Milk Quality Improvement
Program Update and Report for 2017-18

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June 15, 2018
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MQIP Objectives and Approach

**Vision:** Improve New York state dairy product quality and safety from farm-to-table to position NY as the #1 producer of high quality dairy products and to assure sufficient processing capacity for raw milk produced in New York

**Approach:**
- Monitor and improve NYS raw milk quality
- Improve quality and shelf life characteristics of commercially processed and packaged NYS milk and dairy products
- Assist NYS dairy plants in identifying and correcting handling and processing problems affecting dairy product quality
- Provide support for dairy economic development in New York State
- Assure dairy food safety in New York (collaborative with NYS AGM)
- Train professionals for the New York dairy industry (e.g., dairy certificate program)
2017-18 Project Reports

- **Core Voluntary Shelf-Life program and dairy industry outreach**
- **Supp. Project 1:** Development of a predictive tool to aid in production of extended shelf life fluid milk products with procedures that control outgrowth of psychrotolerant aerobic spore-forming bacteria (Year 2)
- **Supp. Project 2:** Development and assessment of new tools for raw milk and finished product testing: preparing NY dairy industry for the future (Year 2)
- **Supp. Project 3:** Development of molecular and phenotypic tools to control fungal contamination of dairy products (Year 2)
- **Supp. Project 4:** Control of *Clostridium tyrobutyricum* a remerging concern in hard cheese production (New)
- **Supp. Project 5:** Development and deployment of a rapid response team that responds to on-farm milk quality issues that affect processing or finished product quality (New)
- **Special Supplement:** Building research capacity in dairy foods processing: dairy fermentations
Shelf-Life of Fluid Milk Products

• Short shelf-life and inconsistent quality affect ability of fluid milk to compete with other beverages

• Products with shorter shelf life may also be more likely to experience quality issue earlier in shelf life if exposed to temperature abuse

• Problems with shelf life can occur through (i) post-processing contamination (PPC) (Gram-negative bacteria) and (ii) bacteria that survive pasteurization (Gram-positive bacteria that form “spores”)
  – Root causes for PPC are also possible causes for food safety issues
NYS Milk Quality Improvement Program
Voluntary Shelf Life (VSL) Program

• Collect raw milk and processed fluid milk products from virtually all NYS processors

• Hold milk at 43° F and test at initial day, day 7, day 10 and day 14 (day 17 and day 21 for selected plants) for:
  – Microbiological quality
  – Chemical quality (Freezing point, butter fat - initial day only)
  – Flavor analysis/Milk defect judging

• Provide feedback and support to address root causes for shelf life and quality issues
  – Plants are classified into Tier I (highest quality) to Tier III (quality challenges)
# VSL Program Plant Status and Update

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong># of Plants</strong></td>
<td>96</td>
<td>49</td>
<td>27</td>
<td>31</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(24 NY, 2 NJ, 1 PA)</td>
<td>(24 NY, 1 each in MA, ME, NH, PA, &amp; VT, 2 in NJ)</td>
<td>(23 NY, 1 each in MA, ME, NH, &amp; VT)</td>
<td>(21 NY, 1 each in MA, ME, NH, &amp; VT)</td>
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<tr>
<td><strong>Sell-By</strong></td>
<td>&lt; 12.0 d</td>
<td>12.5 d</td>
<td>13.9 d</td>
<td>17.0 d</td>
<td>17.0 d</td>
<td>18.0 d</td>
</tr>
<tr>
<td>≤ 20,000 Day 10</td>
<td>15% (day 12)</td>
<td>25%</td>
<td>50%</td>
<td>63%</td>
<td>62%</td>
<td>68%</td>
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<tr>
<td>≤ 20,000 Day 14</td>
<td>--</td>
<td>17%</td>
<td>32%</td>
<td>43%</td>
<td>48%</td>
<td>58%</td>
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<tr>
<td>≤ 20,000 Day 17*</td>
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<td>--</td>
<td>--</td>
<td>14%</td>
<td>42%</td>
<td>53%</td>
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<tr>
<td>≤ 20,000 Day 21*</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>23%</td>
<td>23%</td>
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</table>

* Day 17 results apply to 15 plants in 2010, Days 17 & 21 apply to 20 plants in 2015 and to 19 plants in 2016.
Percentage of Processed Milk Samples with SPC ≤20,000 cfu/ml by Test Day (2008-2017)
Avg. % Samples with SPC ≤20,000 by Test Day (1991-2017 Trends in 5-Year Increments)
Initial Day % Coliform and % Gram (-) Positive and % Gram (-) Positive for Days 7-21 (2017)
Samples % Positive vs. % Negative for Total Gram (-) Bacteria Over Shelf Life (2017)

<table>
<thead>
<tr>
<th>Test Day</th>
<th>% Positive</th>
<th>% Negative</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>93</td>
</tr>
<tr>
<td>7</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>10</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>14</td>
<td>49</td>
<td>51</td>
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<td>17</td>
<td>45</td>
<td>55</td>
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<tr>
<td>21</td>
<td>43</td>
<td>57</td>
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</table>
Average Flavor Score by Test Day

*Day 7 testing stopped at end of 2010 to allow enough sample for Day 21 testing.
2017 Fluid Milk State Fair Award Winners

- 1st - Stewarts Processing
- 2nd - Battenkill Valley Creamery
- 3rd - Upstate Rochester
- 4th - Hillcrest Dairy
School milk quality (2013-17)

Day 14 Total Bacteria Count (log CFU/mL)

Day 14 Sensory Score

*Indicates significant difference p<0.05
Data weighted by volume

2017 Unweighted vs. Weighted SPC

2017 Unweighted vs. Weighted Flavor Scores
VSL Field Team

- All VSL plants were visited by a VSL field team member at least once; the majority of Tier 2 and Tier 3 plants were visited twice
- The milk quality testing report and report guide were updated to improve clarity
- A needs assessment was administered to all participating plants to determine areas of opportunity for the program
Small Processors in the VSL program

- 10 of the 25 participating VSL plants qualify as small processors (processing less than 10 million lbs. of milk per year)
- A fluid milk award was created specifically for small processors to be awarded at the NYS fair in 2018
- Small processors report VSL field team member visits are useful
  - 90% of small processors report on-site visits are and/or would be useful
  - “On-site visits are about the only way to [get] ideas for what to improve...when you’re looking at something every single day, you’re seeing the same thing so you need someone else who knows what’s going on but looking at it from a different perspective and maybe looking at something that we’re overlooking” – Owner of Hoover’s Dairy (small processor)
- Small processors appreciate assistance with implementing long-term changes to improve milk quality
  - 100% of small processors report assistance with implementing quality programs would be useful
  - “You have helped us create a more efficient and effective cleaning system that has helped tremendously with our milk quality...[and have] also helped us set up a taste test chart that has also helped tremendously in keeping track of milk flavor changes and quality” – Lead Operator at Cowbella (small processor)
## New Start-Up Plants Need Guidance

### April 2017

**Sample Information**

- **CL**: ½ Gal Plastic
- Processed: 4/12/17
- Code: 5/3/17
- Days In Code: 21 Days

**Rapid PPC Stress Test (DI):** Positive

**Coliform Count (DI):** < 1 E, Butterfat (%): 4.50

<table>
<thead>
<tr>
<th>Test Date</th>
<th>Day</th>
<th>Standard Plate Count/ml</th>
<th>Total Gram Negative Count/ml</th>
<th>Flavor Score</th>
<th>Flavor Criticisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/13/17</td>
<td>D1</td>
<td>82 E</td>
<td>&lt; 20 E</td>
<td>8.3</td>
<td>NCD</td>
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<tr>
<td>4/19/17</td>
<td>D7</td>
<td>&gt; 400,000 E</td>
<td>&gt; 400,000 E</td>
<td>6.0</td>
<td>RA, LF</td>
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<tr>
<td>4/21/17</td>
<td>D9</td>
<td>9,500,000 E</td>
<td>140,000,000</td>
<td>5.9</td>
<td>RA, LF</td>
</tr>
<tr>
<td>4/26/17</td>
<td>D14</td>
<td>220,000,000 E</td>
<td>510,000,000</td>
<td>0.0</td>
<td>NT-US</td>
</tr>
<tr>
<td>4/28/17</td>
<td>D16</td>
<td>96,000,000 E</td>
<td>180,000,000</td>
<td>0.0</td>
<td>NT-US</td>
</tr>
<tr>
<td>5/3/17</td>
<td>D21</td>
<td>670,000,000 E</td>
<td>860,000,000</td>
<td>0.0</td>
<td>NT-US</td>
</tr>
</tbody>
</table>

**Flavor Attribute Key:** LF=Lacks Freshness, NCD=Not clearly defined, NT-US=Not tasted due to previous unacceptable score, RA=Rancid

### Sept 2017

**Sample Information**

- **CL**: ½ Gal Plastic
- Processed: 9/26/17
- Code: 10/17/17
- Days In Code: 21 Days

**Rapid PPC Stress Test (DI):** Negative

**Coliform Count (DI):** < 1 E, Butterfat (%): 4.33

<table>
<thead>
<tr>
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<th>Total Gram Negative Count/ml</th>
<th>Flavor Score</th>
<th>Flavor Criticisms</th>
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<tbody>
<tr>
<td>9/28/17</td>
<td>D1</td>
<td>&lt; 10 E</td>
<td>&lt; 20 E</td>
<td>9.0</td>
<td>CK</td>
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<td>10/3/17</td>
<td>D7</td>
<td>20 E</td>
<td>&lt; 20 E</td>
<td>9.3</td>
<td>NC</td>
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<tr>
<td>10/6/17</td>
<td>D10</td>
<td>50 E</td>
<td>&lt; 20 E</td>
<td>8.6</td>
<td>CK</td>
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<tr>
<td>10/10/17</td>
<td>D14</td>
<td>2,500 E</td>
<td>660</td>
<td>8.8</td>
<td>NC</td>
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<td>10/13/17</td>
<td>D17</td>
<td>3,000 E</td>
<td>3,200</td>
<td>8.6</td>
<td>NC</td>
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<td>10/17/17</td>
<td>D21</td>
<td>18,000 E</td>
<td>15,000</td>
<td>8.6</td>
<td>NC</td>
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</tbody>
</table>

**Flavor Attribute Key:** CK=Cooked, NC=No Criticism

### April 2018

**Sample Information**

- **CL**: ½ Gal Plastic
- Processed: 4/6/18
- Code: 4/27/18
- Days In Code: 21 Days

**Rapid PPC Stress Test (DI):** Negative

**Coliform Count (DI):** < 1 E, Butterfat (%): 5.23

<table>
<thead>
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<th>Test Date</th>
<th>Day</th>
<th>Standard Plate Count/ml</th>
<th>Total Gram Negative Count/ml</th>
<th>Flavor Score</th>
<th>Flavor Criticisms</th>
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<tr>
<td>4/13/18</td>
<td>D1</td>
<td>10 E</td>
<td>&lt; 20 E</td>
<td>7.6</td>
<td>CK</td>
</tr>
<tr>
<td>4/13/18</td>
<td>D7</td>
<td>&lt; 10 E</td>
<td>20 E</td>
<td>8.9</td>
<td>CK</td>
</tr>
<tr>
<td>4/16/18</td>
<td>D10</td>
<td>&lt; 10 E</td>
<td>20 E</td>
<td>7.8</td>
<td>LPO</td>
</tr>
<tr>
<td>4/20/18</td>
<td>D14</td>
<td>&lt; 10 E</td>
<td>20 E</td>
<td>4.9</td>
<td>LPO</td>
</tr>
<tr>
<td>4/23/18</td>
<td>D17</td>
<td>&lt; 10 E</td>
<td>20 E</td>
<td>0.0</td>
<td>NT-US</td>
</tr>
<tr>
<td>4/27/18</td>
<td>D21</td>
<td>&lt; 10 E</td>
<td>20 E</td>
<td>0.0</td>
<td>NT-US</td>
</tr>
</tbody>
</table>

**Flavor Attribute Key:** CK=Cooked, LPO=Lipid Oxidized, NT-US=Not tasted due to previous unacceptable score

### April 2018

**Sample Information**

- **CL**: ½ Gal Plastic
- Processed: 4/11/18
- Code: 5/2/18
- Days In Code: 21 Days

**Rapid PPC Stress Test (DI):** Positive

**Coliform Count (DI):** < 1 E, Butterfat (%): 4.61

<table>
<thead>
<tr>
<th>Test Date</th>
<th>Day</th>
<th>Standard Plate Count/ml</th>
<th>Total Gram Negative Count/ml</th>
<th>Flavor Score</th>
<th>Flavor Criticisms</th>
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<tbody>
<tr>
<td>4/13/18</td>
<td>D1</td>
<td>10 E</td>
<td>&lt; 20 E</td>
<td>5.7</td>
<td>LPO</td>
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<tr>
<td>4/18/18</td>
<td>D7</td>
<td>51 E</td>
<td>&lt; 20 E</td>
<td>6.4</td>
<td>LPO</td>
</tr>
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<td>4/20/18</td>
<td>D9</td>
<td>10 E</td>
<td>&lt; 20 E</td>
<td>6.9</td>
<td>NCD</td>
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<td>4/25/18</td>
<td>D14</td>
<td>400 E</td>
<td>41 E</td>
<td>6.8</td>
<td>LPO</td>
</tr>
<tr>
<td>4/27/18</td>
<td>D16</td>
<td>270 E</td>
<td>160 E</td>
<td>7.0</td>
<td>NCD</td>
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<td>5/2/18</td>
<td>D21</td>
<td>17,000 E</td>
<td>10,000</td>
<td>7.0</td>
<td>NCD</td>
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</table>

**Flavor Attribute Key:** LPO=Lipid Oxidized, NCD=Not clearly defined
Conclusions and Outlook

• Some NYS Fluid Milk Plants show long term improvements with regard to control of post-pasteurization contamination
  – Next leap in shelf life requires control of organisms that survive pasteurization and subsequently grow in refrigerated milk (“sporeformers”).
  – Sporadic post-pasteurization contamination still an issue
• While major improvements in reducing coliform contamination have been made, a number of Fluid Milk Plants still show considerable frequency of post-pasteurization contamination (typically with non-coliform Gram-negative bacteria)
  – Program will continue to focus on reducing these problems
• School milk may warrant further work
Long term impacts of the VSL program

• Only long-term benchmarking program for HTST fluid milk in the US
  • Provides NY fluid milk manufacturers with data and motivation to constantly improve fluid milk quality
• Allows for early discovery of new challenges and opportunities in fluid milk industry
  • Discovery of the role in sporeformers in fluid milk spoilage
• Strong partnership with New York State Ag & Mkts to assure dairy food safety
  • Provide safe harbor where processors can get confidential help with food safety issues
  • Food safety record is essential to assure consumer confidence and maintain and grow export markets
Additional Programming

- Support development of new and expansion of existing dairy processing capabilities
- Workforce development: Training programs for the NYS dairy industry, including dairy industry workshops and certificate program
  - Certificate program focus areas in (i) fluid milk; (ii) cheese; (iii) other fermented dairy products, (iv) membrane, evaporation & drying technology
  - Goal is a well recognized certificate program (like Wisconsin Master Cheesemakers), but across product categories
- Provide food safety expertise and training to reduce risk to overall industry
  - Particularly important to protect export markets in dairy
Dairy Extension Metrics

• 2017 - 18,550 total contact hours/62 workshops
• 2016 - 23,778 total contact hours/38 workshops
• 2015 - 16,236 total contact hours/34 workshops
• 2014 - 14,706 total contact hours/28 workshops
• 2013 - 11,094 contact hours
• Certificates presented in 2017:
  – Fluid Milk Processing for Quality and Safety (2)
  – Cheese Making (Basic Level) (3)
  – Yogurt & Fermented Dairy Products (Basic Level) (2)
  – Membrane Filtration (3)
2017 Workshops - examples

- HTST Workshops (Apr 11-13, Jul 25-27, Oct 10-12)
- Dairy Science & Sanitation Workshops* (Feb 7-8, Mar 7-8, May 10-11, Aug 8-9)
- Dairy HACCP (Apr 13, May 9)
- Science of Cheese*/Vat Pasteurizer Workshop (Oct 24-25)
- Artisan Dairy Food Safety Plan* (Oct 4-5)
- FSMA Preventive Controls Qualified Individual Training (Feb 14-16, May 23-25, Dec 5-7)
- Milk Defect Judging (Mar 1)
- Vat Pasteurization (Jan 10)
- Science of Yogurt & Fermented Dairy Products – Basic* (May 31-Jun 1, Jun 6-7), Advanced (Jun 13-15)
- Regional Dairy Processing Plant Superintendent Workshops w/Ag & Markets – 7 (Mar 28-31, Apr 4-7)
- Regional Laboratory Workshops with Ag & Markets - 5 (Mar 26 – Apr 11)
- CMI School (July 18-20)

*Five workshops are available in multi-modal form, a self-paced online lecture section followed by a hands-on on-campus portion.
Other Dairy Foods Training and Workforce Development Related Activities

• Support for 2- Year A.A.S Degree in Food Processing at GCC
  – Started Fall 2014
• 10 Month Certificate Program in Food Processing at ECC
  – Implemented Fall 2014
• Support 4- Year Western NY Tech Academy (High School Level)
  – Students can choose a track in Food Processing and attend GCC program for free upon graduation
• Annual Courses with NYS Ag & Markets and FDA
• Support for Annual Dairy-Related Conferences
• Specialized Training
  – e.g., for Milk Market Administrator Auditors
• Yearly course catalog
• Bi-monthly e-mail newsletter to better widely communicate project findings and Cornell capabilities
Development, Retention, and Expansion of Dairy Processing Capacity in New York State

- Supported various new dairy processors and existing dairy processors that seek to expand capacities
  - Serve a resource for business planning and product development
- Continued efforts to further develop (artisan) cheese industry in New York state (focus on food safety and quality)
  - Considerable efforts to help small processors develop FSMA-mandated food safety plans
- Provide assistance with troubleshooting and root cause analysis to address product quality and food safety issues
- Workforce development activities
  - work with BOCES, 2-year colleges
  - On-site trainings
- Work with Economic Development Agencies to recruit dairy processors into NY and coordinate funding for necessary workforce training
SQF Gap audits & Food Safety Consulting – 2017 examples

Chobani, New Berlin
Upstate Farms
Grober Industries
Danascara Farms
Anita’s Yogurt
Old Chatham Cheese
Ample Hills Ice Cream
Lively Got Run
Trinity Valley
HP Hood
Byrne Dairy
Summary

• Core VSL program not only provides support for fluid milk quality improvement, but has broad impact on dairy processors in NY
• Capstone program that provides contact with processors

A 100-Year Review: Microbiology and safety of milk handling

Kathryn J. Boor, Martin Wiedmann, Sarah Murphy, and Sam Alcaine
Department of Food Science, Cornell University, Ithaca, NY 14853

Symposium review: Effect of post-pasteurization contamination on fluid milk quality

Nicole H. Martin, Kathryn J. Boor, and Martin Wiedmann
Milk Quality Improvement Program, Department of Food Science, Cornell University, Ithaca, NY 14853
2017-18 Project Reports

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- **Special Supplement:** Building research capacity in dairy foods processing: dairy fermentations
Sporeformer Background

- Ubiquitous in natural environments
  - Soil
  - Water
- Can survive environmental stresses in spore from:
  - Heat
  - Freezing and Drying
  - Pressure
  - Chemical sanitizers
- Metabolically dormant structure
Psychrotolerant Sporeformers in Fluid Milk

• Main hurdle to improve shelf life of fluid milk
• Understanding and modeling their growth behavior can allow us to evaluate strategies to reduce their presence in fluid milk

![Graph showing aerobic plate count for Pseudomonas and Gram-positive spore formers over time after pasteurization.](image-url)
Suppl. Project #1: Development of a predictive tool to aid in production of extended shelf life fluid milk products with procedures that control outgrowth of psychrotolerant aerobic spore-forming bacteria

- Key goal is to develop tools and knowledge needed to improve fluid milk quality through improved control of psychrotolerant aerobic spore-forming bacteria
- As different strategies are being developed to control psychrotolerant aerobic spore-forming bacteria there is a need for tools that allow for rational decision making on which strategy (e.g., reduced raw milk spore load, use of bactofuge) is appropriate under a given set of circumstances
Predictive Modeling

Deterministic Approach

- Level of spores in raw milk
- Consumption (g)
- Exposure (CFU)

Probabilistic Approach

- Level of contamination (cfu/g)
- Consumption (g)
- Exposure (CFU)

Bacterial numbers in finished product

Level of spores in raw milk \( \times \) Likelihood of subtype \( \times \) Growth parameters = Bacterial numbers in finished product
Input 1: spore numbers in raw milk

Psychrotolerant Sporeformer Counts in Bulk Tank Milk

Mean: -0.723
SD: 0.99
Input 2: Subtypes found in raw milk

Table 1. Numbers of psychrotolerant sporeformer rpoB ATs obtained from 3 or more New York State farms from spore-pasteurized bulk tank milk samples, collected from 99 New York State farms over one year (Masiello, 2014)

<table>
<thead>
<tr>
<th>Genus</th>
<th>species1</th>
<th>rpoB AT</th>
<th>Total no. of unique isolates</th>
<th>% of isolates</th>
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<td>weihenstephanensis</td>
<td>3</td>
<td>22</td>
<td>6.16</td>
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<td>75</td>
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<td>odorifer</td>
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<td>cf. peoriae</td>
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<td>cf. peoriae</td>
<td>170</td>
<td>3</td>
<td>0.84</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>13</td>
<td>27.16</td>
<td></td>
</tr>
</tbody>
</table>

1Sensu lato = in the broad sense; cf. = unspecified identification, resembling the named species
2Table does not include isolates collected two times or fewer; percent displayed does not total 100.
Input 3: Growth of different subtypes found in raw milk

A5-0030: Paenibacillus peoriae
Input 3: Growth of different subtypes found in raw milk (cont.)

Fitted growth curves for different subtypes
Simulation Overview

1. Select raw bulk tank spore concentration

2. Selected sporeformer subtype; assumption: one AT per half-gallon

3. Apply growth parameters appropriate for subtype

4. Calculate bacterial counts at different days

<table>
<thead>
<tr>
<th>Iteration</th>
<th>initial count/ml</th>
<th>rpoBAT</th>
<th>final bact. count/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>-0.338548621</td>
<td>3</td>
<td>3.0185809</td>
</tr>
<tr>
<td>4</td>
<td>-2.355846790</td>
<td>513</td>
<td>3.0185809</td>
</tr>
<tr>
<td>5</td>
<td>-1.608639577</td>
<td>179</td>
<td>3.0185809</td>
</tr>
<tr>
<td>6</td>
<td>-0.814028551</td>
<td>179</td>
<td>2.0821889</td>
</tr>
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<td>7</td>
<td>-1.085047992</td>
<td>15</td>
<td>3.9216301</td>
</tr>
<tr>
<td>8</td>
<td>-2.410513173</td>
<td>15</td>
<td>3.0185809</td>
</tr>
<tr>
<td>9</td>
<td>-0.839902318</td>
<td>17</td>
<td>3.0185809</td>
</tr>
<tr>
<td>10</td>
<td>-0.977208274</td>
<td>15</td>
<td>3.0185809</td>
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<td>11</td>
<td>0.013499921</td>
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<tr>
<td>12</td>
<td>-0.379248379</td>
<td>3</td>
<td>3.0185809</td>
</tr>
<tr>
<td>13</td>
<td>0.231900649</td>
<td>15</td>
<td>3.9216301</td>
</tr>
<tr>
<td>14</td>
<td>-1.823080340</td>
<td>3</td>
<td>5.5921345</td>
</tr>
<tr>
<td>15</td>
<td>-0.527303966</td>
<td>100</td>
<td>3.9216301</td>
</tr>
<tr>
<td>16</td>
<td>-2.152860535</td>
<td>61</td>
<td>3.0185809</td>
</tr>
</tbody>
</table>
Monte Carlo Simulation Results – base model

Distribution of counts per half-gallon on Day 21

- 25% of half-gallons less than 20,000 CFU/mL

Distribution of counts per half-gallon on Day 24

- 5.1% of half-gallons less than 20,000 CFU/mL

Based on storage at 6°C
Monte Carlo Simulation Results – base model

Mean count on day 24: 5.790
Baseline scenario – current raw milk quality and storage at 6 C

Distribution of counts per half-gallon on Day 21

25% of half-gallons
<20,000 CFU/mL

What-if scenario – current raw milk quality and storage at 4 C

Distribution of counts per half-gallon on Day 21

95 % of half-gallons
< 20,000 CFU/mL
What if scenario: 4 C (39 F) versus 6 C (43F)

Mean count on day 24:
3.13
Mean count on day 24: 4.083
# What-if Scenario Outcomes

<table>
<thead>
<tr>
<th>What-if condition</th>
<th>Storage temperature</th>
<th>Concentration at 21 d (Log\textsubscript{10}CFU/mL)</th>
<th>Fraction of half-gallon containers that exceed 4.3 Log\textsubscript{10}CFU/mL at day 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial condition</td>
<td>6°C</td>
<td>4.54 1.71</td>
<td>66%</td>
</tr>
<tr>
<td>Lower refrigeration temperature</td>
<td>4°C</td>
<td>2.37 1.52</td>
<td>9%</td>
</tr>
<tr>
<td>Lower initial raw milk contamination levels by 2.2 Log\textsubscript{10}MPN/mL via microfiltration</td>
<td>6°C</td>
<td>3.03 1.83</td>
<td>13%</td>
</tr>
</tbody>
</table>

Table 5. Summary of what-if scenario analysis outcomes
Validation with Voluntary Shelf-Life Program Samples
Summary—Supp. Project 1

- Collected and generated input data for predictive model on fluid milk spoilage due to sporeformers
- Developed initial model that can predict fluid milk spoilage due to sporeformers
- Next steps will include testing whether predictions on the effects of interventions and control strategies are correct, followed by use of this model to support implementation of changes
2017-18 Project Reports

- Core Voluntary Shelf-Life program and dairy industry outreach
- **Supp. Project 1**: Development of a predictive tool to aid in production of extended shelf life fluid milk products with procedures that control outgrowth of psychrotolerant aerobic spore-forming bacteria (Year 2)
- **Supp. Project 2**: Development and assessment of new tools for raw milk and finished product testing: preparing NY dairy industry for the future (Year 2)
- **Supp. Project 3**: Development of molecular and phenotypic tools to control fungal contamination of dairy products (Year 2)
- **Supp. Project 4**: Control of *Clostridium tyrobutyricum* a remerging concern in hard cheese production (New)
- **Supp. Project 5**: Development and deployment of a rapid response team that responds to on-farm milk quality issues that affect processing or finished product quality (New)
- **Special Supplement**: Building research capacity in dairy foods processing: dairy fermentations
Suppl. Project #2: Development and assessment of new tools for raw milk and finished product testing: preparing NY dairy industry for the future

• Increasing use of new (metagenomics) tools throughout the food systems (private labs, processors, regulatory agencies)
  • These tools will likely play a key role in the “war on antibiotic resistance”
• Key goal is to develop these tools for the dairy industry and to develop basic and knowledge and understanding to minimize incorrect interpretation of data and results
CDC/FDA Partnership Targets Whole Genome Sequencing of Listeria Monocytogenes

By Brian Saunders | November 27, 2013

In a prior APHLTech blog post (NGS in Action: FDA’s Genome TRAKR Network), Victor Waddell of the Arizona State Public Health Laboratory described the newly formed network of laboratories formed by the U.S. Food and Drug Administration (FDA). Known collectively as Genome TRAKR, the member laboratories perform whole genome sequencing (WGS) on bacterial foodborne pathogens isolated primarily from food and environmental sources.

On Sept. 1, 2013, the Centers for Disease Control and Prevention (CDC) began a partnership with the FDA Genome TRAKR network to utilize the network to conduct WGS of all Listeria monocytogenes collected from reported human illness cases in the United States. This effort leverages public health resources to evaluate and
**Listeria Outbreaks and Incidence, 1983-2014**

<table>
<thead>
<tr>
<th>Era</th>
<th>Outbreaks per year</th>
<th>Median cases per outbreak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-PulseNet</td>
<td>0.3</td>
<td>69</td>
</tr>
<tr>
<td>Early PulseNet</td>
<td>2.3</td>
<td>11</td>
</tr>
<tr>
<td>Listeria Initiative</td>
<td>2.9</td>
<td>5.5</td>
</tr>
<tr>
<td>WGS</td>
<td>10</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Data are preliminary and subject to change.
Consortium for Sequencing the Food Supply Chain

IBM Research and Mars tackle global health with food safety partnership
Dairy companies join SAFE food safety program to develop bacteria-detection software

By Jim Cornall+, 28-Apr-2016

The €1.7m ($1.9m) Enterprise Ireland and industry funded program, Sequencing Alliance for Food Environments (SAFE), aims to develop a predictive software toolbox to enhance food quality and safety approaches, nationally and with global reach, using environmental intelligence data.

SAFE is a partnership between the UCD Centre for Food Safety; six leading food and nutrition companies; Dairygold, Dawn Farm Foods, Glanbia, Kerry, Mead Johnson Nutrition and Nutrition Supplies; and Creme Global, suppliers of predictive intake modelling software.

Mapping microbiomes

By mapping these microbiomes, the consortium will develop databases that leverage gene sequencing technology and statistical analysis to define bacterial characteristics at the DNA level.

These databases will then be used to develop a predictive software toolbox. This will enable quicker and more accurate quality control analysis of the bacteria present in food facilities. The consortium says that this will create a quicker and more sustainable response to prevent bacteria that can spoil food or pose a human health risk entering the food supply chain.
A new standard in food.

Clear Labs analyzes food at the molecular level to help the world’s best brands differentiate on quality and stand behind their value.

Request a Demo
DNA blunder creates phantom serial killer

Police admit they wasted 15 years hunting for the 'Woman Without a Face'

She was a mysterious serial killer known as the "The Woman Without a Face" and detectives across Europe spent more than 15 years doing their utmost to bring her to justice for at least six brutal murders and a string of break-ins. Yesterday, however, they were forced to admit that she probably didn't exist.

The only clues that "The Woman Without a Face" left behind at 40 different crime scenes were DNA traces. These were collected on cotton swabs, supplied to the police in a number of European countries. Now police investigators have established that in all probability the DNA had not been left by their quarry but by a woman working for the German medical company supplying the swabs, who had inadvertently contaminated them.

German police who had been leading the hunt said they had probably been involved in one of the longest and most perplexing wild goose chases in criminal history. "This is a very embarrassing story," admitted police spokesman Josef Schneider.
Supplemental Project #2

- **Objective 1**: Evaluate and optimize different metagenomics approaches for their ability to characterize raw milk and selected finished dairy products (focusing on fluid milk and dairy powders)

- **Objective 2**: Assess correlations between metagenomics data for raw milk and production efficiency and finished product quality
  - *Work to date focused on development of tools to predict phenotypes (e.g., spoilage, cold growth, antimicrobial resistance, ability to cause disease) based on DNA sequence data for dairy associated microbes*
50 shades of gray: *Pseudomonas* causes gray discoloration in HTST milk
Key gene unique to *Pseudomonas* causing gray (and blue) color defects

<table>
<thead>
<tr>
<th>Gene name</th>
<th>Annotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>trpD</td>
<td>Anthranilate phosphoribosyltransferase</td>
</tr>
<tr>
<td>trpF</td>
<td>N-(5'-phosphoribosyl)anthranilate isomerase</td>
</tr>
<tr>
<td>trpA</td>
<td>Tryptophan synthase alpha chain</td>
</tr>
<tr>
<td>trpB</td>
<td>Tryptophan synthase beta chain</td>
</tr>
<tr>
<td>iolG</td>
<td>Inositol 2-dehydrogenase/D-chiro-inositol 3-dehydrogenase</td>
</tr>
<tr>
<td>mdh</td>
<td>Malate dehydrogenase</td>
</tr>
<tr>
<td>Peptidase M</td>
<td>Xylose Isomerase Domain-Containing Protein</td>
</tr>
<tr>
<td>degT</td>
<td>Pleiotropic regulatory protein</td>
</tr>
<tr>
<td>trpC</td>
<td>Indole-3-glycerol phosphate synthase</td>
</tr>
<tr>
<td>solR</td>
<td>Transcriptional activator protein solR</td>
</tr>
<tr>
<td>rhtB</td>
<td>Homoserine/homoserine lactone efflux protein</td>
</tr>
</tbody>
</table>

This reaction requires 3 oxygenses!!
Finding genetic markers for cold growth

• Some species of the *B. cereus* group are known to grow at low temperatures
  – *B. mycoides*
  – *B. weihenstephanensis*
  – *B. wiedmannii*

• Performed cold growth experiments and whole genome sequencing on *B. cereus* group isolates as a model/test case
  – Selected because of importance for spoilage and food safety
Radius 1.8 / SMB & BHI at 6C, averaged by Isolate

<table>
<thead>
<tr>
<th>BHI</th>
<th>SMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Cluster

- 1
- 2
- 3

Lab media

Skim milk broth
Understanding genes responsible for ability to cause disease

- Link of certain genes to ability to cause disease well established for some organisms (e.g., *Listeria, Salmonella*)
- Focused on identification of virulence genes in sporeformers classified into the *Bacillus cereus* group
Standard genetic differentiation among *B. cereus* group species is not reliable.
8/7/2014

Product Recall Bulletin

[U.K.]

Snapshot

Dairy Crest Ltd recalls two date codes of Weight Watchers West Country Thick Cream – Reduced Fat due to high levels of Bacillus cereus

8/15/2014

Product Recall Bulletin

[Ireland ex Germany][Mars Chocolate Drinks – UD #1]

Snapshot

Mars Chocolate Drinks Recalls Certain Milk Drink Products Manufactured by Milchwerke Mittelelbe GmbH (Bacillus species)
Production of hemolysin BL by *Bacillus cereus* group isolates of dairy origin is associated with whole-genome phylogenetic clade

Jasna Kovac, Rachel A. Miller, Laura M. Carroll, David J. Kent, Jiahui Jian, Sarah M. Beno and Martin Wiedmann

Rapid, High-Throughput Identification of Anthrax-Causing and Emetic *Bacillus cereus* Group Genome Assemblies via BTyper, a Computational Tool for Virulence-Based Classification of *Bacillus cereus* Group Isolates by Using Nucleotide Sequencing Data

Laura M. Carroll, Jasna Kovac, Rachel A. Miller, Martin Wiedmann
Department of Food Science, Cornell University, Ithaca, New York, USA
Milk Nucleic Acids

• To date, all literature available has pre-processed milk samples through centrifugation or clarification steps before isolation of nucleic acids from milk.

• Bovine DNA frequently dominate sequencing reads.
## Nucleic Acid Extraction

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Kit</th>
<th>Nucleic Acid</th>
<th>Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninoculated Milk</td>
<td>AllPrep PowerViral DNA/RNA kit</td>
<td>DNA/RNA</td>
<td>Manual</td>
</tr>
<tr>
<td></td>
<td>MagMAX CORE Nucleic Acid Isolation kit</td>
<td>DNA/RNA</td>
<td>Automated</td>
</tr>
<tr>
<td>Inoculated Milk 1</td>
<td>ZymoBIOMICs DNA/RNA mini kit</td>
<td>DNA/RNA</td>
<td>Manual</td>
</tr>
<tr>
<td>Inoculated Milk 2</td>
<td>MagAttract PowerMicrobiome</td>
<td>DNA/RNA</td>
<td>Automated</td>
</tr>
<tr>
<td>Inoculated Milk 3</td>
<td>DNeasy PowerFood</td>
<td>DNA</td>
<td>Manual</td>
</tr>
<tr>
<td>Mock Community</td>
<td>E.Z.N.A. Food DNA kit</td>
<td>DNA</td>
<td>Manual</td>
</tr>
<tr>
<td>No Template Control</td>
<td>RNeasy Protect Bacteria Mini Kit</td>
<td>RNA</td>
<td>Manual</td>
</tr>
<tr>
<td></td>
<td>E.Z.N.A.® HP Total RNA Kit</td>
<td>RNA</td>
<td>Manual</td>
</tr>
</tbody>
</table>

### 3 Experiments (Biological Replicates)
Experimental Design

- Bacillus wiedmannii
- Listeria monocytogenes
- Mycobacterium smegmatis
- Salmonella sp.
Results

Listeria monocytogenes
Results

Bacillus wiedmanii
Milk DNA is dominated by Bovine DNA

The useful information lies in <0.23% of total DNA

<table>
<thead>
<tr>
<th>Organism</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine DNA</td>
<td>99.94%</td>
</tr>
<tr>
<td>Bacillus wiedmannii</td>
<td>0.01%</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>0.01%</td>
</tr>
<tr>
<td>Mycobacterium smegmatis</td>
<td>0.02%</td>
</tr>
<tr>
<td>Salmonella sp.</td>
<td>0.01%</td>
</tr>
<tr>
<td>SPC</td>
<td>0.01%</td>
</tr>
</tbody>
</table>
Summary—Supp. Project 2

- Collected and generated data on genomic characteristics linked to spoilage, cold growth, antimicrobial resistance, ability to cause disease of key dairy associated pathogens
  - This information is essential to facilitate correct interpretation of data from new tests increasingly applied to dairy products
  - Further developed tools to prevent misidentification of dairy associated microorganisms, focusing on spore formers
- Almost completed efforts to identify best methods to extract bacterial DNA from milk
- Next steps will include direct DNA-based testing of milk and dairy products without initial isolation of pure bacteria
2017-18 Project Reports

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- **Special Supplement:** Building research capacity in dairy foods processing: dairy fermentations
Suppl. Project #3: Development of molecular and phenotypic tools to control fungal contamination of dairy products

- Yeast and mold contamination a key issue in dairy quality, particularly for cheese, yoghurt, and other fermented products (e.g., dips, sour cream)
- Key goal is to develop tools that can be used to rapidly detect and characterize yeast and mold contamination
  - Will develop knowledge needed to differentiate raw milk and processing plants issues
  - Will help address issues that likely occur in older facilities
Kraft, Polly-O recall string cheese

Posted by Mitch Lipka

October 28, 2013 12:11 PM

Millions of packages of string cheese made by Kraft Foods and sold under the Kraft and Polly-O brands are being recalled because they can spoil before the dates on the packages, according to an announcement distributed by the U.S. Food and Drug Administration.

Consumer complaints about the cheese spoiling too soon led to the recall, Kraft said. A factory in upstate New York was the source of the cheese in question. Production there was halted and the company said it is investigating what caused the problem.

The recalled cheese packages -- 735,000 cases worth -- were shipped nationwide and have dates to use the cheese by ranging from Oct. 25 through Feb. 11, 2014. Spoiled cheese will become discolored, the FDA said.

If you have the cheese, do not eat it. Consumers are advised to return it to the store where they bought it to exchange it for a new package or get a full refund. In addition, can call Kraft Foods at 1-800-816-9432 between 9 am and 6 pm Eastern Time.

A wide range of products are involved, including a variety of different sized packages and types of cheese. A full list of the cheese being recalled and the use-by dates can be found on the FDA site.

The "Best When Used By" date on multi-stick packs can be found near the bottom of the packages the string cheese came in. If the sticks were bought one at a time, the date will be on the bottom front.

Kraft said the recall is limited to the Kraft and Polly-O string cheese products on the list distributed by the FDA.

This blog is not written or edited by Boston.com or the Boston Globe.
The author is solely responsible for the content.
Traditional fungal identification methods

Aspergillus niger vs. Aspergillus luchuensis

Used in biotechnology, for the production of citric acid and enzymes, and in food fermentations. Can produce **mycotoxins** fumonisin and ochratoxin A

Used in food fermentations. No **mycotoxins**!

Hong et al., 2013
Isolates Summary

1,019 Isolates

- 39 from Raw Milk
- 240 from Cheese
- 740 from Yogurt
  - 90 from raw milk cheeses
  - 150 from pasteurized milk cheeses
Species Identification: *Penicillium commune*

| Isolate 1 | AACATGCAGACTGACGATTCGACGTAGGCTAGACGTTGACTG |
| Isolate 2 | AACATGCAGACTGACGATTCGTCGTAGGCTAGACGTTGACTG |
| Isolate 3 | AACATGCAGACTGACGATTCGACGTAGGCTAGACGTTGACTG |
| Isolate 4 | AACATGCATCTGACGATTCGACGTAGGCTAGACGTTGACTG |
Unique genetic subtypes (ITS ATs) from all products

79 ITS ATs
Characterization of isolates from two facilities

- 852 isolates
  - 742 Ascomycetes
  - 97 Basidiomycetes
  - 13 Mucoromycetes
- 2 production facilities represented
  - 303/852 isolates from facility “A”
  - 549/852 isolates from facility “B”
- 200 ITS ATs
  - 92 unique ITS ATs in facility A
  - 138 unique ITS ATs in facility B
  - 30 ITS ATs collected at both facilities
Figure 1. Internal transcribed spacer (ITS) allelic type (AT) matrix displaying ITS ATs collected a total of three or more times from raw material samples, in-product process samples, environmental samples, or finished product samples from two yogurt facilities. Classification represents genera, with the exception of ITS ATs 14, 25, 26, 38, 51, 98, 159, and 174, where phyla are displayed.
**Figure 2.** Association between sample type and ITS AT within each yogurt processing facility. Numbers represent chi-square test statistic, followed by Benjamini and Yekutieli (2001) method adjusted p-values in parentheses. Numbers in white represent comparisons between sample type and ITS AT within facility A. Numbers in grey represent comparisons between sample type and ITS AT within facility B.

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Facility A</th>
<th>Facility B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw material</td>
<td>In-process</td>
</tr>
<tr>
<td>Raw material</td>
<td></td>
<td>24.9</td>
</tr>
<tr>
<td></td>
<td>(&lt;0.05)</td>
<td>(≥0.05)</td>
</tr>
<tr>
<td>In-process</td>
<td>44.1</td>
<td>62.5</td>
</tr>
<tr>
<td></td>
<td>(&lt;0.05)</td>
<td>(≥0.05)</td>
</tr>
<tr>
<td>Environmental</td>
<td>149</td>
<td>131</td>
</tr>
<tr>
<td></td>
<td>(≥0.05)</td>
<td>(≥0.05)</td>
</tr>
<tr>
<td>Finished product</td>
<td>224</td>
<td>199</td>
</tr>
<tr>
<td></td>
<td>(&lt;0.05)</td>
<td>(&lt;0.05)</td>
</tr>
</tbody>
</table>
Within each plant

- **Facility A**
  - ITS AT distribution for in-process samples & environmental samples were both individually associated with finished product sample ITS AT distribution ($P < 0.05$)

- **Facility B**
  - ITS AT distribution for raw material samples, in-process samples & environmental samples were individually associated with finished product sample ITS AT distribution ($P < 0.05$)

- Both facilities have distribution of ITS ATS from environmental samples associated with distribution of ITS ATS from finished product samples $\rightarrow$ suggests environmental PPC route of contamination for fungal organisms
Figure 3. Flow diagram of yogurt processing steps for facility A. Hexagons represent where internal transcribed spacer (ITS) allelic type (AT) 30 was isolated along the processing continuum.
Summary—Supp. Project 3

- Developed method that allows for quick and reliable identification of yeast and mold issues
- Created database of 1,019 dairy-related fungi to help facilitate source tracking
  - This will facilitate prevention of recalls and negative publicity associated with dairy
  - Data and tools will allow for improved identification of yeast and mold sources and differentiation of farm and processing plant sources
- Tools will be particularly important to help processors in older facilities maintain their processing operations and avert recalls and temporary shut-downs
  - Includes development of facility specific control strategies
2017-18 Project Reports

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- **Special Supplement:** Building research capacity in dairy foods processing: dairy fermentations
Suppl. Project #4: Control of *Clostridium tyrobutyricum*, a re-emerging concern in hard cheese production

- *Clostridium tyrobutyricum* is a sporeforming bacterium that can survive pasteurization and other heat treatments.
  - Economic concern for the dairy industry because it causes structural and sensory defects in cheeses
- Control in cheese is expensive and/or involves compounds that need to be labelled (“egg white lysozyme”)
- Cheese makers increasingly test raw milk and may only select raw milk suppliers with low *C. tyrobutyricum* counts
- Tools are needed to (i) assess value of raw milk with low *C. tyrobutyricum* counts and to (ii) help farmers produce raw milk with low *C. tyrobutyricum* counts
Clostridium spores have been implicated in “late-blowing” cheese defect

- As few as 1 spore/L can lead to late blowing
- *Clostridium tyrobutyricum*, *C. butyricum*, *C. sporogenes* and *C. beijerinckii* have been implicated in late blowing
  - Also known as butyric acid bacteria (BAB)
  - Defect visible 7-60d after processing, depending on strain present

Gomez-Torres, et al., 2015
Supplemental Project #3

- **Objective 1**: Characterize *C. tyrobutyricum* previously isolated from raw milk in New York State as well as comparison isolates from cheeses to identify subtypes that differ in their ability to cause cheese defects.

- **Objective 2**: Develop an initial Monte Carlo simulation model that can be used to predict the likelihood of cheese defects as well as the benefits of different intervention strategies at the farm and processing facility level.

- **Objective 3**: Analyze previous *C. tyrobutyricum* data from a cross section of farms to identify risk factors in order to implement an intervention study to test strategies to reduce raw milk *C. tyrobutyricum* counts.
Characterization of previously isolated *Clostridium*

- 740 isolates from BAB tests performed in previous studies; approx. 500 isolates sequenced to date
- ~85% of isolates are *Clostridium*; remaining isolates are primarily facultatively anaerobic sporeformers (e.g., *Bacillus licheniformis*)
- *Clostridium botulinum/sporogenes* accounts for >60% of the *Clostridium* isolates
The age of molecular diagnostics and a cautionary tale
New Zealand dairy giant finds botulism bacteria in milk products

WELLINGTON, New Zealand -- New Zealand dairy giant Fonterra announced Saturday that tests of some ingredients used in infant formula and sports drinks have turned up a type of bacteria that could cause botulism, and customers were urgently checking their supply chains.

One New Zealand company has already locked down five batches of infant formula and China is asking importers to immediately recall products.

Singapore had determined Fonterra must pay the award to cover the recall costs suffered by Danone in 2013.
Fonterra products didn't have botulism bacteria after all, New Zealand tests show

Naomi Tajitsu

4 MIN READ  

WELLINGTON (Reuters) - Dairy giant Fonterra's products at the center of a global contamination scare this month did not contain a bacteria that could cause botulism, and posed no food safety threat, New Zealand officials said on Wednesday.
Summary—Supp. Project 4

- Gas producing *Clostridia* found in raw milk represent a larger diversity than previously assumed
  - Potential for misidentification

- Nest steps:
  - Develop tools that can be used to predict impact of different *Clostridia* control strategies on cheese quality
    - These efforts will also set up capability to develop further models on impact of raw milk quality parameter on cheese quality and yield
  - Develop data on risk factors for *C. tyrobutyricum* presence and contamination levels in raw milk, which will be used to assess different interventions
    - Improved information for producers that may want or need to reduce *C. tyrobutyricum* levels in raw milk (includes powder)
2017-18 Project Reports

• Core Voluntary Shelf-Life program and dairy industry outreach
• **Supp. Project 1:** Development of a predictive tool to aid in production of extended shelf life fluid milk products with procedures that control outgrowth of psychrotolerant aerobic spore-forming bacteria (Year 2)
• **Supp. Project 2:** Development and assessment of new tools for raw milk and finished product testing: preparing NY dairy industry for the future (Year 2)
• **Supp. Project 3:** Development of molecular and phenotypic tools to control fungal contamination of dairy products (Year 2)
• **Supp. Project 4:** Control of *Clostridium tyrobutyricum* a remerging concern in hard cheese production (New)
• **Supp. Project 5:** Development and deployment of a rapid response team that responds to on-farm milk quality issues that affect processing or finished product quality (New)
• **Special Supplement:** Building research capacity in dairy foods processing: dairy fermentations
Background and justification

• With increasingly sophisticated and demanding consumers as well as increased pressure to produce extended shelf life dairy products and to improve processing efficiencies, processors increasingly identify raw milk quality and other on-farm issues as potential root causes of problems
  – Spore concerns, flavor issues, etc.

• Need for rapidly mobilizable team to address these issues both at the processing facility and at the farm
  – Will facilitate rapid translation of research
  – Will inform future research and training
Supplemental Project #5

• **Objective 1**: Communicate and advertise availability of rapid response team to New York state dairy farmers

• **Objective 2**: Develop standard operating procedures and formalized plans for the rapid response team

• **Objective 3**: Deploy team to respond to appropriate milk quality issues
ON-FARM RAPID RESPONSE TEAM

Responds to on-farm milk quality issues that affect processing or finished product quality.

COW TO CUP
Enhances the connections between farm, processing facility, and laboratory to ensure the highest quality dairy products.

RAW MILK QUALITY
Addresses raw milk quality issues (e.g., presence of spores, flavor defects, oxidation).

RAPID RESOLUTION
Facilitates rapid resolution of dairy product quality issues traced back to farm level issues.

RESEARCH FINDINGS
Allows for rapid translation of research findings.

EARLY INFORMATION
Provides early information on new and emerging raw milk quality issues that affect finished product quality.
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Improving the microbial safety and quality of the global food supply through innovative research, education, and outreach.

On-Farm Rapid Response Team

Milk Quality Improvement Program
Cornell University
358 Stocking Hall Ithaca, NY 14853
607-255-2894

food safety.foodscience.conell.edu/mqip

MILK QUALITY IMPROVEMENT PROGRAM

Cornell CALS  
College of Agriculture and Life Sciences
Preliminary Discovery
- Determine nature of quality defect
- Review previously collected data

Targeted sample collection and analysis to determine causative agent

Farm Visit
- Further review of existing data and practices
- Sample collection and analysis

Root Cause Analysis, Recommendations and Follow up

Alternative Troubleshooting
Communication of On-farm Rapid Response Team availability to NYS dairy industry

- Personal communication through MQIP staff, students and extension associates
- Article in Dairy Foods Extension Newsletter
- Article in Progressive Dairyman
- Brochure
Deployment of the On-farm Rapid Response Team

• The MQIP Rapid Response Team has been deployed on three occasions to date:
  – Fluid milk processor experiencing persistent sweet curdling defect typically associated with psychrotolerant sporeforming bacteria
  – Cheese processor suspecting late blowing defect caused by anaerobic BAB sporeformers
  – Producer coop responding to processor concerns of spore levels in raw product

• After preliminary discovery phase, all three incidents were determined to be non-farm related quality issues
Key Outcomes to date

• Better awareness of Cornell troubleshooting capabilities available to producers and processors
  – More rapid transfer of Cornell knowledge and technologies
• Capability to rapidly deploy teams to address different issues
• More rapid resolution of quality issues before they affect producers
2017-18 Project Reports

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Special Supplement: Building research capacity in dairy foods processing: dairy fermentations

• Funding will recruit and support a new faculty member with focus on dairy fermentations. Specific objectives are:
  – **Obj. 1.** Improve dairy fermentation processes and develop new and modified fermented dairy products
  – **Obj. 2.** Provide technology transfer in the area of fermented dairy products to the New York state dairy industry
Sam Alcaine

• Areas of expertise
  • Dairy cultures and fermentation
  • Dairy food safety
  • Production of value added dairy products

• Research program focuses on developing technologies that improve the quality, safety, and potential applications of fermented dairy products and co-products. Current projects explore:
  • the applications of bacteriophage to improve health, dairy safety, and fermentation performance
  • the use of natural cultures and enzymes to enhance product shelf life and safety
  • novel applications and uses for co-products of dairy fermentations
  • Identification and establishment of analytical technologies (ElastoSens and iCinac) that can be leveraged by industry to improve fermentation processes and product development.
Key activities and successes

• Improve dairy fermentation processes and develop new and modified fermented dairy products
  – Set up FPDL to facilitate new product development efforts in cheese and Greek yogurt
  – Further developed cheese making capabilities (cheddar, surface ripened cheeses)
• Provide technology transfer in the area of fermented dairy products to the New York state dairy industry
  • Addressed yeast, mold, coliform, and phage contamination issues in fermented dairy products
  • Leverage analytical equipment (ElastoSens and iCinac) to help fermented dairy producers troubleshoot ingredient/formulation impact on fermentation activity.
• Dairy by-product utilization work has been presented at multiple conferences and is attracting considerable attention
A nature-based spoilage solution?

Bio-protective cultures could make your brand more attractive to diverse consumers

It is not hard to imagine a consumer reaching past a bloated yogurt package with a look of disgust. Now imagine him or her reaching past that yeast-spoiled cup for a pristine package of the adjacent yogurt.
Key activities and successes (con’t)

- Provided training on both science of cheese/yogurt as well as food safety to NYS dairy producers (6 workshops 2017, 9 workshops 2018)
- Sam has been elected to Member-at-Large in American Dairy Science Association (ADSA). He is co-chairing the ADSA Whole Genome Sequencing symposium at the annual conference and the Graduate Student Poster Presentation Competition, as well as supporting a pre-conference workshop on spore controls for dairy producers
- Elected “Scientific advisor” for the New York State Cheese Manufacturers Association
- Obtained a $300K USDA funding for outreach and training on dairy food safety for small dairy processors
Artisan Dairy Food Safety Plan Coaching Workshop Fall 2017-Fall 2018 Trainings
Alcaine Research Groups First Two Graduates!

Jeffery Tokman (MSc) will be going to work for Intralytix a company focusing on the application of phages for pathogen control in food and food processing environments, including dairy.

Sofia Lara (MSc) will work for DSM to support and grow their dairy culture business. She was recognized for her research (supported by Dairy Board) and leadership, and received 5 offers from companies spanning dairy processors, dairy culture houses, and dairy research institutions.
The Team - Research & Training (current)

**RESEARCH STAFF:**
- Nicole Martin
  M.S.
  MQIP Associate Director
- Nancy Carey
  M.A.T.
  Research Support Specialist I
- David Kent
  B.S.
  Technician III
- Rachel Evanowski
  B.S.
  Technician II
- Sean (Xiaodong) Guo
  M.S.
  Technician III
- Jordan Skeens
  B.S.
  Technician III
- Miquela Hanselman
  B.S.
  Technician I

**GRADUATE STUDENTS:**
- Ariel Buehler
  Ph.D.
  Graduate Student
- Sarah Murphy
  Ph.D.
  Graduate Student
- Sam Reichler
  Ph.D.
  Graduate Student
- Red marks any student with (partial) non dairy promotion support

**EXTENSION STAFF:**
- Robert Ralyea
  Senior Extension Associate
- Kimberly Bukowski
  Extension Professional
- Louise Felker
  Extension Specialist
- Carmela Beliciu
  Extension Aide II
  Dairy Extension Specialist
- Alex Solla
  Extension Aide I
- Barb Williams
  Northern NY
  Harvest NY Dairy Processing Specialists
- Anika Zuber
  Western NY
  Harvest NY Dairy Processing Specialists

**POST DOC:**
- Erika Ganda
  Ph.D.
  Post Doctoral Associate
Food Science Students – Connected to Dairy processors

- 2 Students to Ample Hills Ice Cream, Brooklyn, NY
- 1 Student to Chobani, New Berlin, NY
- 1 Student to Sabra Dipping Co., Farmington, NY
- 1 Student to Murrays Cheese, NY, NY
- 1 Student to All Seasoning Ingredients, Canastota, NY
- 1 Student to Fruit Crown, NY, NY, supplies fruit to dairy industry
- 1 Student to Grober Foods, Auburn, NY, processes Cayuga Milks waste products into animal feed
- 1 Student to Old Chatham Cheese Company, Old Chatham, NY
- 1 Student to BelGioioso Cheese, Schenectady, NY
Expanding the reach of Dairy Foods Extension

Barb Williams
• Harvest NY Northern NY region Dairy Processing Specialist - based in CCE in Lowville, Lewis County.
• BS in Biology – Siena College
• Works towards assisting NNY dairy facilities with resources they need to gain access to markets and produce high quality products
• Experience in SQF, food safety planning, fluid milk and employee training

Anika Zuber
• Harvest NY Western NY region Dairy Processing Specialist - based in CCE in Batavia, Genesee County
• BS in Food Science – Cornell University
• Works extensively with area manufacturers, educators and the community to provide training and increase awareness of the products and career opportunities within the dairy industry
• Experience in dairy product manufacturing for safety & quality, food safety planning, and employee training.
Undergraduate Training – the past

**Sam Reichler**
Class of 2015
Internships:
- Garelick Farms, 2014
- Biomerieux, 2014

*Current Ph.D. graduate student in MQIP.*

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**Clint Hervert**
Class of 2014
Internships:
- Kraft Foods, 2014

Semester abroad in Parma, Italy

*Currently working as a Kraft Heinz Senior Analyst, the corporate quality lead for the Dessert and Family Favorites product categories.*

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**Sarah Kozak**
Class of 2015
Internships:
- Leprino Foods, 2014
- Summer Scholar, 2013
- Upstate Niagara Coop., 2012

*Technician in the Alcaine Lab, after getting an MS at U. Conn*

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**Tristan Zuber**
Class of 2008
Previous positions:
- Leprino Foods
- USDEC
- TIC Gums

*Currently working as an Account Manager for Chr. Hansen.*

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**Sarah Kozak**
Class of 2015
Internships:
- Leprino Foods, 2014
- Summer Scholar, 2013
- Upstate Niagara Coop., 2012

*Technician in the Alcaine Lab, after getting an MS at U. Conn*
Undergraduate Training - continued

Miquela Hanselman  
Class of 2017  
Worked in MQIP lab as undergrad (research on *Salmonella, Bacillus cereus*, also worked on projects related to on-farm sources of sporeforming bacteria)  
*Currently pursuing MPH degree, summer internship at DMI*

Aziza Taylor  
Class of 2018  
Assisted Sarah Murphy, characterizing sporeforming bacteria from bedding samples from U.S. dairy farms
National Collegiate Dairy Products Evaluation Competition

- The Cornell DPSE team included 3 undergrads and two grad students.
- Results included:
  - Melanie Franks - 1st place in the Butter category for Graduate Students
  - Melanie Franks – 2nd place in the Ice Cream category for Graduate Students
  - Ana Ortiz Quezada - 4th place in the Milk and Yogurt Category for Graduate Students
  - Marlie Lukach - 6th place in the Cheddar Cheese category
- Overall, the Cornell DPSE Team’s standing for all Dairy Products was 7th.
One student team from Cornell has been selected as one of the top 3 winners in the National Dairy Council New Product Competition for their product called SunBites. This year’s competition challenged student teams to develop a dairy based snack that answers the evolving needs of today’s snacking consumer. The new product had to be an excellent source of protein, be good tasting, healthful and in line with regulatory criteria and promote the Real®Seal.

Products were judged by a panel of industry leaders including dairy producers, representatives from media and leaders from dairy processing companies. First, second, and third place winners will be announced Tuesday, June 26th at an NDC-sponsored networking reception during the American Dairy Science Association Annual Meeting in Knoxville TN.
What are “SunBites”? 

- Savory cheesy snacks
- Made up of cheesy cracker pieces and crispy puffs
- Unique bite-size, cluster shape
- Completely vegetarian
- An excellent source of protein
Product Breakdown

Cheese Cracker Bits:
- Cheese
- Yogurt
- Flour
- Milk Protein Concentrate
- Whey Permeate
- Carrageenan

Binder:
- Acacia Gum
- Flavoring (Cheese Powder)

Crisps:
- Extruded Milk Protein
What exactly is TEAFIR?

- **TEAFIR** = Kefir + Kombucha Jellies

Think of bubble tea (boba tea) – now replace the milk tea with kefir and the boba with kombucha jelly pieces

- **Main contact:**
  - Zhixin Wang (zwx485)

- **Members:**
  - Lingxi Zhou (lz468)
  - Yungyi Tiao (y1497)
Additional funding to support dairy research

- **Chobani**: gift to support dairy quality related activities
- **New York Farm Viability Institute**: Outreach and training efforts related to reducing sporeformers in raw milk
- **National Dairy Council**: projects on Listeria, spores, and spore detection methods
- **BioMerieux**: Graduate Assistantship, focus on dairy spoilage
- **Dairy Certificate Program Fees**: Standard workshops are self-sustaining
Thanks for Making Cornell a Great Place for Dairy Research and Outreach!