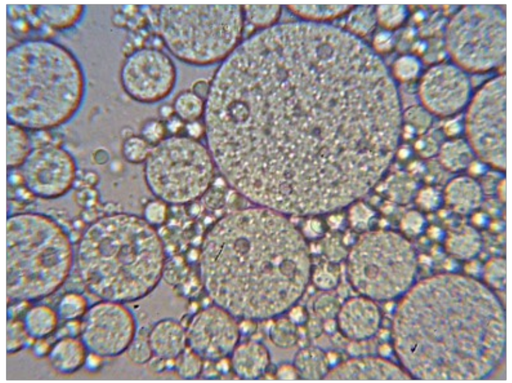
# Microscopy landscape



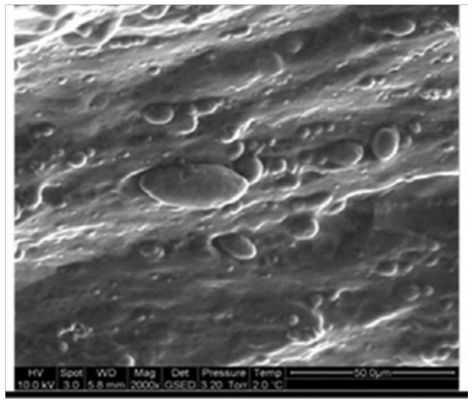

CSLM-Mozzarella cheese



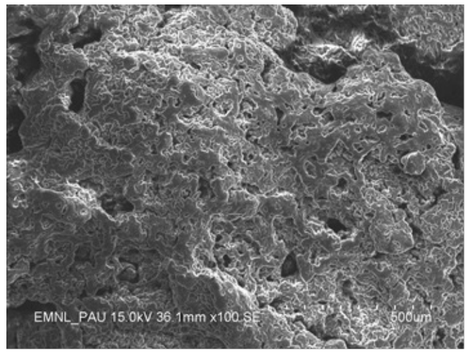
CSLM-Double emulsions



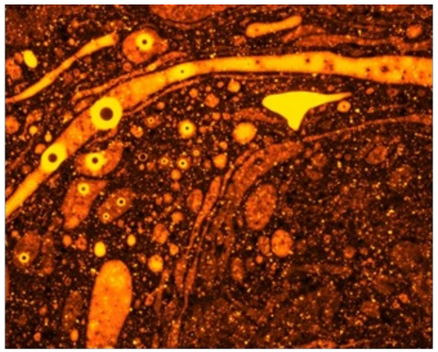
Light microscopy-Double emulsions



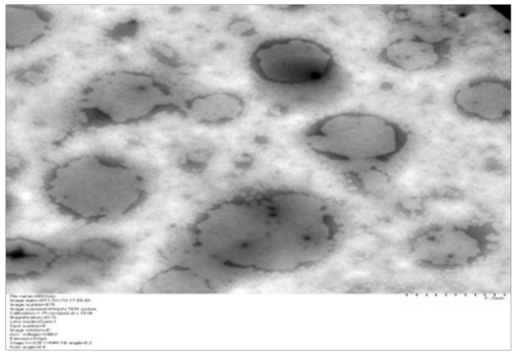
ESEM-sheared cheese




SEM Paneer



Fluorescent Microscopy-Emulsions



TEM- Double Emulsion


Cryo-SEM cheese

- Advanced training on Cryo-SEM/ ESEM, TEM from Prof. Bryony James, Auckland University
- Thorough understanding of principles of X-ray scattering techniques, micro-CT, Small angle X-ray, Synchrotron etc.

THE UNIVERSITY OF AUCKLAND
Te Whare Wananga o Tamaki Makaurau
NEW ZEALAND

UtahState University

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UtahStateUniversity | Nutrition, Dietetics & Food Sciences
College of Agriculture and Applied Sciences



Heidi Wengreen

## Minors, Associates and Certificates

- Food Science (Minor)
- Hunger and Food Security Studies (Minor)

## Undergraduate Degrees

- Coordinated Program Emphasis
- Didactic Program Emphasis
- Dietetics (BS)
- Food Science (BS)
- Nutrition Science (BS)
- Pre-Health Emphasis
- Sports Nutrition Emphasis

## Graduate Degrees

- Dietetics Administration (MDA)
- Dietetics Internship Graduate Certificate
- Food Safety & Quality (MFSQ)
- Nutrition & Food Science (MS, PhD)
- Public Health Nutrition (MPH)


**Master's Degree in 33 Credits**

**Fully online**

**Flexibility for Working Professionals**

- Four USDA-NIFA grant in 2022
- ~20 undergraduate food science students
- ~20 graduate students


Silvana Martini


Marie Walsh


Robert Ward


Sulaiman Matarneh


Luis Bastarrachea


Taylor Oberg


Prateek Sharma

**Karin Allen**
Program Director
Karin.allen@usu.edu
435-797-1768

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WDC | WESTERN DAIRY CENTER

BUILD DAIRY

dairy west®

Eric Bastian

## Program Overview

The "BUILD" in BUILD Dairy stands for "Building University-Industry Linkages through Learning and Discovery". By bringing together students, professors, universities and companies, we can help strengthen every link in the dairy chain.

**Learn more**

## Universities & Faculty

Our program is centered around education. University professors and faculty members play a key role in aiding our efforts to broaden the network of technically trained, knowledgeable professionals in the industry.

**Learn more**

## Stipend Funding

BUILD offers stipends for students to help them further their education and contribute meaningful research with real-world dairy applications.

**Learn more**


## Career Opportunities

BUILD aligns university research initiatives with the priorities of dairy companies, naturally readying students for careers in the industry. And we actively work to match graduates with dairy companies looking for the best and brightest in the field.

**Learn more**

## Admission Requirements

BUILD offers opportunities for both undergraduate and graduate level students. Any college or university student can be involved in the BUILD Dairy program, if their program of study or research is in some way related to dairy foods or the dairy industry.

**Learn more**

# Short Courses & Workshops

The Western Dairy Center offers artisan and industrial cheese making classes. We partner with other educators to provide specialized and personalized workshops for companies. For more information on customized workshops, email westcent@usu.edu.

## Cheese making Short Courses

Cheese making short courses are held once yearly. Students will spend time in the classroom learning definitions, terminology, techniques, and the science of making cheese. They will also get hands-on experience making a variety of cheeses in our dairy plant. Classes are limited to 15 people and fill up quickly, so register early. For registration information, email westcent@usu.edu or call 435-797-3466.

### Basic Cheese making Short Course

The Basic Cheese Making Short Course is a three-day class designed for the beginning cheese maker and those who have never made cheese before. The course will include an introduction to milk, cheese, dairy cultures and the steps in cheese making. Students will spend a day in the pilot plant making three varieties of cheese the old fashioned way, by hand.

**February 14-16, 2023**

### Advanced Cheese making Short Course

This four-day course is for people who have cheese making experience and want to expand their knowledge of milk chemistry, cheese chemistry, curd handling and controlling cheese manufacture. This class will cover the basics of how to make cheese as well as a more in-depth exploration of the science of cheese making and flavor development of cheese. Students will spend two days in the pilot plant making several different varieties of cheese.

**March 7-10, 2023**


★ Welcome to the ★
2022 ADSA® Annual Meeting
2022 ADSA® Annual Meeting
Exhibit Hours
Monday, June 20
8:00 am – 5:00 pm
Tuesday, June 21
8:00 am – 4:00 pm
2022 ADSA® Annual Meeting
Welcome ようこそ
Bienvenidos Bienvenue
BEM-VINDOS Välkommen
Benvenuti!
Witamy Welkome
欢迎 Willkommen
VALKOMMEN
Chào Mừng
WELKOM Welcome
Bienvenidos Bienvenue
BEM-VINDOS Willkommen
Witamy Welkome


BUILD DAIRY
CONNECTING SCIENCE AND DAIRY TO LAUNCH CAREERS
BUILDdairy.com


What is HC-MCC?
Highly Concentrated Micellar Casein Concentrate
17-23% casein solution
Micelles still in native state
Forms a gel at cold temperatures
Skim Milk
Microfiltration and Diafiltration
Vacuum Evaporation
Extra Water
HC-MCC
MARRIOTT PROVO


Dairy Powders
DIVERSE COMPOSITIONS
LARGE INDUSTRIAL SECTOR
SIGNIFICANT MARKET VIABILITY
RHEOLOGICAL TESTING FOR FLOWABILITY

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# MOBA BOBA

PINEAPPLE-COCONUT

Moba Boba - dairy-based energy drink fused with high protein gummies. Utilizing untapped channels of raw and potent energy, Moba Boba fuels your thrist for performance while helping the human team journey towards a more balanced and sustainable future. Buff your game with Moba Boba!

No Added Sugar

31g Protein

130mg Caffeine

210 Calories

16 oz (454 g) - Keep Refrigerated

9781234567890

REAL®

## Nutrition Facts

| | |
|---|---|
| **Serving size** | **16 fl oz (454g)** |
| **Amount per serving** | |
| **Calories** | **210** |
| | **% Daily Value *** |
| **Total Fat** 3.5g | **4%** |
| Saturated Fat 2g | **10%** |
| *Trans* Fat 0g | |
| Polyunsaturated Fat 0g | |
| Monounsaturated Fat 1g | |
| **Cholesterol** 45mg | **15%** |
| **Sodium** 240mg | **10%** |
| **Total Carbohydrate** 28g | **10%** |
| Dietary Fiber 0g | **0%** |
| Total Sugars 25g | |
| Includes 0g Added Sugars | **0%** |
| **Protein** 31g | |
| Vitamin D 1.5mcg | 8% |
| Calcium 560mg | 45% |
| Iron 0.4mg | 2% |
| Potassium 680mg | 15% |
| Vitamin A 170mcg | 20% |
| Thiamin 0.3mg | 25% |
| Riboflavin 0.7mg | 50% |
| Niacin 3.1mg | 20% |
| Vitamin B6 0.3mg | 20% |
| Folate 50mcg DFE (25mcg Folic Acid) | 15% |
| Vitamin B12 1.5mcg | 60% |
| Phosphorus 430mg | 35% |
| Magnesium 70mg | 15% |
| Zinc 2.7mg | 25% |

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

INGREDIENTS: Acid Whey, Reduced Fat Milk, Caffeine Concentrate, Gelatin, Whey Protein Isolate, SPLENDA, Whey Protein Phospholipid Concentrate (WPPC), Pineapple Flavoring, Coconut Flavoring, Stevia Leaf extract

CONTAINS: milk

2022 HIGHLIGHTS

# NDFS-National Dairy Council Product Development competition

Mackenzie Taylor
Nathan Paugher
Chandler Stafford
Melissa Marsh

DMI
DAIRY MANAGEMENT INC.™

# Dairy Product Development Competition


*A USU team has developed a meatless alternative to the traditional chicken nugget. The award-winning "Moogets" are dairy-based nuggets that are packed with protein and provide a taste and texture similar to traditional chicken nuggets.*

## PROBLEM

Many consumers who have eliminated or reduced their meat intake are deficient in at least one of protein, vitamin B12, or calcium. Thus, there is a need for meatless food products with higher levels of these nutrients than what is currently being offered. There is also a need for a meatless nugget that can replicate the taste and texture of the traditional chicken nugget.

## SOLUTION

In response to these needs, USU researchers have developed "Moogets" using

## CONTACT

Questions about this technology including licensing availability can be directed to:

**CHRISTIAN IVERSON**
*Director*
Technology Transfer Services
(435) 797-9620
christian.iverson@usu.edu

## INVENTORS

Ireland Green, Sophie Overbeck, Melissa Marsh, Jun Mun Yang and Savannah Branson

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Sensory tasting panel room

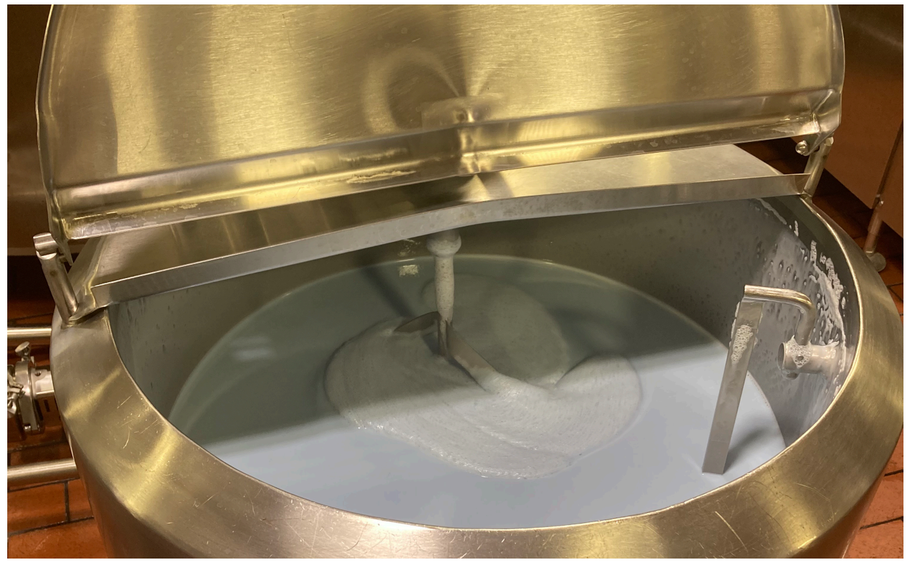

Research kitchen

Aggie™
CREAMERY
Since 1888


# Ice Cream

- Continuous freezer
  - Nut feeder (inclusions)
  - Variegate pump
  - Cup filler (4 oz and pint)
  - Manual filling ½ gal and 10 qt
- Batch freezers
  - 2.5 gallon and 2 quart ml capacity



# Cheese

Horizontal Cheese Vats (HCV)

- 1500 lb capacity
- Two vats (can be simultaneous)
- Drain table with stirrors

Open vats

- 500 lb capacity
- Manual cutting and stirring
- 3 vats for individual or simultaneous makes

Horizontal Process cheese cooker

Single screw mozzarella cheese cooker and stretcher



# Filtration System

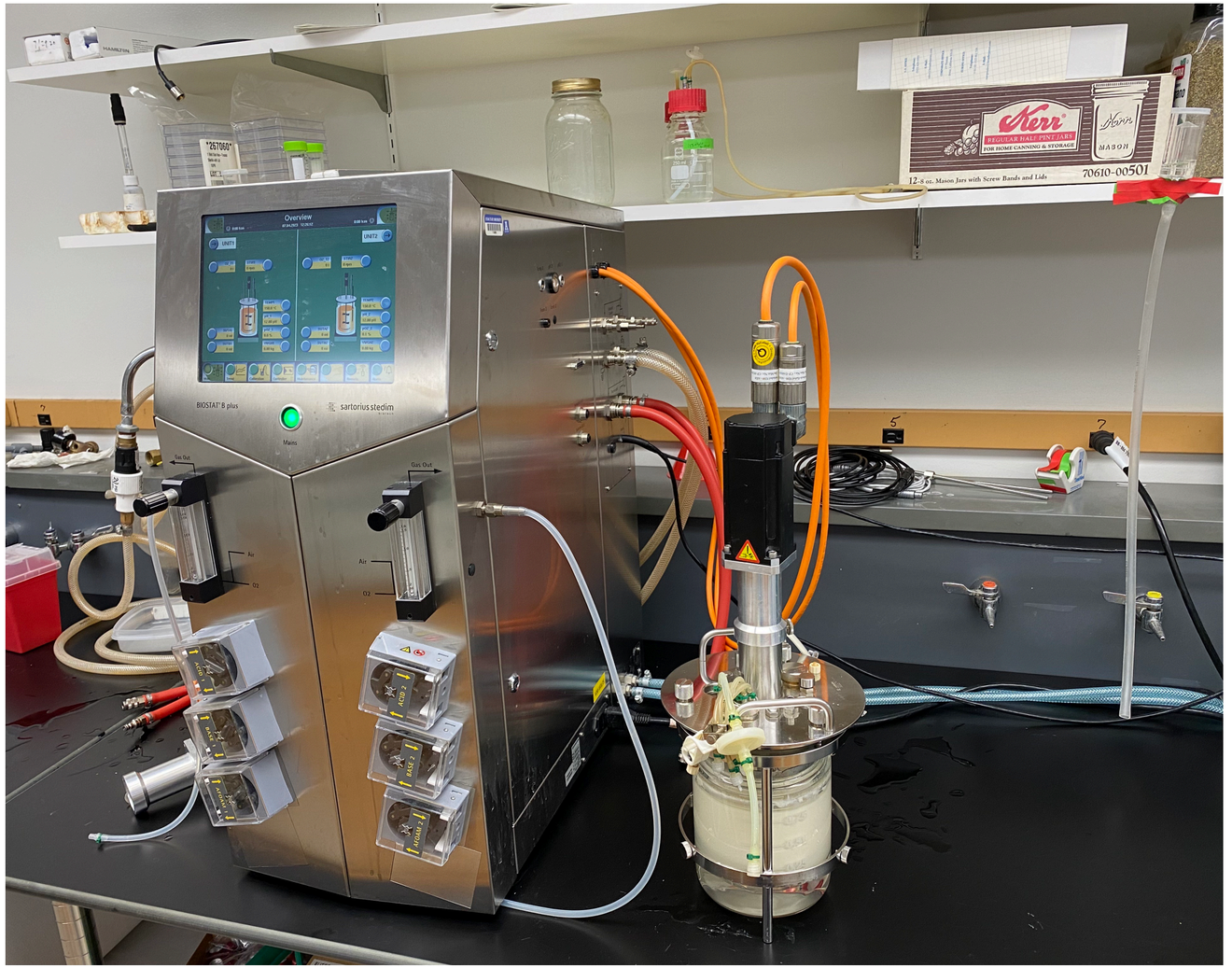
- 4-module of spiral bound membrane
- Membrane Type: spiral-wound polyethersulfone membranes
- Make: Synder Filtration, Vacaville, CA
- MWCO: 10-kD
- Model: ST-2–3838,
- Size: 10 cm × 100 cm with a 0.76-mm spacer, 7-$m^2$ surface area;

# Yogurt making equipment

- 100-gallon capacity
- Inoculation and blending tank
- Adjustable smoothing valve for texture control
- Packaging machine

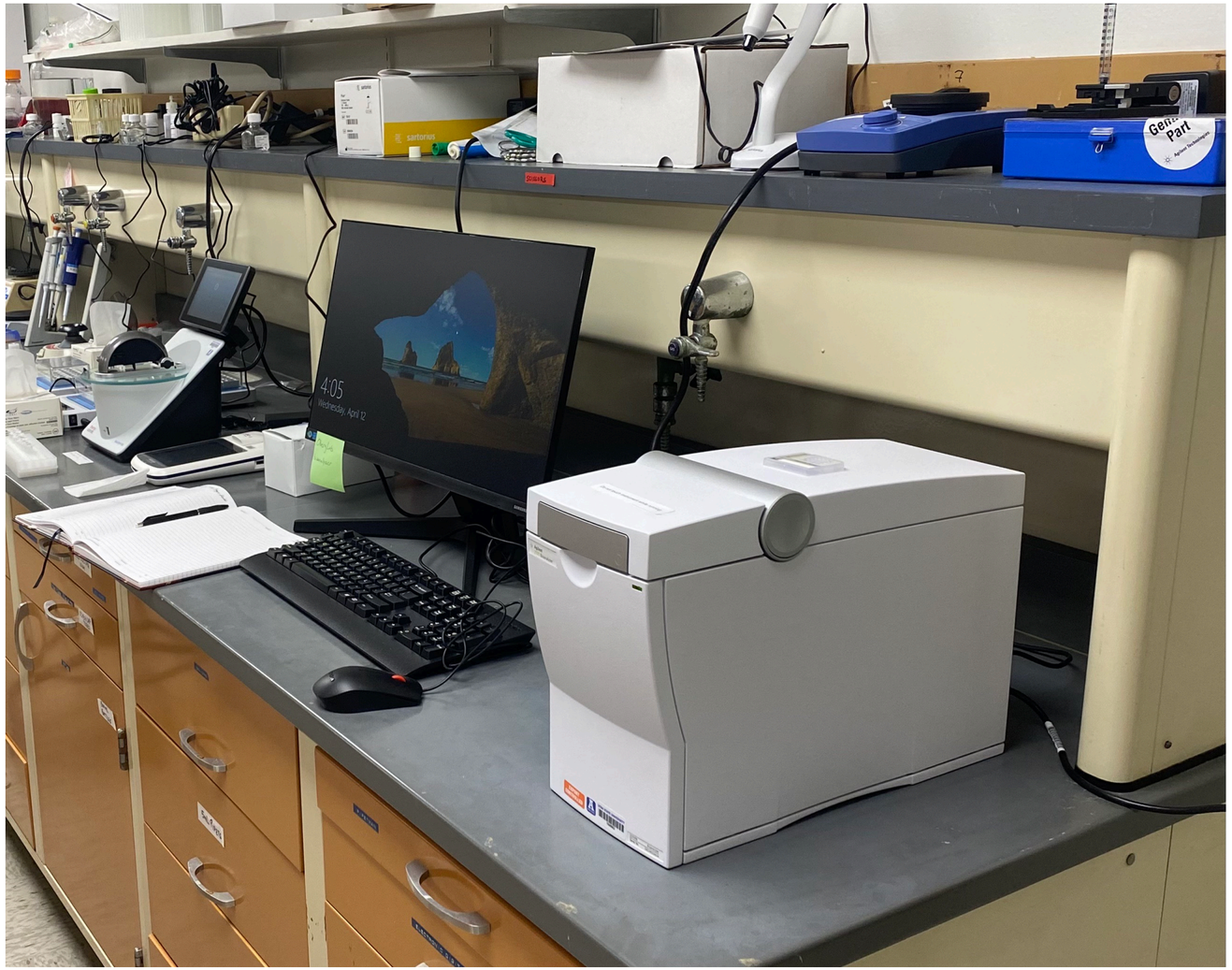
# Microbial Biofermentation

- Lab scale dual 1 L biofermentation unit
- Precise control of:
  - pH
  - Aerobic/Anaerobic
  - Temperature
- Potential use: Model cheese preparation for cheese buffering project



# Agilent 2100 Bioanalyzer

- Perform rapid quantification and size measurements on:
  - DNA
  - RNA
  - Protein
- Quality check DNA/RNA for high throughput sequencing



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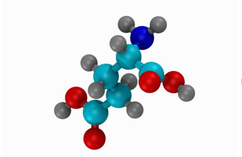
# Understanding the pizza baking properties of Mozzarella cheese

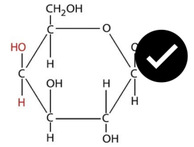
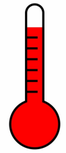
Anjali Verma

- **Low-moisture part skim milk Mozzarella cheese is widely consumed as a pizza ingredient.**
- **Pasta- filata cheese**
- **Functional properties - Melting**
  **- Stretchability**
  **- Oiling off**
  **-Browning and blistering**
- **Major factors contributing to functionality include milk composition, manufacturing process, cheese composition, calcium, residual sugars, and ageing.**

**OUR RESEARCH FOCUSES ON**

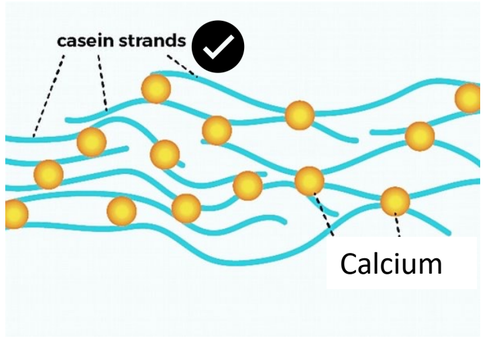
## Effect of starter culture – Limits galactose



Amino acids +  Galactose +  High temperature = Browning

*Low galactose content, low browning and blistering

## Effect of calcium – Intact casein matrix




*Low calcium , better melting, stretchability, and free oil release resulting reduced browning and blistering.

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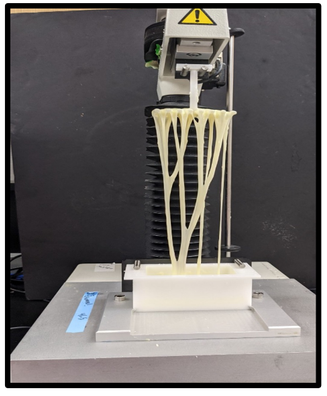
# Cheese functionality analysis

## Melting

**Anton Paar MCR-302**

- Oscillatory rheology
- Temperature sweep test (20°C-90ºC)

## Stretchability



**TA-XT Plus Texture Analyzer.**

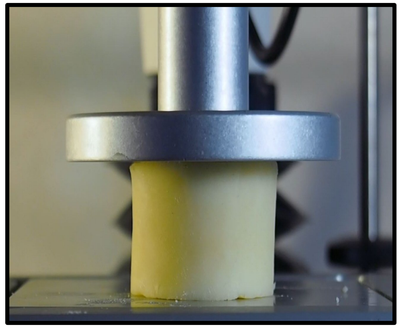
- Using extensibility rig
- Cheese extended to 260 cm

## Residual Sugars


**Megazyme enzymatic kit**

- Spectrophotometer at 340 nm wavelength will be used to obtain the absorbance value

## Texture Profile analysis



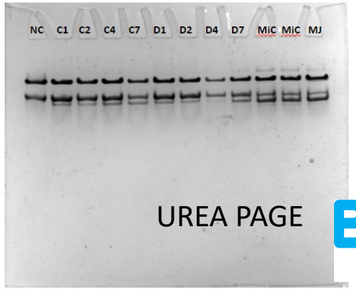
**TA-XT Plus Texture Analyzer.**

- Using texture profile analysis rig
- Hardness, springiness, cohesiveness, chewiness are determined

## Pizza baking

**Air forced impinger over**

- Baking done at 250ºC/6 min
- Visual appearance
- Image analysis through Image J




UREA PAGE

- Mozzarella cheese is produced using 1500 lbs. of milk at USU's pilot plant facility.
- Other analysis includes moisture, fat, salt, protein, free oil %, expressible serum, UREA-PAGE, shreddability work.

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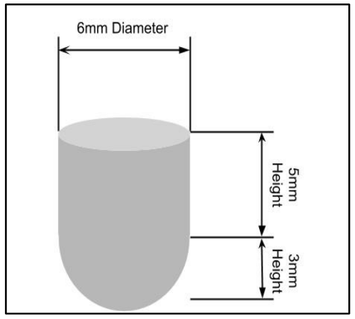
# Wear Behaviors of Process Cheese With Varying Formulations and the Development of Predictive Models on Shreddability

Jason Young

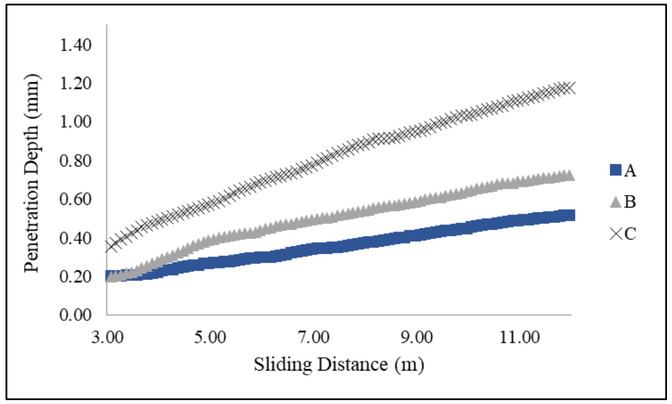
## Tribological (wear) Tests




Pin on Disk arrangement

Important parameters:

1. Mass loss
2. Penetration depth

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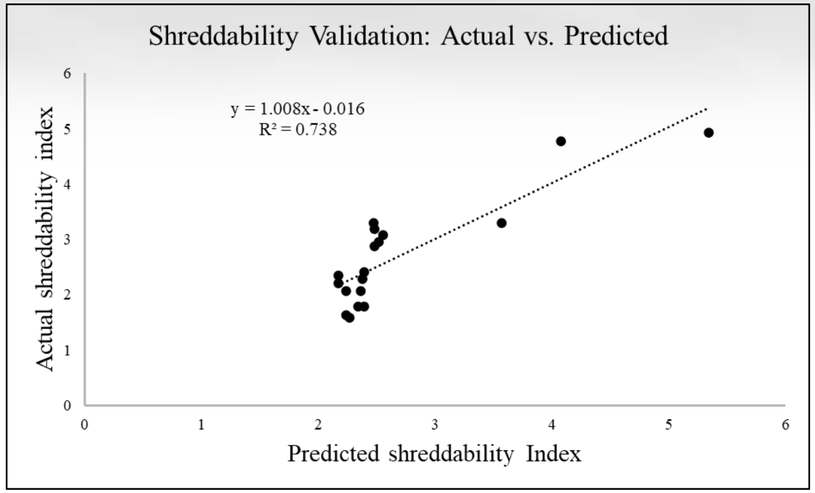
UtahStateUniversity

# Shreddability Index


**Shreddability Index ∝ length of shreds + production of fines + adhesion to equipment**

(Apostolopoulos C., and R.J. Marshall al 1994; Childs, et al., 2007)




**S = 3.22 + 0.83M– 2.41P**

**S** = shreddability index score

**M** = mass loss

**P** = penetration depth

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UtahStateUniversity

# Development of predicting models for sliceability of Cheddar cheese using wear behavior and mechanical properties

Sreebhavya Immadi

**Hypothesis :**

- Cheese sliceability will be dependent on the cheese composition (fat, moisture, protein) and the age of the cheese (extent of proteolysis).
- The combination of wear behavior and other texture/rheological measurements can be used to develop a predictive modeling system for measuring cheese sliceability.

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**Methods :**
Wear behavior
Tack test
Texture profile analysis
Cheese slice quality measurements

- **Results :**
  - Quantitative measurement of cheese slice quality index.
  - Establishing a relationship cheese slice quality and its functional properties, with the development of predictive formula

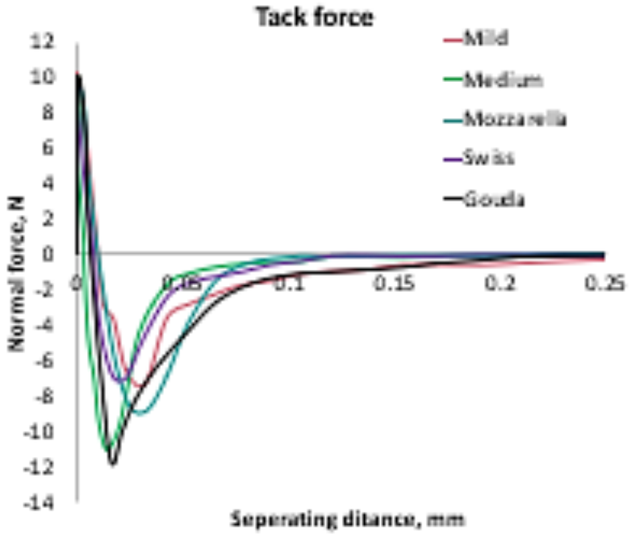


Fig 2: Tack force measurements of five cheeses

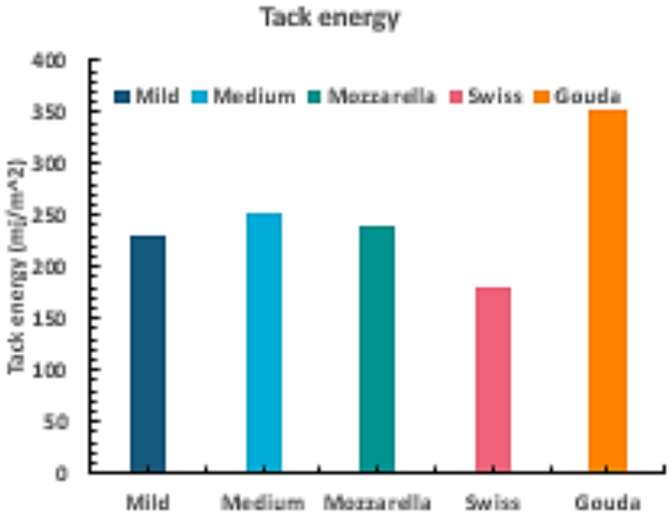


Fig 3: Tack Energy measurements of five cheeses

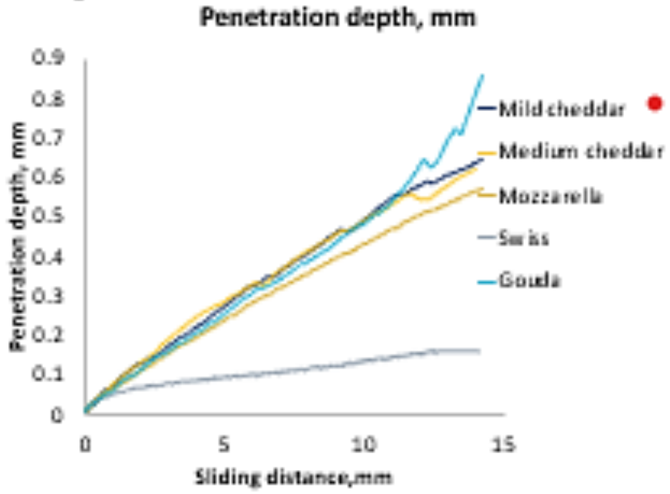


Fig 4: Wear measurements of five cheeses

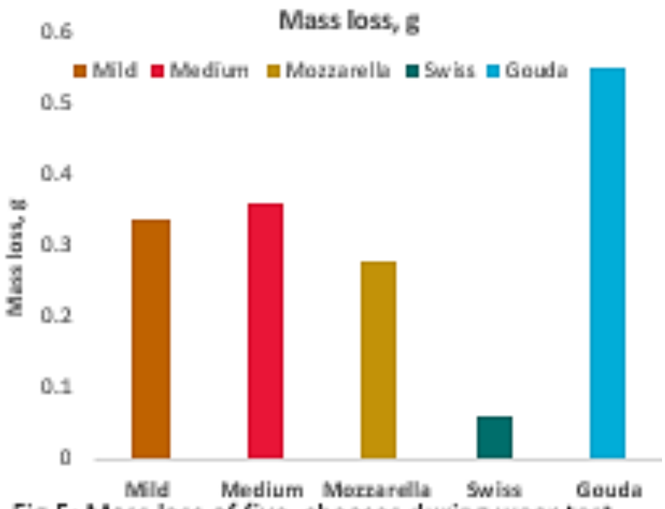


Fig 5: Mass loss of five cheeses during wear test

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# Understanding the Impact of Colloidal Calcium Phosphate on the pH Variation in Cheddar Cheese During Early Stages of Aging

Rachel Lindstrom

## Issue

Cheese may have pH variations that can cause quality issues in the cheese's **texture, body, and flavor.**

## Hypothesis

The pH variation in cheddar cheese is linked to the changes in the **calcium equilibrium**.
We intend to identify factors that affect calcium equilibrium in the final cheddar cheese.

## Objectives

**ONE** Develop a method to measure the colloidal calcium phosphate (CCP) levels in the curd during cheesemaking.

**TWO** Track the state of CCP and its changes during the manufacturing process and in the early stages of storage.

**THREE** Study the effects of slow and fast acid-producing starter cultures on the pH of cheddar cheese during cheesemaking

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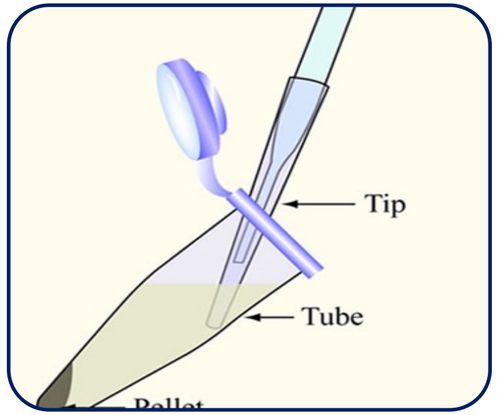
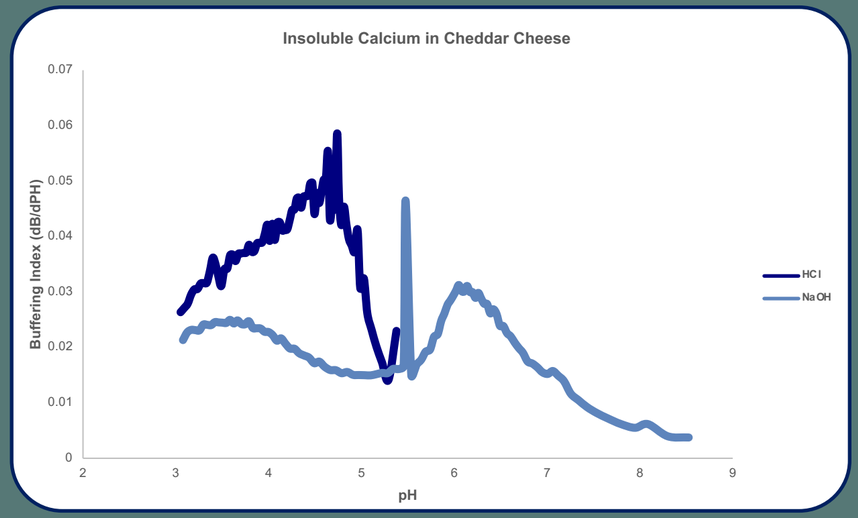
# Ionic calcium

Ultra-centrifuge


Calcium ion active probe

# Insoluble calcium (INSOL Ca)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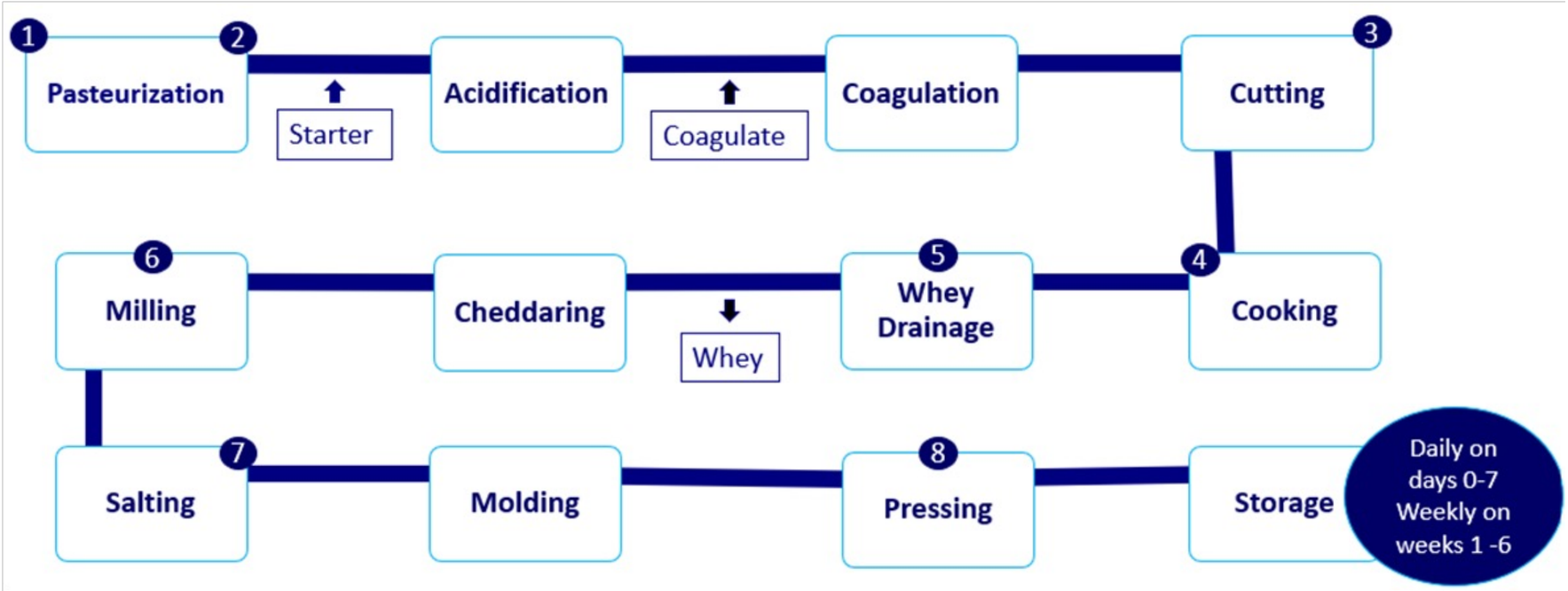
# SAMPLING PLAN




Each number represents a point in the cheesemaking process when a sample will be taken.

# Assessing Impact of Food Structure on Nutrient Delivery of Food Proteins

Lamis Ali

## Introduction








## Objectives

Study the mechanical properties, such as rheology and tribological properties of the selected dairy products

Study the impact of food protein type on *in vitro* digestibility of proteins and their rate of release

## HYPOTHESIS

The variation in food structure will impact the mouthfeel sensation, and the rate of protein digestion and nutrient releases in the gastro-intestinal tract

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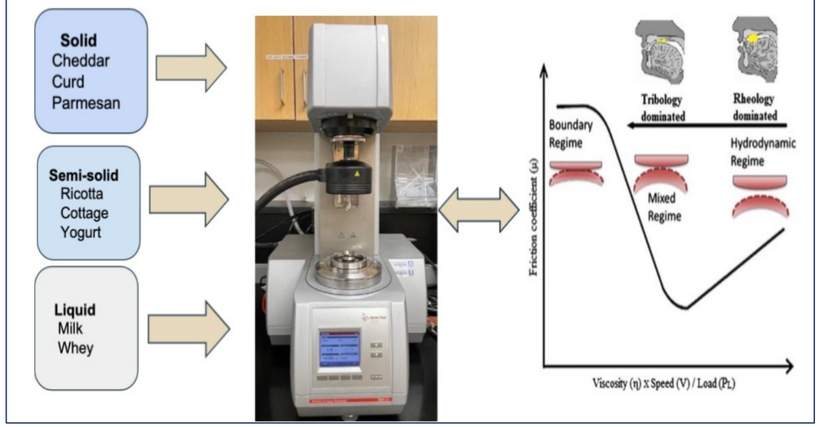
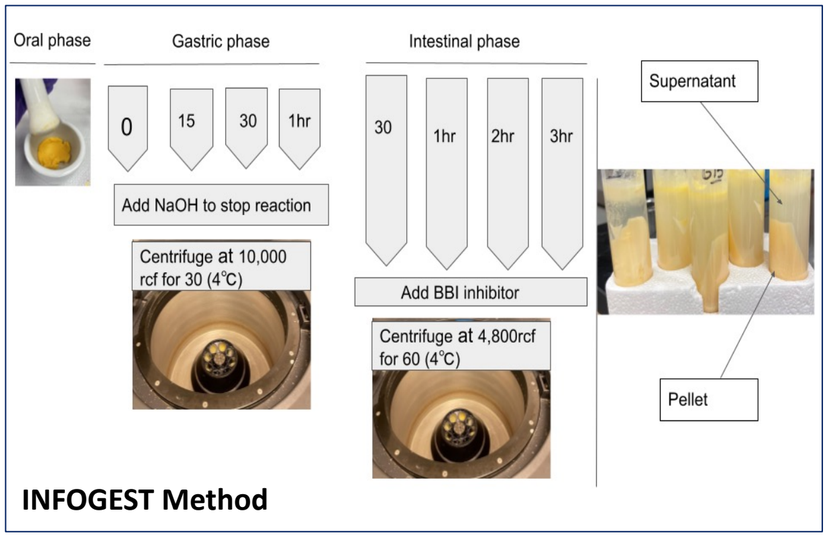
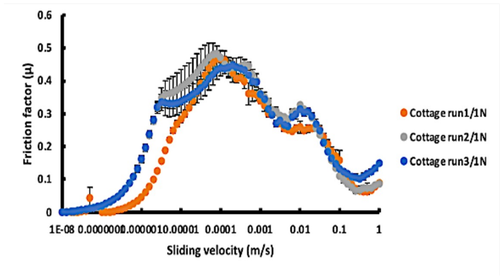
# Methodology



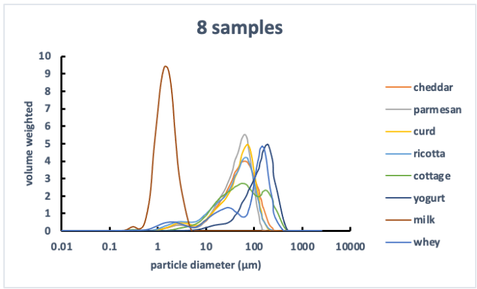



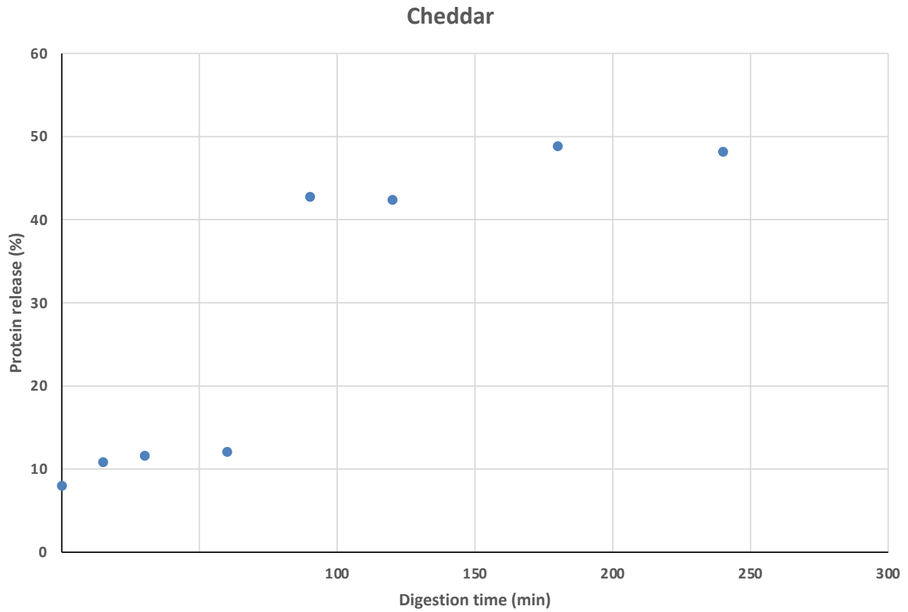

# Results

Tribology




Particle size analysis




# What's new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# Impact of Moisture Content & Composition on Flow Properties of Dairy Powders

Katelynn Palmer

## Hypothesis

Powder flowability is impacted by the relative humidity & temperature of the environment & storage time.

Powder composition & particle size also affect flow properties

## Why Study Rheology?

- ✓Prevent core flow issues
- ✓Decrease impact of environmental exposure
- ✓Ensure high quality product
- ✓Reduce production downtime

UtahState University Research Completed by: Katelynn Palmer

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# Materials & Techniques

## Materials

High Protein Milk Powders

Milk Powder Permeate

## Physical Properties

Particle Size Analysis

Bulk Density

SEM

## Flow Characteristics

Powder Rheometer

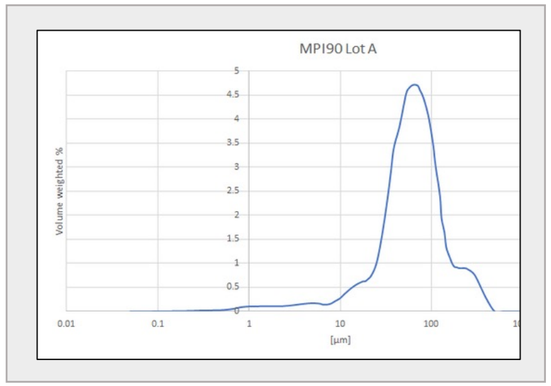
Shear Cell

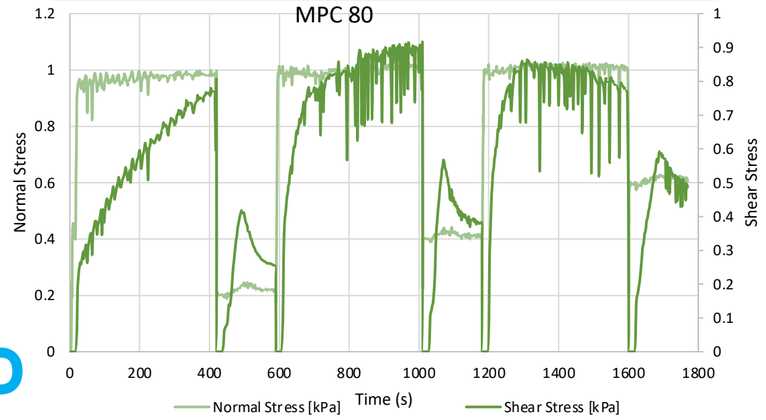
Relative Humidity Generator

Flow Cell

Powder Rheometer


Shear Cell

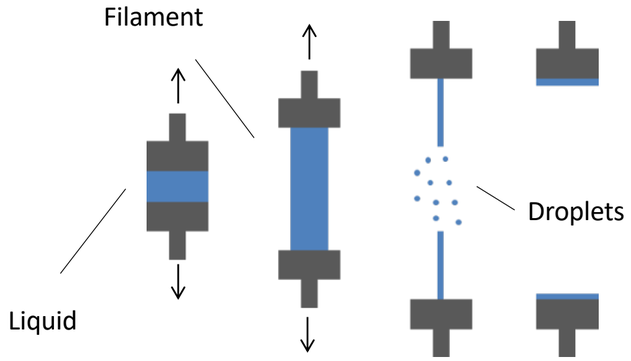


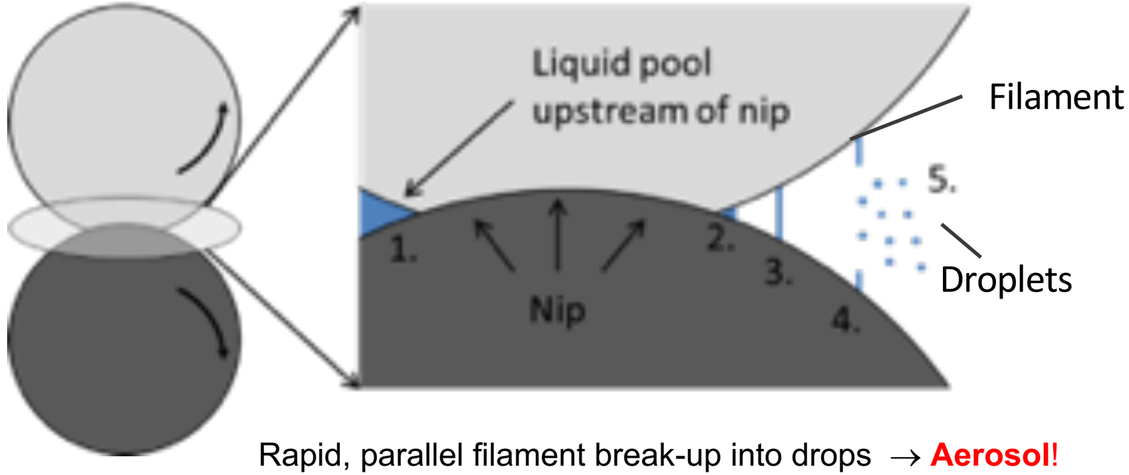
# Filament extension atomizer

Ashutos Parhi

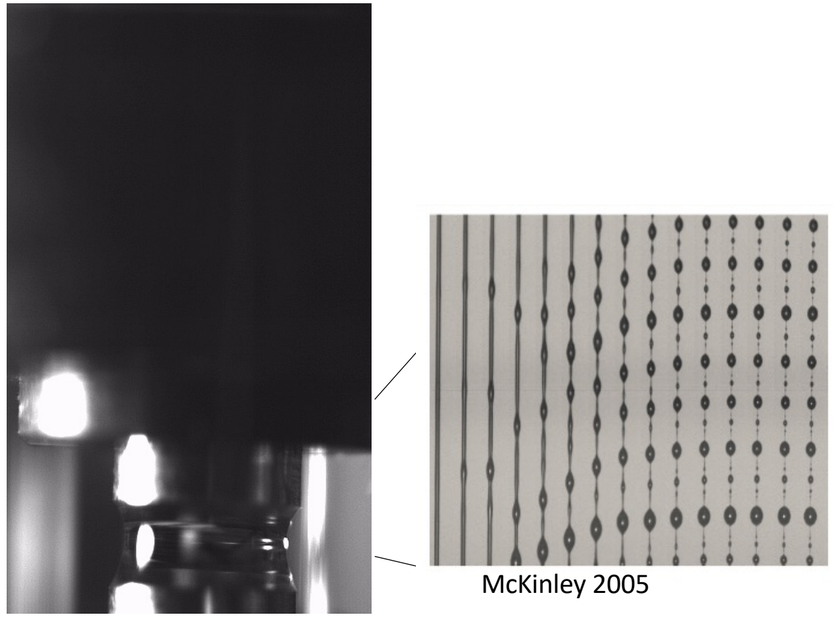
## Single filament break-up




## Multiple filament break-up

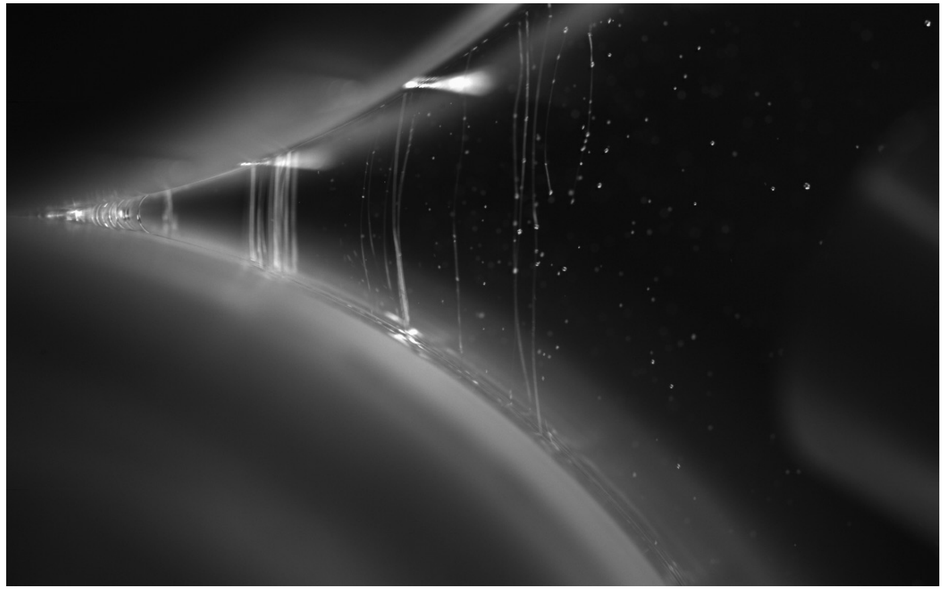



Rapid, parallel filament break-up into drops → **Aerosol!**





McKinley 2005

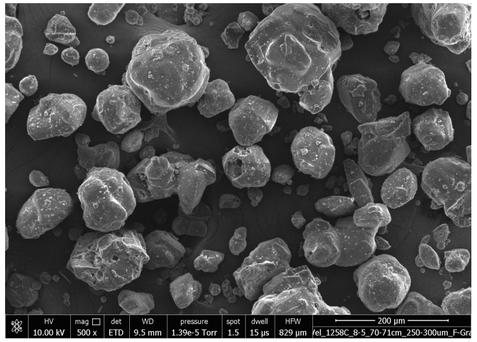


parc
A Xerox Company

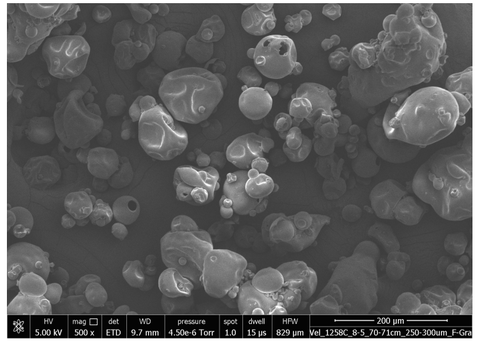
U.S. DEPARTMENT OF ENERGY

# Effect of particle shape and size on the flowability of dry whey, WPC 80 and MCC powders

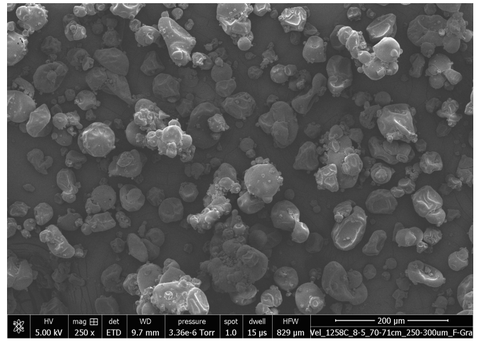
**Dry whey**



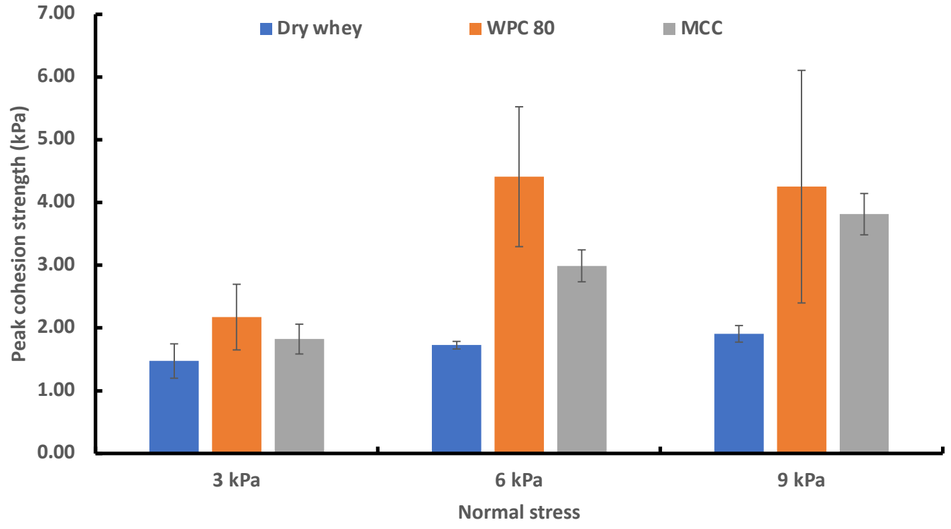
**WPC 80**



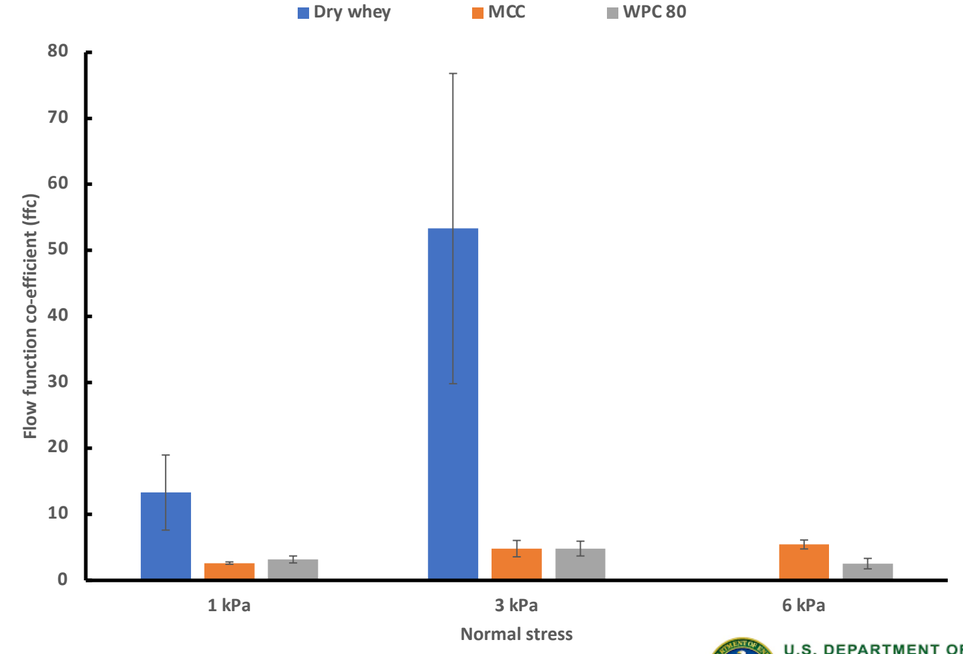
**MCC**



**Scanning Electron Microscopy images of dairy powders**




| Powder | D 10 (µm) | D 50 (µm) | D 90 (µm) | Mean size volume averaged (D[4,3]) (µm) |
|---|---|---|---|---|
| Dry whey | 22.7±0.38 | 89.2±0.93 | 234.3±5.89 | 115.4±2.23 |
| WPC 80 | 29.9±0.86 | 85.8±0.87 | 228.7±1.74 | 113.6±1.14 |
| MCC | 14.3±0.42 | 61.6±1.04 | 186.1±2.62 | 85.6±1.06 |



# Cold gelling properties of HC-MCC

Nathan Pougher

- Highly Concentrated-Micellar Casein Concentrate
  - 17-23% protein in solution
- Forms a gel in cold temperatures
- Goal: understand and optimize gelation

Cold gelled HC-MCC @ 5°C

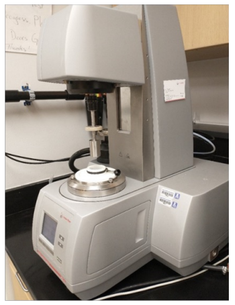
HC-MCC diluted to minimum protein concentration (16.8%)

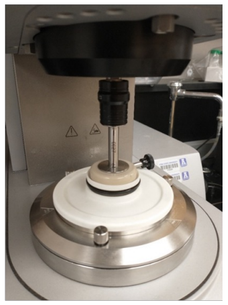
↓

Test with 5 acidity levels on a wt/wt % basis of GDL (0, 0.5, 1, 1.5, 2)

↓

3 Stages of testing
1) 1 hour Frequency sweep @ 60°C
2) 1 hour temperature sweep from 60°C to 5°C
3) 10 hour Frequency sweep @ 5°C





Skim Milk

↓

Microfiltration (0.14 µm) and Diafiltration → MF Permeate

↓

Vacuum Evaporation → Evaporated Water

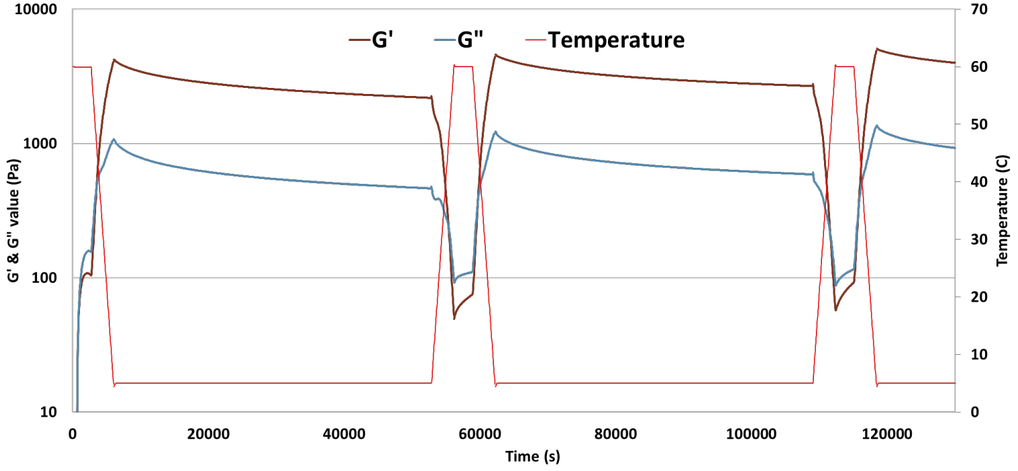
↓

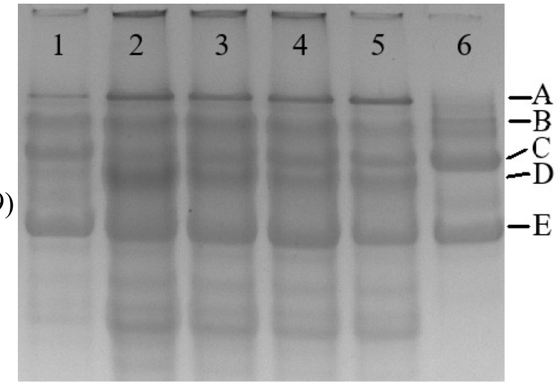
**HC-MCC**

Litesizer 500 Particle/Zeta Analyzer

# Methods

- Modify HC-MCC with different treatments
  - Dilution, calcium chelation, pH adjustment, carrageenan addition
- Multiwave rheological measurements
  - Winter and Chambon criterion for gelation determination
- Additional testing for better understanding
  - Texture analysis
  - Particle size & zeta potential
  - Urea PAGE
  - TEM Imaging




A: κ-casein
B: β-casein fragment (f108-209)
C: β-casein
D: β-casein fragment (f1-192)
E: $\alpha_{s1}$-casein

Urea PAGE of Modified HC-MCC Supernatants

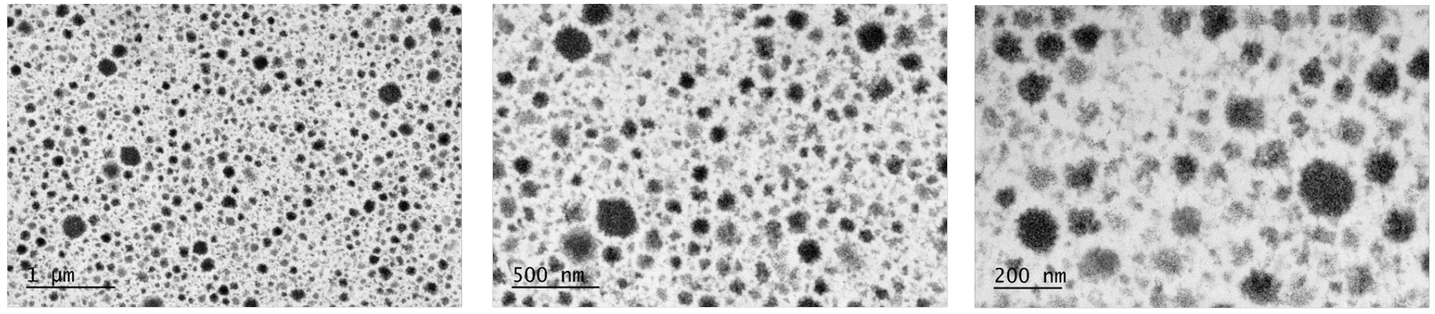



**Figure 5:** TEM imaging of unmodified 18.5% protein HC-MCC at increasing magnification levels from left to right. The micellar structure is easily visible, and variation in micelle size is evident.

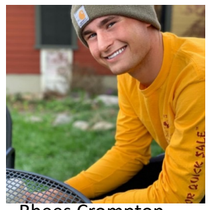
# Outline

- About myself
- NDFS department-Food Science program
- Western Dairy Centre/BUILD Dairy
- Student product development competitions
- Aggie Creamery/Dairy Production lab capabilities
- My research program
- Other research programs

# Other dairy research projects


Taylor Oberg


Brantzen Wood

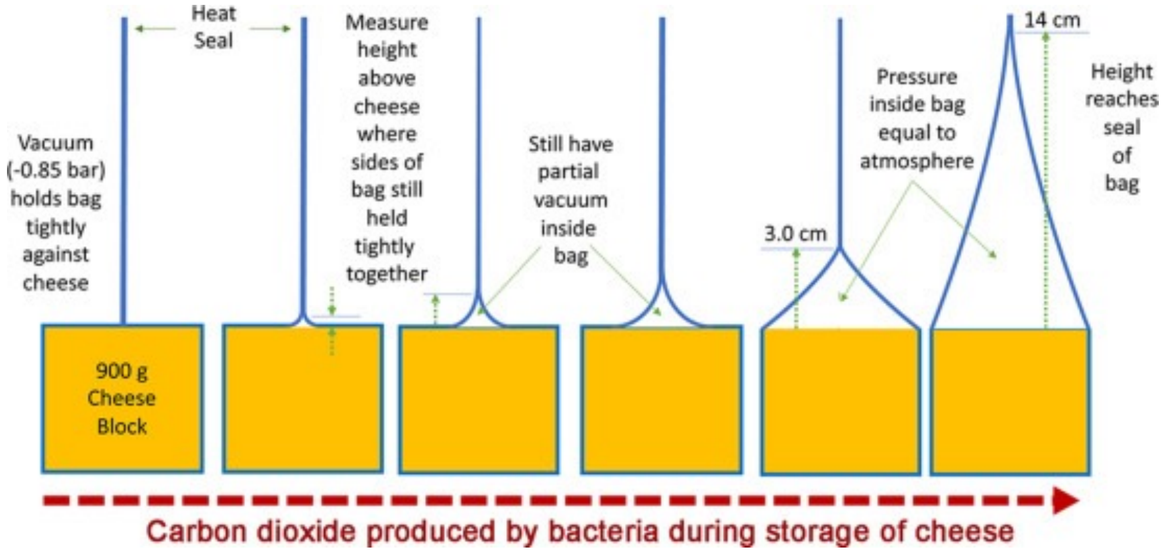

Rhees Crompton

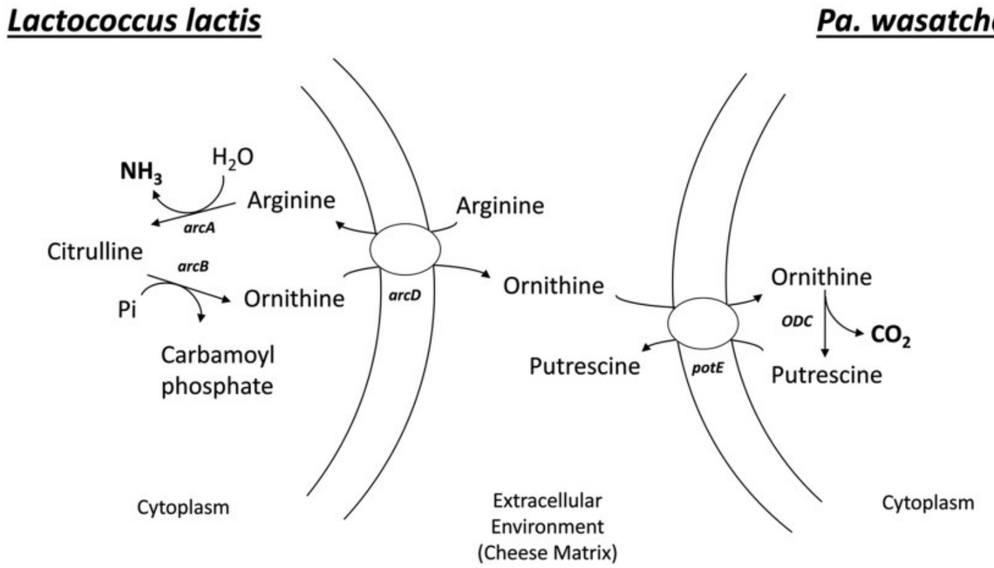

Niharika Mishra


Sam Clarke


Chase Wahlstrom

- Taylor Oberg
  - Genome analysis methods to screen lactococcus starter cultures for bitter-related genes and differentiate using qPCR for *Lactococcus lactis* and *Lactococcus cremoris* species in cheddar cheese. (Brantzen Wood)
  - Use of protective lactic acid bacteria adjunct cultures to decrease the incidence of gas defects in cheddar cheese. (Rhees Crompton)
  - Studying the interaction between a starter culture *Lactococcus lactis* and the non-starter *Paucilactobacillus wasatchensis*, and their contribution to late gas defects in the cheese. (Niharika Mishra)
  - Understanding the effect that cheddar cheese starter cultures have on the pH during the early stages of aging. (Sam Clarke)
  - Using *Lactobacillus curvatus* as a potential preservative adjunct culture in yogurt. (Chase Wahlstrom)



# Other dairy research projects


Silvana Martini


Annalisa Broadhead

- Taylor Oberg
  - Genome analysis methods to screen lactococcus starter cultures for bitter-related genes and differentiate using qPCR for *Lactococcus lactis* and *Lactococcus cremoris* species in cheddar cheese. (Brantzen Wood)
  - Use of protective lactic acid bacteria adjunct cultures to decrease the incidence of gas defects in cheddar cheese. (Rhees Crompton)
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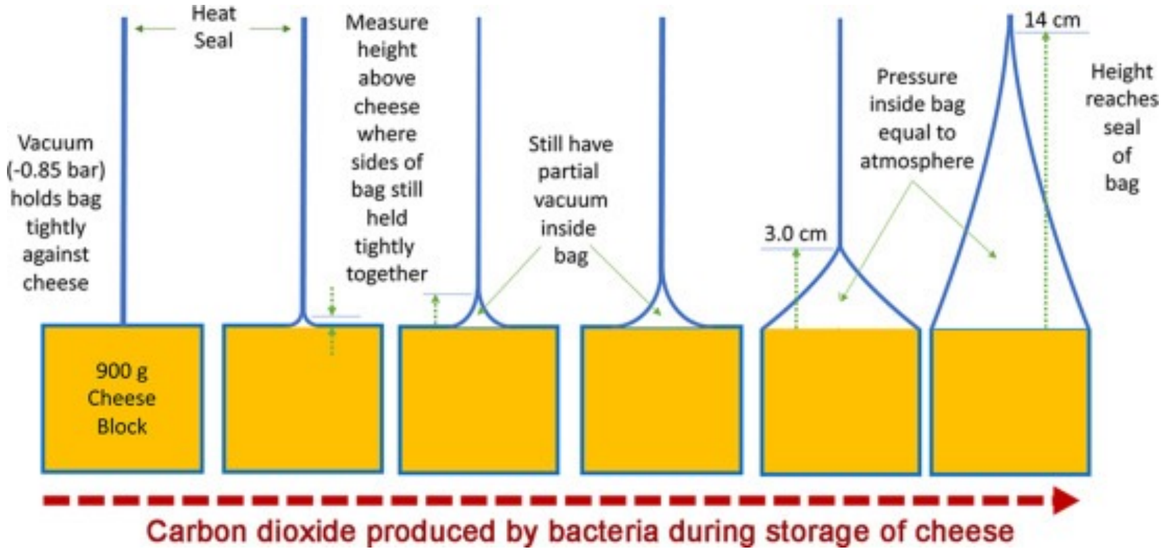
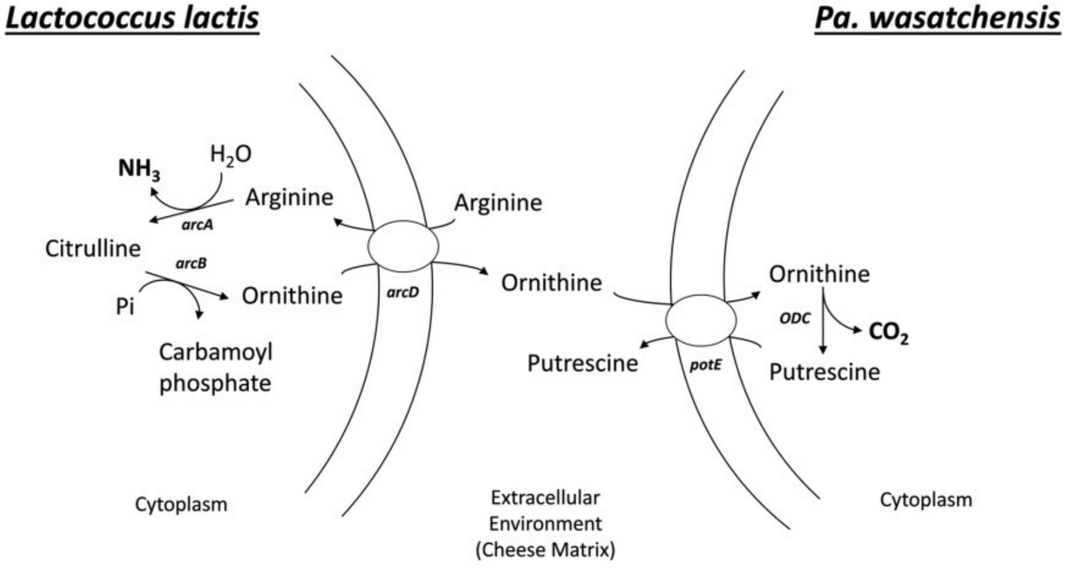
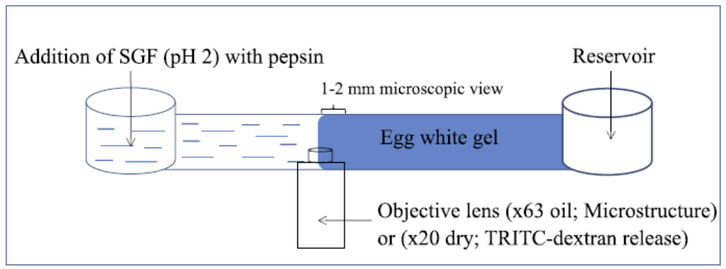
  - Understanding the effect that cheddar cheese starter cultures have on the pH during the early stages of aging. (Sam Clarke)
  - Using *Lactobacillus curvatus* as a potential preservative adjunct culture in yogurt. (Chase Wahlstrom)
- Silvana Martini
  - Physical properties of Butter and water loss. (Annalisa Broadhead)



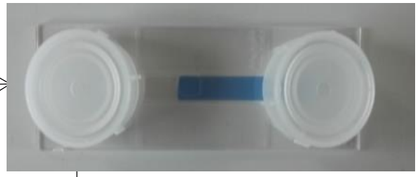



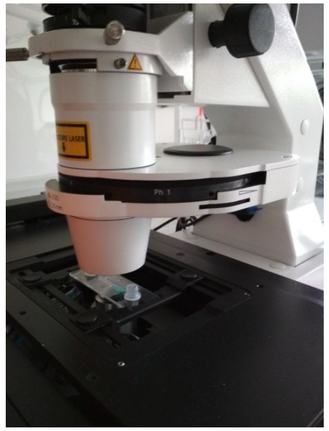
# Salt diffusion in renneted casein gel

- ✓ Microstructure analysis - Fast Green
- ✓ Salt diffusion – Corona Green




| MCC gel (15% Protein)-1 ml | Corona Green 100 µM (wt/v) | Fast Green 1% (wt/v) | MCC solution + GDL - 2% w/v + Rennet |
|---|---|---|---|
| pH 5.4 | 20µl | 10 µl | 1 ml+20 mg+ 10 µl |
| pH 6.8 | 20 µl | 10 µl | 1 ml +0+10 µl |



40 µL of each solution was slowly injected into the chamber of an IBIDI cell, and carefully spread to cover the one third of the channel length

Horizontally incubated at 30 °C for 30 min for coagulation then 2h at 20°C

0.4 mm channel height

Total duration= 40 minutes
Tile scan Configuration: 200 FramesX5 tiles
Size: 1.87 mmX425.10 µm



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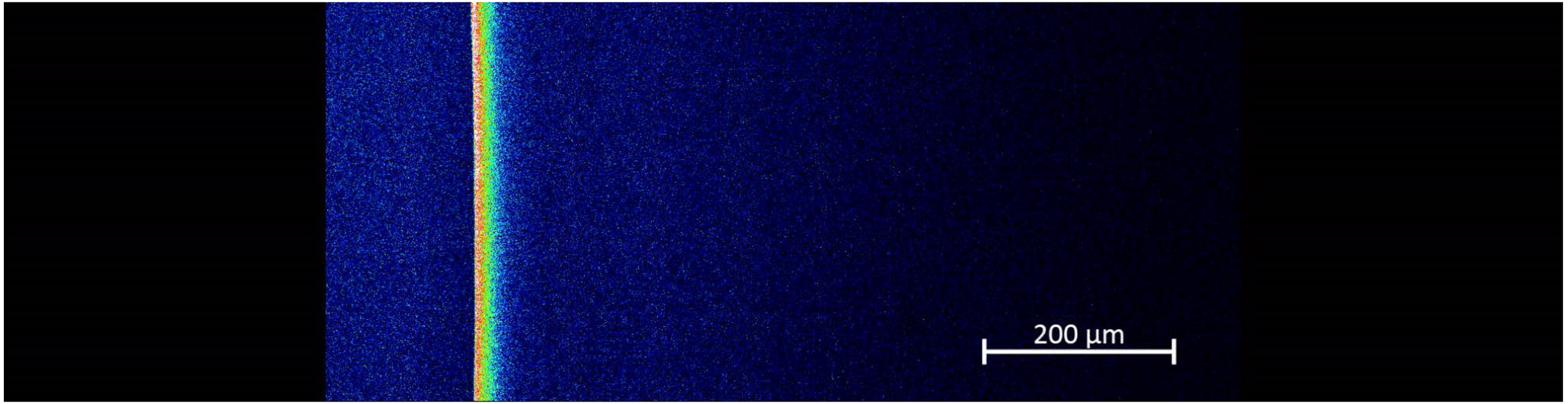
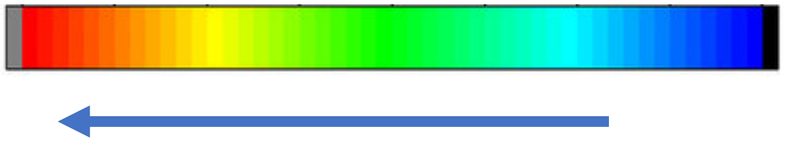
# Salt diffusion in model cheese




Total duration= 40 minutes
Each second corresponds to Approx 1 min
Configuration: 200 FramesX5 tiles
Size: 1.87 mmX425.10 µm



Concentration of $Na^+$ increasing

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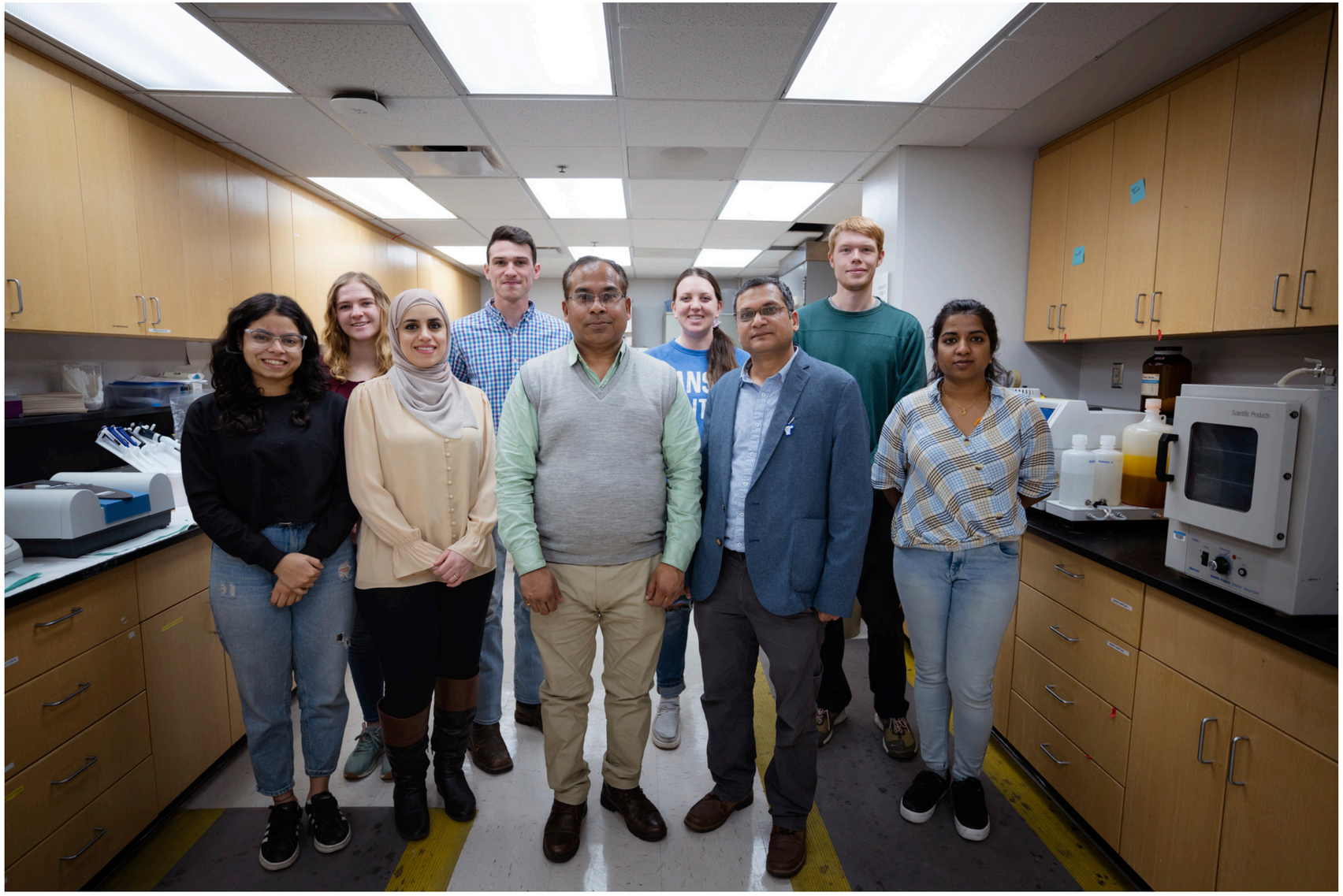
# Future projects- looking for PhD students

- Elucidating mechanism of formation of thermoreversible gels from associative protein-polysaccharide mixtures. (USDA-NIFA 2023-26)
- Understanding impact of concentrated plasmin system due to ultrafiltration and microfiltration process on the quality of Cheddar cheese produced from high protein ingredients. (DMI/NDC 2023-26)
- Grad student search
  - Fall/Spring start, Interested candidate send CV, two references and SOP ASAP to prateek.sharma@usu.edu .

# Thank you
# for your kind attention



## Questions and feedbacks ?????

*prateek.sharma@usu.edu*

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