Diversify Your Food Safety and Quality Data: Where Are My Results and What Are They Telling Me?

**Moderator:** Matt Hahs and Mark Carter, Hygiena

**Organized by** IAFP’s Applied Laboratory Methods PDG & Data Management & Analytics PDG

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Webinar
Diversify Your Food Safety and Quality Data
Where Are My Results and What Are They Telling Me?
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We Take Pride In Our Mission

Mission:

We create innovative diagnostics for a healthier world

Customer Focus:

We provide integrated One Health Diagnostics™ from farm to fork to our customers around the world in the areas of environmental monitoring, production animals, food manufacturing, water, food service, healthcare and other industrial fields. We embrace the “One Health” belief that the health of people is closely connected to the health of animals in our shared environment.
Diversify Your Food Safety and Quality Data

Where Are My Test Results and What Are They Telling Me?

Data Digitization for Holistic Food Safety and Quality Management

New Approach to Microbial Testing to Keep up with New & Innovative Advances

Maximize Your Testing Budget for Actionable Data-Driven Decision-Making
Top Data Challenges in Food Manufacturing Today

**Volume Overwhelm**
Large testing data volume leading to operational and cost inefficiencies.

**Fragmented Data Sources**
Different data sources creating information silos

**Delayed Decision-Making**
Slow alerts and analysis prevents quick action on food safety issues.

**Ever-Changing Compliance**
Keeping data ready for stringent and evolving regulations.

**Proactive Risk Management**
Moving from reactive to predictive in identifying safety risks.
Meet our Speakers

Webinar Moderator
Matthew Hahs
Sr Global Product Manager, Hygiena

Webinar Moderator
Mark Carter
Sr. Global Software Product Manager, Hygiena

Webinar Presenter
Mindy Brashears
Director of ICFIE at Texas Tech University

Webinar Presenter
Karen Beers
Director of Lab Services at Pilgrim’s
Microbial Testing for Process Control:
Supplementing Indicators with Pathogen Testing

Mindy Brashears, PhD
Texas Tech University

Angelica Sanchez, MS
Overview

- Historically we have used indicators to measure process control, especially in raw/fresh product production areas.
- Evolution of rapid testing platforms allows us to supplement indicator testing with pathogen testing giving additional insight into process control.
Environmental Monitoring Programs

Verifies cleaning, sanitation, and pathogen controls to prevent cross-contamination of the finished product from the environment.

Microbial Indicators

- Aerobic counts (AC)
- Enterobacteriaceae (EB)
- Generic E. coli (EC)

Pathogens

- Salmonella spp.
- Shiga toxin-producing E. coli. O26, O45, O103, O111, O121, and O145.
Study 1: Enviro-mapping

Sampling Time Points

- 5:30 am pre-operation
- 8:30 am morning break.
- 11:30 am before cleaning.
- 12:30 pm after cleaning.
- 3:00 pm at the end of the shift.

Sampling

MicroSnap™
Study 1: Enviro-mapping

Enviro-mapping baseline of a beef fabrication floor

- **Objective:** identify microbial harborage sites and evaluate concentration over time throughout the day in the fabrication area of a beef processing facility.
- **Hypothesis:** bio-mapping of microbial indicators in the facility's environment can provide data for processors to make decisions to prevent cross-contamination with potential pathogens.
Study 1: Enviro-mapping

Sampling Location

- Chuck: L1
- Loin: L2
- Round: L3
- Trim: L4
Sampling Sites

**Z1**

**Conveyor Belts:** $N = 60$

Areas:
- $L_1 = 17.40 m^2$
- $L_2 = 20.11 m^2$
- $L_3 = 21.2 m^2$
- $L_4 = 8.95 m^2$

**Cutting Boards:** $N = 90$, 0.5 $m^2$.

**Knives:** $N = 90$, $\sim 20 cm^2$.

**Z2**

**Board frames:** $N = 90$, 90$cm^2$.

**Z3**

**Drains:** $N = 90$, 320 $cm^2$.

**Handrails:** $N = 18$, 37 $cm^2$.

**Stairs:** $N = 18$, 25 $cm^2$
Sampling Sites

**Z1**  
**Conveyor Belts:** $N = 60$
Areas:
- $L_1 = 17.40m^2$
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**Cutting Boards:** $N = 90$, 0.5 m$^2$.

**Knives:** $N = 90$, ~20 cm$^2$.

**Z2**  
**Board frames:** $N = 90$, 90cm$^2$.

**Z3**  
**Drains:** $N = 90$, 320 cm$^2$.

**Handrails:** $N = 18$, 37 cm$^2$.

**Stairs:** $N = 18$, 25 cm$^2$.
Sample Processing: MicroSnap

Study 1: Enviro-mapping
Results: Aerobic Counts

Study 1: Enviro-mapping

* N = 90

* N = 60
Study 1: Enviro-mapping

Results: Aerobic Counts

*N = 90

- Knives
  - Anova, p = 0.013
- Board Frame
  - Anova, p = 8.4e-05

- Chuck
  - *N = 90

- Log CFU/mL
  - Anova, p = 0.8
- Loin
  - Anova, p = 3.1e-05

- Round
  - Anova, p = 2.9e-11

Pre-operation, Morning, Before Cleaning, After Cleaning, End of the day
Study 1: Enviro-mapping

Results: Aerobic Counts

*N = 90

*N = 36
Study 1: Enviro-mapping

Results: Enterobacteriaceae

*N = 60

*N = 90
Results: Enterobacteriaceae

Study 1: Enviro-mapping

* N = 90
Study 1: Enviro-mapping

Results: Enterobacteriaceae

*N = 90

- Drains
  - Anova, p = 0.06
  - Log CFU/mL

- Chuck
  - Anova, p = 0.1

- Stairs
  - Anova, p = 0.63

- Handrail
  - Anova, p = 0.94

- Tum/UdC go
  - Anova, p = 0.3

- Round
  - Anova, p = 0.35

- Pre-operation
  - End of the day

*N = 90
Study 1: Enviro-mapping

Results: Generic *E. coli*

*N = 90*
Study 1: Enviro-mapping

Results: Generic *E. coli*

**Knives**

- Anova, $p = 0.26$

**Board Frame**

- Anova, $p = 0.15$

- Anova, $p = 0.54$

- Anova, $p = 0.16$

* $N = 90$
Results: Generic *E. coli*

**Study 1: Enviro-mapping**

- **Drains**
  - Anova, p = 0.2
  - **Handrail**
    - Anova, NA
  - **Stairs**
    - Anova, p = 0.68

- **Chair**
  - Anova, p = 0.5

- **Round**
  - Anova, p = 0.35

*N = 90*
Visualization platform

SureTrend® Cloud is a platform that provides a gateway to actionable insights.

- Environmental maps help you identify critical areas to manage and mitigate risk.
- Track and trend cleaning efforts across multiple facilities.
- Quickly identify cleaning trends and problem areas to improve corrective actions.
- Identify training opportunities around cleaning protocol.
- Visualize and report environmental monitoring, food safety, and quality test results across multiple facilities.
- Alerts when something is not working to specification.
Map: 
Aerobic Counts

Threshold limit of 1,000 CFU

Study 1:
Enviro-mapping

Chuck   Loin   Roun   Trim
Study 1: Enviro-mapping

Map: Enterobacteriaceae
Threshold limit of 100 CFU
Study 1: Enviro-mapping

Map: Generic *E. coli*

*Threshold limit of 100 CFU*
Pathogen Monitoring
Study 2: Pathogen Monitoring

Sample Collection
BAX System Q7 Real-Time PCR

- Rapid and accurate detection of microorganisms in food and environmental samples.
- Detection and quantification of specific DNA sequences in a sample.
- Primarily used for food safety testing in the food industry.
- It can detect various pathogens and microorganisms of concern, such as Salmonella, Listeria, E. coli, Campylobacter, and others.
Study 3: Pathogen Monitoring

Sample Processing
Results: *Salmonella*

<table>
<thead>
<tr>
<th>Line</th>
<th># Positives</th>
<th>% Positives</th>
<th>Mean Log CFU/Positive samples</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuck</td>
<td>0/68</td>
<td>0.00%</td>
<td>&lt;LOQ</td>
<td>0.015</td>
</tr>
<tr>
<td>Trim</td>
<td>5/60</td>
<td>8.33%</td>
<td>3.8</td>
<td></td>
</tr>
</tbody>
</table>

*Salmonella* presence in conveyor belts treated (Chuck) and not treated (Trim) with ozonated water at 810 ORP. N = 128
Study 3: Pathogen Monitoring

Results: Presumptive Non-O157 STECs Top 6

Presumptive Non-O157 STECs by line.
**STEC Serotypes**

- **O 45**: Chuck 66, Trim 54
- **O 121**: Chuck 5, Trim 26
- **O 26**: Chuck 22, Trim 44
- **O 103**: Chuck 1, Trim 16
- **O 145/O 111**: No positives

**P-values**
- **O 45**: p = 0.09
- **O 121**: p = 2.1193E-06
- **O 26**: p = 3.66375E-06
- **O 103**: p = 2.76968E-05

Note: The p-values indicate the statistical significance of the differences between the Chuck and Trim groups for each STEC serotype.
IMPLICATIONS

INDICATOR STUDY:
• Few Changes after 3 Hrs of Operation
• Visualization Platform Gives More Insight Into Changes in Patterns over Time

PATHOGEN STUDY:
• Pathogens are Present in the Fabrication Environment and can Give Insight into Mitigation Strategies
• *All Product is Subject to TWO Antimicrobial Treatments after Fabrication

BOTH APPROACHES HAVE VALUE!
Thanks to Hygienia for Financial Support of this Project
Diversifying Your Food Safety and Quality Data: Where Are My Results and What Are They Telling Me?

Presented by: Karen Beers
Rule #1

Do No Harm

- Data Driven Decisions
- Data accuracy and integrity
- Investment $$$$$
- Where do we get the data and what do we do with it?
Pilgrim’s Labs by the Numbers-Routine

- **4 internal labs**
  - 1 Chem/Feed Analysis supports 26 live complexes
  - 3 Microbiological/ Food Safety supports 26 slaughter, 4 further processing and 2 RTE facilities
  - All approved for USDA ALP Micro and/or Pesticide

- **Microbiology Laboratories**
  - 7 days week, 12 hours/day
  - 271,000 samples
  - **369,000 test analysis**
  - 166,000 Carcass and Parts Rinses
    - Process control using EB
  - 109,000 Quantitative analysis (not EB or Salmonella)
  - 60,000 *Salmonella* prevalence tests
  - 14,000 *Campylobacter* prevalence tests
  - 20,000 *Listeria* tests

- **Chemistry Laboratory**
  - 5 days week, 12 hours/day
  - 135,000 samples
  - **306,000 test analysis**
  - 21,000 pesticide
  - 49,000 NIR
  - 236,000 Wet Chemistry

**Where do the samples come from?**
Support team to collect and ship samples to the lab with correct sample information
Typical Operation of a Vertically Integrated Poultry Firm

1. **Primary Breeder Company**
   - Breeder Chicks
   - Breeder Farm
   - Hatching Eggs
   - Hatchery
   - Broiler Chicks

2. **Feed Mill**
   - Mixed Feed Ration
   - Byproducts

3. **Further Processing**
   - Rendering Plant
   - Byproducts

4. **Processing Plant**
   - Market Ready Broilers

5. **Growout House**

**KEY:**
- Facilities Owned by Vertically Integrated Poultry Firm
- Allied Industry of the Poultry Industry
- Facilities owned by Contract Growers or Integrator

**Feed Ingredients:**
- Corn, soybean meal, other feed ingredients

**Distribution:**
- Retail
- Grocery
- Food Service Institution
- Export
Live Production-Breeder Farm

Pathogen testing
- Currently collect boot sock samples
- Twice in life cycle
- Test for certain *Salmonella* serotypes
- Exploring use of *Salmonella* quantification

Data Driven Decisions

Challenges
- High Background Growth
- Validated Matrix
  - One boot sock sample per farm, per house
  - Cecal Tonsils-how many needed
- LOQ/Serotypes per house
  - Wide Range
- Species vs Serotype
  - Total *Salmonella* but also specific Serotype
- Shipping
  - Prevalence Time/Temp are not as important as Quant. Have to be at Lab within Certain Time and at a Specific Temp
Breeder Farm Example

- One Farm-9 houses
- Very variable
- 14 days prior to slaughter
- Make changes based on data
  - All prevalence positive
  - Quant added next level of interpretation of data
- Know species, serotype, quantification to know if results change with any farm changes implemented
- Data Driven Decisions

<table>
<thead>
<tr>
<th>Hs</th>
<th>Sal Log CFU/4 Bootsocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.65</td>
</tr>
<tr>
<td>2</td>
<td>0.88</td>
</tr>
<tr>
<td>3</td>
<td>2.65</td>
</tr>
<tr>
<td>4</td>
<td>3.78</td>
</tr>
<tr>
<td>5</td>
<td>2.17</td>
</tr>
<tr>
<td>6</td>
<td>4.66</td>
</tr>
<tr>
<td>7</td>
<td>2.17</td>
</tr>
<tr>
<td>8</td>
<td>9.26</td>
</tr>
<tr>
<td>9</td>
<td>1.76</td>
</tr>
</tbody>
</table>
Live Production-Breeder to Broiler

- **Breeder Egg**
  - Not currently tested
  - Not regulated (not table egg)

- **Hatchery**
  - Minimal testing but exploring what to test and where
  - Improve hatchability
  - Improve chick health

- **Feed Mills**
  - Nutritional testing
  - Rule #1 Do No Harm

- **Broiler Farm**
  - Same challenges as the Breeder Farm
  - Data can be used for risk assessment
  - Expand pathogen/quantification collection in Broiler farms to mitigate risk prior to reaching the processing plant
  - Rule #1 Do No Harm
Processing

- **Process Control**
  - Bio-mapping the process
  - Every Day Every Plant
  - EB or other indicator organism
  - Actually use the pathogen of concern using *Salmonella* Quantification Data
  - EB current process control-Data shows no correlation of EB load to *Salmonella* load

- **Challenges**
  - High Background Growth beginning of process, clean end of process
  - Validated Matrix – Carcass or Parts Rinses
  - LOQ
    - Wide Range
    - Also very low post chill
  - Throughput
    - Process control 1/22,000 pre and post chill
  - Species vs Serotype
    - Total *Salmonella* but also specific Serotype
    - Tie into pre-harvest testing

*Data Driven Decisions*
**Quantification Example**

**Hot Rehang**
- Log Sal CFU/Carcass Rinse: 2.48
- % Positive: 98

**Post Evis**
- Log Sal CFU/Carcass Rinse: 1.86
- % Positive: 95

**Post IOBW**
- Log Sal CFU/Carcass Rinse: 1.55
- % Positive: 85

**Post OLR**
- Log Sal CFU/Carcass Rinse: 1.05
- % Positive: 80

**Post Chill**
- Log Sal CFU/Carcass Rinse: 0.50
- % Positive: 7
- Log Sal CFU/Carcass Rinse: 0.25
- % Positive: 0.10

**Post AntiM**
- % Positive: 2

**Parts**
- % Positive: 5

Sal species (Prev) - S. Typhimurium - S. Enteriditis
Further Processing/RTE

- Different verification or validations to be done
- Cross contamination, Interventions, Sanitation
- Actual Quantification of Sal instead of prevalence
- Challenges
  - Different matrix-Sanitation swabs
  - Same platform for all matrix
  - Can see a rebound in parts but what does that really mean

Environmental Mapping
- Follow Sentinel program +
- RTE Products
  - 100% Test and Hold

Validation Example

<table>
<thead>
<tr>
<th>Location</th>
<th>Prevalence (%)</th>
<th>Quantification Log_{10} CFU/Carcass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sal species (Prev)</td>
<td>Sal species</td>
</tr>
<tr>
<td>Pre-Treatment</td>
<td>98</td>
<td>1.45</td>
</tr>
<tr>
<td>Post-Treatment</td>
<td>98</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Prevalence (%):

- S. Typhimurium: Pre-Treatment 0.10, Post-Treatment 0.00
- S. Enteriditis: Pre-Treatment 0.25, Post-Treatment 0.00
How do you interpret the data?
- Central Location
- Data mining Team
- QlikSense program
- Internally Supported
- All Access
- Review the data, what is it telling you?
- Implement process improvements, interventions or other actions to support Rule #1

Applied Research
- Investigates what to look at
- Can’t test all new products
- Need new technologies (like *Salmonella* Quantification, Serotyping, Virulence Gene Detection) to determine best practices
- Support Rule #1
Rule #1
Do No Harm
Thank you to Hygienia and IAFP for this Webinar!

Karen Beers
Karen.Beers@pilgrims.com
Thank You
<table>
<thead>
<tr>
<th>Name</th>
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Upcoming Webinars

November 17, 2023  1:00 PM  Matrix Additions Part 2: Alternative Approaches for Rapid Pathogen Detection Methods

December 13, 2023  11:00 AM  Building a Culture – The Tools and Tips You Need to Succeed

December 14, 2023  9:00 AM  Impact of Water Use and Reuse in Food Production and Processing on Food Safety at the Consumer Phase: Focus on the Fresh Fruit and Vegetable Products Sector

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