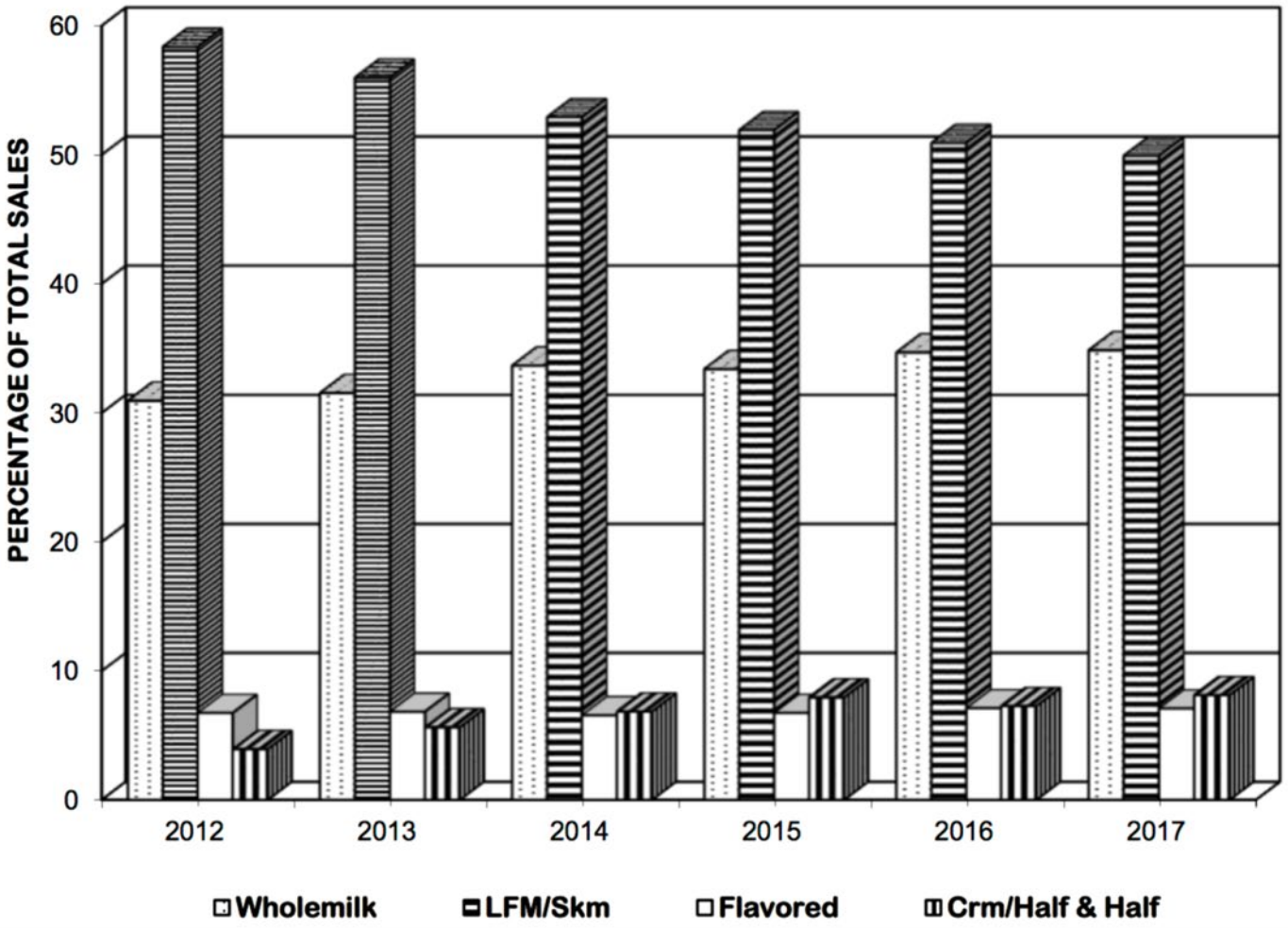
NY Dairy Promotion Board Research Proposals Fall 2020

Fermenting Value for Dairy

Evaluating skim milk as a substrate for the biomanufacturing of value-added ingredients and products – YEAR 2

SDA1-2020Y2

FIGURE 5. SALES OF FLUID MILK PRODUCTS BY NEW YORK MILK PLANTS IN NEW YORK STATE, 2012 - 2017



New York State Dairy Statistics Summary 2017
NY Agriculture & Markets: Division of Milk Control and Dairy Services

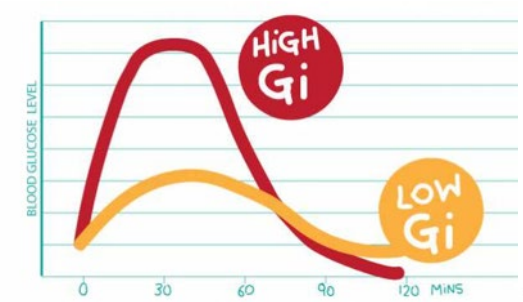
Table 31. MILK AND MILK PRODUCTS USED IN DAIRY PRODUCTS MANUFACTURED IN NEW YORK STATE, BY PRODUCT, 2017

Product	Milk Used		Cream Used		Skim Used		Total Milk, Cream, Skim		Other Dairy Ingred. (1)	
	Lbs. of Milk	Lbs. of Butterfat	Lbs. of Cream	Lbs. of Butterfat	Lbs. of Skim	Lbs. of Butterfat	Lbs. of Product	Lbs. of Butterfat	Lbs. of Product	Lbs. of Butterfat
	(Thousand Pounds)									
Butter	21	1	54,690	22,300	0	0	54,711	22,301	1	
Cheese										
American										
Cheddar	1,236,203	48,123	0	0	0	0	1,236,203	48,123	0	0
Washed Curd & Colby	16,775	626	5	2	0	0	16,780	628	0	0
Italian										
Mozzarella (2)	1,202,582	44,049	7,464	3,187	219,337	77	1,429,383	47,313	199,454	2,692
Ricotta & Ricotone	105,901	4,145	14,827	6,270	5,214	24	125,941	10,439	262,043	2,129
Other Italian (3)	435,935	16,352	1,812	777	61,773	17	499,520	17,146	84,776	85
Cream Cheese	428,017	16,640	111,574	47,133			539,592	63,773	172,858	8,545
Other Cheese (4)	203,013	7,545	985	413	23,550	24	227,548	7,981	44,468	2
Cottage Cheese										
Curd (5)	90	3	0	0	636,142	602	636,232	605	6,867	5
Creamed	4,369	164	9,255	3,807	3,338	2	16,962	3,973	13,196	7
Lowfat	1,855	69	2,783	1,147	7,165	4	11,803	1,221	10,284	6
Total Cheese	3,634,739	137,716	148,706	62,734	956,518	750	4,739,963	201,201	793,946	13,471
Dry Products										
Nonfat Dry Milk	0	0	0	0	656,920	384	656,920	384	0	0
Other Dry Products (6)	0	0	0	0	4,783	3	4,783	3	1,874,091	492
Condensed & Evaporated										
Plain Cond Whl Milk	0	0	0	0	99,142	2,314	99	2	0	0
Plain Cond Skm Milk	0	0	0	0	284,470	186	284,470	186	0	0
Other Cond Prods (7)	113,587	4,365	69	28	12,791	7	126,447	4,400	24,878	171
Sour Cream	83,981	3,214	104,911	43,119	74,686	76	263,577	46,410	34,102	18
Yogurt (2)	77,274	3,014	4,965	2,083	1,644,302	4,344	1,726,541	9,441	44,722	30
Egg Nog	2,159	123	356	137	419	(~)	2,934	261	814	1
Frozen Desserts	36,986	1,424	48,094	19,865	1,960	1	87,039	21,291	220,240	314
Miscellaneous Products (8)	40,552	1,073	21,949	9,320	346,419	214	408,920	10,606	47,471	211
TOTAL (9)	3,989,299	150,931	383,739	159,586	3,983,366	5,968	8,356,405	316,485	3,040,265	14,708

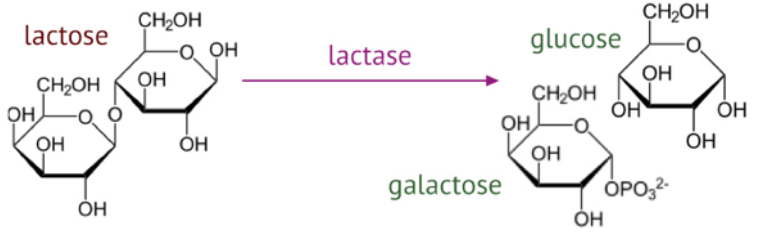
(1) Includes condensed and powdered skim, buttermilk, whey, whey cream, Dried and condensed products are reported on a fluid equivalent basis.
(2) The milk used includes lowfat milk used to manufacture a lowfat product in this catagory. (3) Includes Provolone, Romano and other Italian varieties.
(4) Includes Swiss, Farmers, Brick, Spanish cheese, Feta, Muenster, Neufchatel, Mexican and other miscellaneous varieties. (5) Includes Cottage cheese curd and Bakers cheese.
(6) Includes NFDM for animal consumption, whole milk powder, buttermilk powder, whey powder and dry products blend. (7) Includes condensed buttermilk, condensed whey, sweetened condensed milk and evaporated milk. (8) Includes whipped topping, Whey Protein and Milk Protein Concentrate, Enery Drinks, Baking Products and other miscellaneous dairy products.
(9) Totals may not add due to rounding. (~) Less than 500 lbs.


ARC
30-50 Million
Americans are Lactose Intolerant with rates >70% among minorities
70%
Of the World Population is lactose intolerance

Value-added Product from Skim Milk



Skim Milk
+
Lactase



Concentration
1-3X

Extrusion

Fermentation
To Galactose

GOS
Production

Novel Functional Ingredients

Food Product

Snacks

High Value Ingredients

Beverages

Ethanol

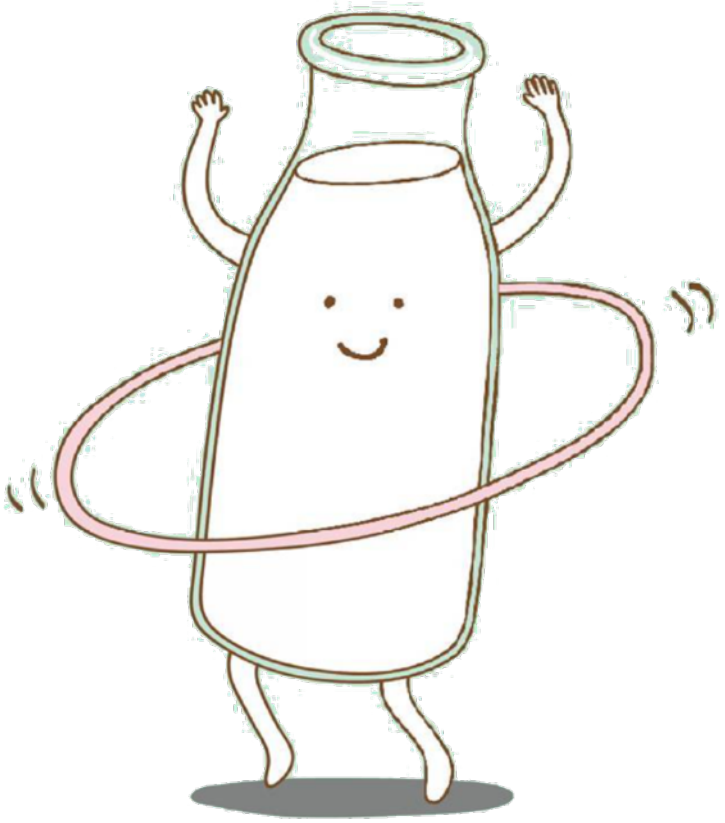
Novel “yogurt”

Rizvi

Alcaine

Project Goals

- Evaluate the fermentation of skim milk and milk concentrates by *Brettanomyces* and related yeast species to produce a galactose-rich fermented milk.
- Optimize fermentation parameters for galactose production from skim milk and milk concentrates by *Brettanomyces*.



Building on Previous Dairy Promotion Board Funded Knowledge

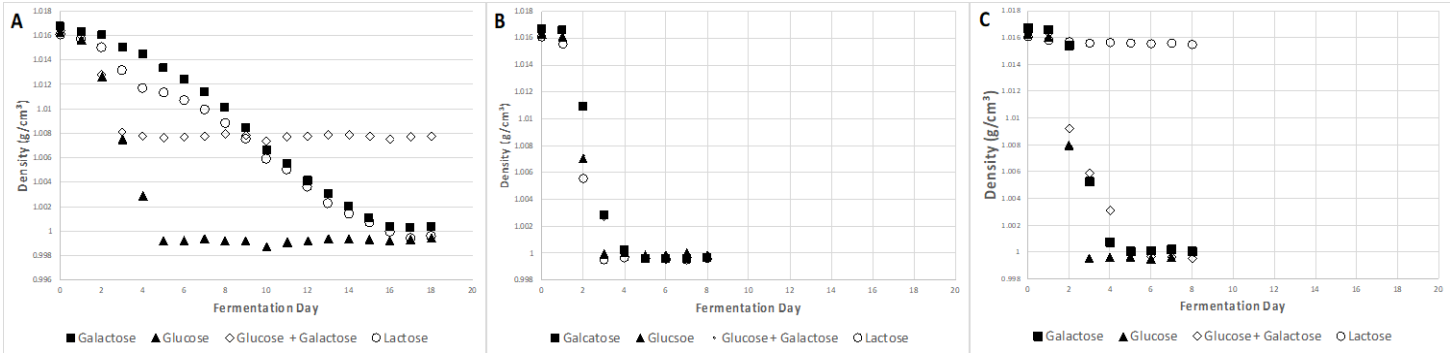
Acetic Acid Production

Table 2. Aerobic acetic acid production (g/L) from whey permeate by various yeast species

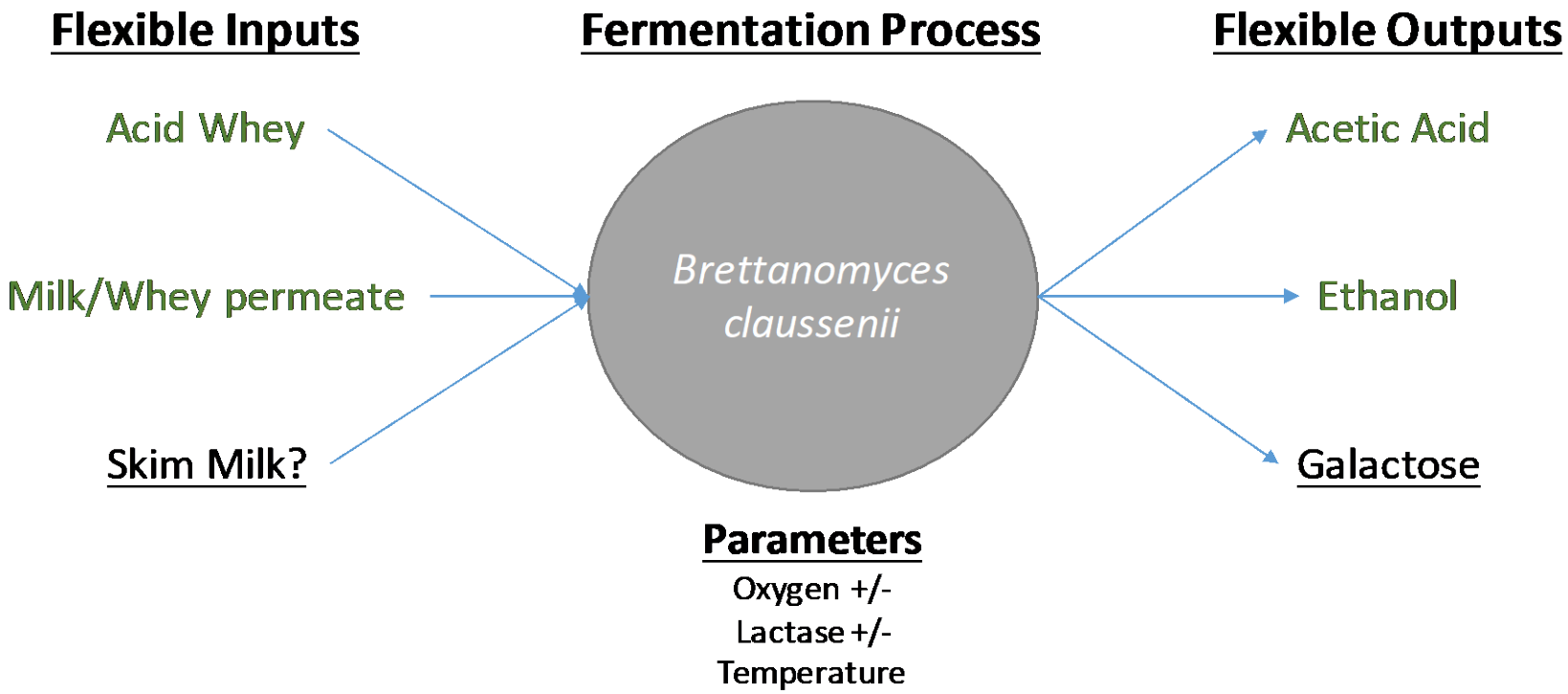
Day	*B. bruxellensis*	*B. claussenii*	*D. anomala*	*K. lactis*	*K. marxianus*
0	0.40 ± 0.08	0.69 ± 0.51	0.86 ± 0.34	0.76 ± 0.24	0.52 ± 0.26
20	N.D.	5.88 ± 3.24	8.49 ± 3.03	0.75 ± 0.34	0.48 ± 0.28
34	0.03 ± 0.05	7.75 ± 4.37	9.18 ± 3.38	2.68 ± 1.81	0.34 ± 0.17

N.D. Not Detected

Potential Galactose Production



Amplifying Dairy Support



NYS P2I | New York State Pollution Prevention Institute

$100,000

USDA

$460,000

Fermenting Value for Dairy

Evaluating skim milk as a substrate for the biomanufacturing of value-added ingredients and products.

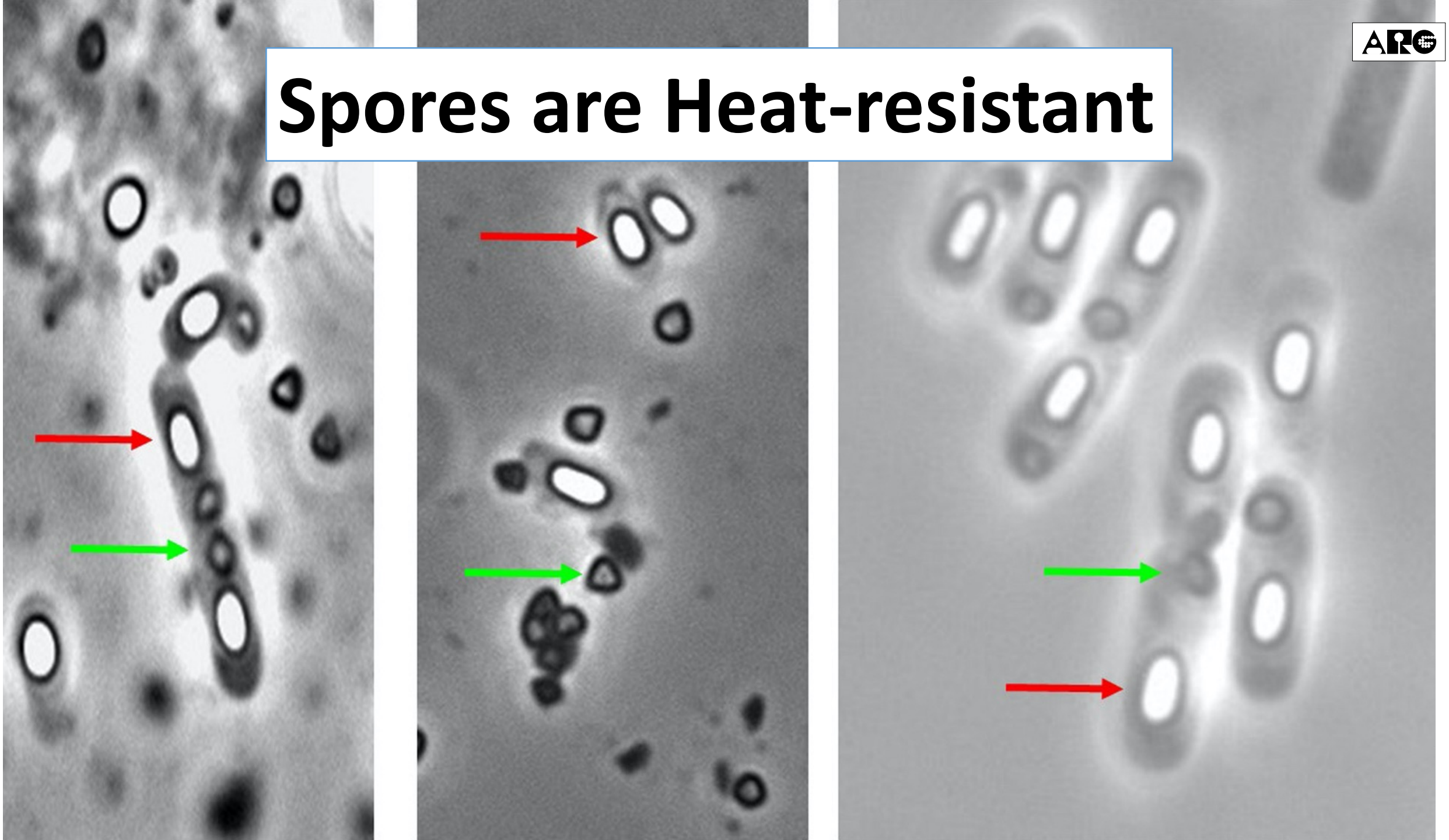
Project SDA1-2020Y2, Year 2: Request from NYS Milk Promotion Board for the period January 1st, 2021 – December 31[25], 2021 - $89,561.

SPORES

The application of lactose oxidase to control sporeformers in dairy products.

SDA2-2020Y1

Spores are Heat-resistant



Spores Cause Many Dairy Product Defects

Lactose oxidase (LO)

Lactose oxidase + Lactose + O_2 ⟶ **H_2O_2** + Lactobionic acid

LO

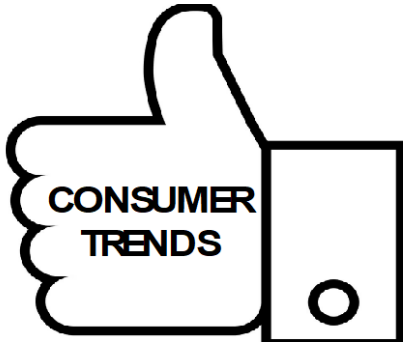
- Preservation of tissues
- Cosmetics
- Protein and fat replacer

Lactoperoxidase + SCN^- + **H_2O_2** ⟶ **ANTIMICROBIAL COMPOUNDS**

LP

Lactose is naturally present in milk

Enzymes are a common ingredient in dairy products



Build on Previous Dairy Success

UHT Shelf life – The application of lactose oxidase to control *Pseudomonas* and improve UHT milk.

Raw Milk **LOX** **Control**

Proteolysis

Plasmin

Bacterial

Project Phases

1. Strain selection	2. Lactose oxidase testing	3. Shelf life testing	4. Sensory evaluation
Screen different *Pseudomonas* spp. strains for heat-stable protease production	Study ability of lactose oxidase to control heat-stable protease producers in sterile and raw milk under refrigeration conditions	Assess shelf-stability, in the form of age gelation, of UHT milk treated with lactose oxidase	Explore sensorial impact on UHT milk made from raw milk treated with lactose oxidase

Outcomes:

Papers: 2 Published, 1 Submitted
Posters: 3 presented (1 finalist in grad student competition)
Presentations: 12 (national and regional)
Interest from industry - feedback raw milk storage has potential need for improvement

Specific Goal of the Project: To evaluate the use of lactose oxidase to control sporeformers in raw milk, and thus improve dairy product quality.

Objectives:

1. Evaluate the impact of lactose oxidase on thermal inactivation of common fluid milk associated sporefomers: *Bacillus weihenstephanensis*, *Bacillus cereus*, *Paenibacillus. odorifer*, *Paenibacillus amylolyticus*, and *Paenibacillus graminis*.
2. Evaluate the impact of lactose oxidase on thermal inactivation of common dairy powder associated sporefomers: *Bacillus licheniformis*.
3. Evaluate the impact of lactose oxidase on thermal inactivation of common cheese associated sporefomers: *Clostridium tyrobutyricum*.
4. Demonstrate the ability lactose oxidase treatment of raw milk to reduce sporeformers in in fluid milk under typical storage conditions.
5. Demonstrate the ability lactose oxidase treatment of raw milk to reduce sporeformers in in skim milk powder under typical storage conditions.
6. Demonstrate the ability lactose oxidase treatment of raw milk to reduce sporeformers in in cheese under typical storage conditions.
7. Demonstrate that there is minimal detrimentally sensorial impact on fluid milk and skim milk powder made from lactose oxidase-treated raw milk.

How will this project benefit NYS Dairy Producers or the NYS Dairy Industry?

This project will benefit NYS Dairy producers by validating a novel, easy-to-implement method that could then used to improve NY raw milk quality and improve the fluid milk shelf-life, reduce cheese, and increase the competitiveness of NY dairy powders.

Early Signs of Promise

The application of lactose oxidase to control sporeformers in dairy products.

Project SDA2-2020Y1, Year 1: Request from NYS Milk Promotion Board for the period January 1st, 2021 - December 31st, 2021 - $90,033.

SLITS

Control of heterofermentative bacteria isolated from NY Cheddar and Gouda Cheese to prevent slit and discoloration defects

SDA3-2020Y1

Cheese 1

Lactobacillus wasatchensis

Lactobacillus coryniformis

Lactobacillus versmoldensis

Cheese 2

Lactobacillus parabuchneri

Lactobacillus paracasei

Cheese 3

Lactobacillus paracasei

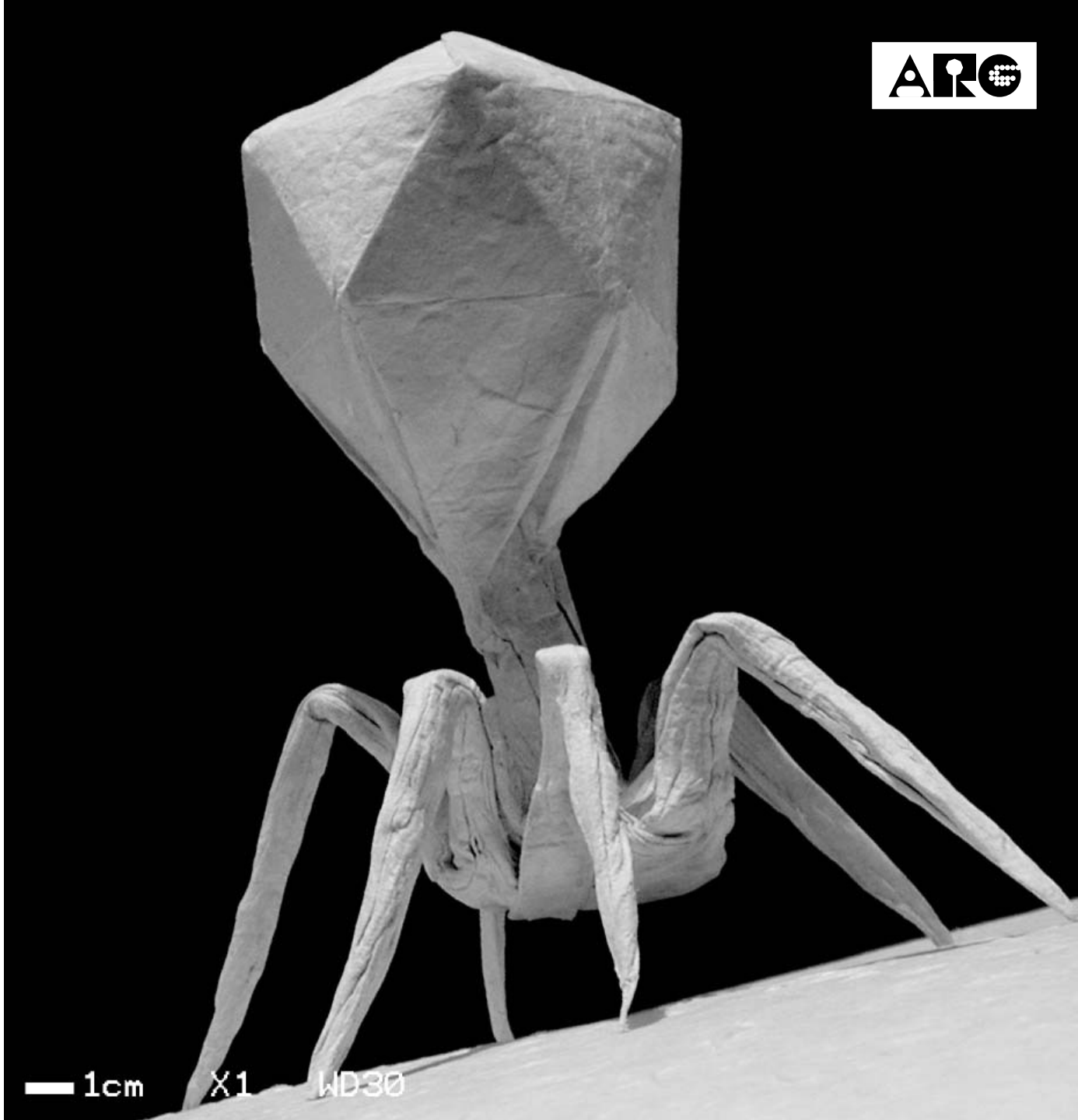
Cheese 4

Lactobacillus paracasei

NY Cheese Survey

Bacteriophage Hunt

- Viruses than attack only bacteria
- Very Specific
- Must numerous organism on the plant
- Typical Found in the Environment of their Host
- Natural Control Mechanism



Goal of the Project: To confirm the role of heterofermentative, lactic acid bacteria as the cause of defects in NY State cheese and identify potential control mechanisms.

Objectives:

1. Demonstrate that both *Lactobacillus wasatchensis* and *Lactobacillus parabuchneri* results in slit/gas defects in cheddar and gouda cheese.
2. Isolate phage that target *Lactobacillus wasatchensis* and *Lactobacillus parabuchneri*.
3. Demonstrate that the phage can be used to control *Lactobacillus wasatchensis* and *Lactobacillus parabuchneri* and prevent defects in cheddar and gouda cheese

How will this project benefit NYS Dairy Producers or the NYS Dairy Industry?

This project will benefit NYS Dairy producers by addressing an industry wide defect, and thus improving quality, sustainability, and sales of key NYS dairy products.

SLITS

Control of heterofermentative bacteria isolated from NY Cheddar and Gouda Cheese to prevent slit and discoloration defects

Project SDA3-2020Y1, Year 1: Request from NYS Milk Promotion Board for the period January 1st, 2021 - December 31st, 2021 - $65,961.

Samuel D. Alcaine, Ph.D.
Assistant Professor - Dairy Fermentations
Department of Food Science
Cornell University

362 Stocking Hall
Ithaca, NY 14853
607-255-9183
alcaine@cornell.edu