

# Interventions in Meat Processing Plants: Functions, Selection and Implementation

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# Presentation Outline

- Interventions
  - Selection
  - Efficacy
  - Proper role
  - .....
- Major remaining beef industry challenges
- Worthwhile observations

# Interventions

- Are important components of an effective food safety system.
- Must be properly researched, selected, validated and implemented.
- Ongoing (multiple times a day) verification
- Interventions reduce but do not eliminate the hazard.
- The level of reduction depends on the intervention and the microbial load.

# Interventions

- The selection of an intervention needs to be a thoughtful and methodical process, not just copying someone else.
- Company X is taking out steam vacuum, should we?
- Company X and Y are turning hot water off and going to chemical intervention, should we?

“Hey Mohammad,

I hope this email finds you healthy, happy and at peace.

What is going on with the beef companies shutting down the hot water and steam pasteurization? I heard they are using decreased shelf life as the reason but it does not make sense to me. Your science (and many others) has always been hot water and lactic acid are the best intervention. Do you know what is really driving this?

Thanks as always,

XXXXXXXX”

# Interventions

- The selection of an intervention needs to be a thoughtful and methodical process, not just copying someone else.
- Company X is taking out steam vacuum, should we?
- Company X and Y are turning hot water off and going to chemical intervention, should we?
- The intervention selection should be based what is needed and what is needed is different in different plants.

# Interventions

- I could argue that a plant may go with minimal reliance on the interventions.

# Interventions

## Plant A

- Clean cattle
- Set chain speed based on type of cattle coming in
- Slaughter sequence based on feedlot
- Hide on intervention
- Effective sanitary dressing practices
- Low employees turnover
- Robust trim lot size, sampling and testing program

## Plant B

- Dirty cattle
- Set chain speed
- No slaughter sequence
- No hide intervention
- Ineffective sanitary dressing practices
- High employees turnover
- Less than optimum lot size, sampling and testing



# Interventions

- So an intervention(s) must be chosen to match the need of the process, i.e., the microbial load just prior to intervention.
- In your hands what can you realistically expect from your intervention(s)?
- What is the microbial counts AFTER the intervention? Residual and not log reduction as log reduction depends on the microbial load.
- In-plant validation and ongoing verification

# Effect of Exposure Time and Organic Matter on Efficacy of Antimicrobial Compounds against Shiga Toxin–Producing *Escherichia coli* and *Salmonella*

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# The Study

- **Objective:** was to evaluate effectiveness of time of exposure of various antimicrobial compounds against seven strains of STEC strains and four strains of *Salmonella* in aqueous antimicrobial solutions with and without organic matter.
- **Purpose:** To assist the industry to identify antimicrobial compounds suitable for interventions at various stages as well as their effective use (optimized parameters of application) in the process that can significantly improve the safety of meat products.

# Effect of Exposure Time and Organic Matter on Interventions Efficacy

- Test tube assay
- Cocktail of top 7 EHEC and Salmonella strains
- $1.5 \times 10^7$  to  $1.5 \times 10^8$  CFU/ml (7.2-8.2 logs/ml)
- The following six antimicrobial treatments were prepared at room temperature:
  - Lactic acid 2.0%, pH = 2.4 – Organic Acid)
  - Lactic acid (4%, pH = 2.2 – Organic Acid)
  - Beefxide (2.5%; pH = 2.6 – Organic Acid)
  - Aftec 3000 (1%; pH = 1.8 – Inorganic Acid)
  - Peracetic acid (200 ppm [PAA], pH = 2.9 – Acidic Oxidizer)
  - Hypobromous acid (300 ppm, pH = 6.5 – Neutral Oxidizer)

# Effect of Exposure Time and Organic Matter on Interventions Efficacy

- The antimicrobial treatments were performed by mixing inoculum with antimicrobial compound.
- Exposure times: 15, 30, 60, 120, 300, 600, and 1,800 s.
- Sterile water
- Purge: Beef purge contains protein and fat and was used to simulate the organic load on the carcass/meat surface.

# Results: Sterile Water

<b>Antimicrobial</b>	<b>15 seconds</b>	<b>60 seconds</b>	<b>300 seconds</b>	<b>1800 seconds</b>
2% Lactic Acid	1.3	2.2	4.0	5.7
4% Lactic Acid	2.4	3.2	5.8	5.8
Beefxide	0.3	0.9	1.7	3.9
Aftec	0.7	2.3	4.4	5.8
PAA	5.6	5.6	5.6	5.6
Hypobromous Acid	5.2	5.7	5.7	5.7

# Results: Beef Purge

<b>Antimicrobial</b>	<b>15 seconds</b>	<b>60 seconds</b>	<b>300 seconds</b>	<b>1800 seconds</b>
2% Lactic Acid	1.0	2.6	5.6	6.0
4% Lactic Acid	2.8	3.3	6.0	6.0
Beefxide	0.3	0.5	1.9	4.9
Aftec	0.5	2.0	4.5	6.0
PAA	1.6	2.9	3.5	4.0
Hypobromous Acid	0.1	0.1	0.2	0.2

# Results

- Antimicrobials had similar effect on all pathogens.
- For brevity, only discussing effects on *E. coli* O157 in this presentation.
- Increasing exposure time to antimicrobial compounds significantly increased the effectiveness against pathogens tested. For example: 4% LA reduced *E. coli* O157 by 2.8, 3.3, and 6.0 logs after 15, 60 and 300 seconds.
- Even after extended exposure (30 min), not all were eliminate.



# Results

- In aqueous antimicrobial solutions without organic matter, both PAA and BR were the most effective.
- However, in antimicrobials containing organic matter, LA4 was the most effective compound.
- Ineffective of oxidizing compounds in purge.
- Another level of complexity – Method of application.

# Results

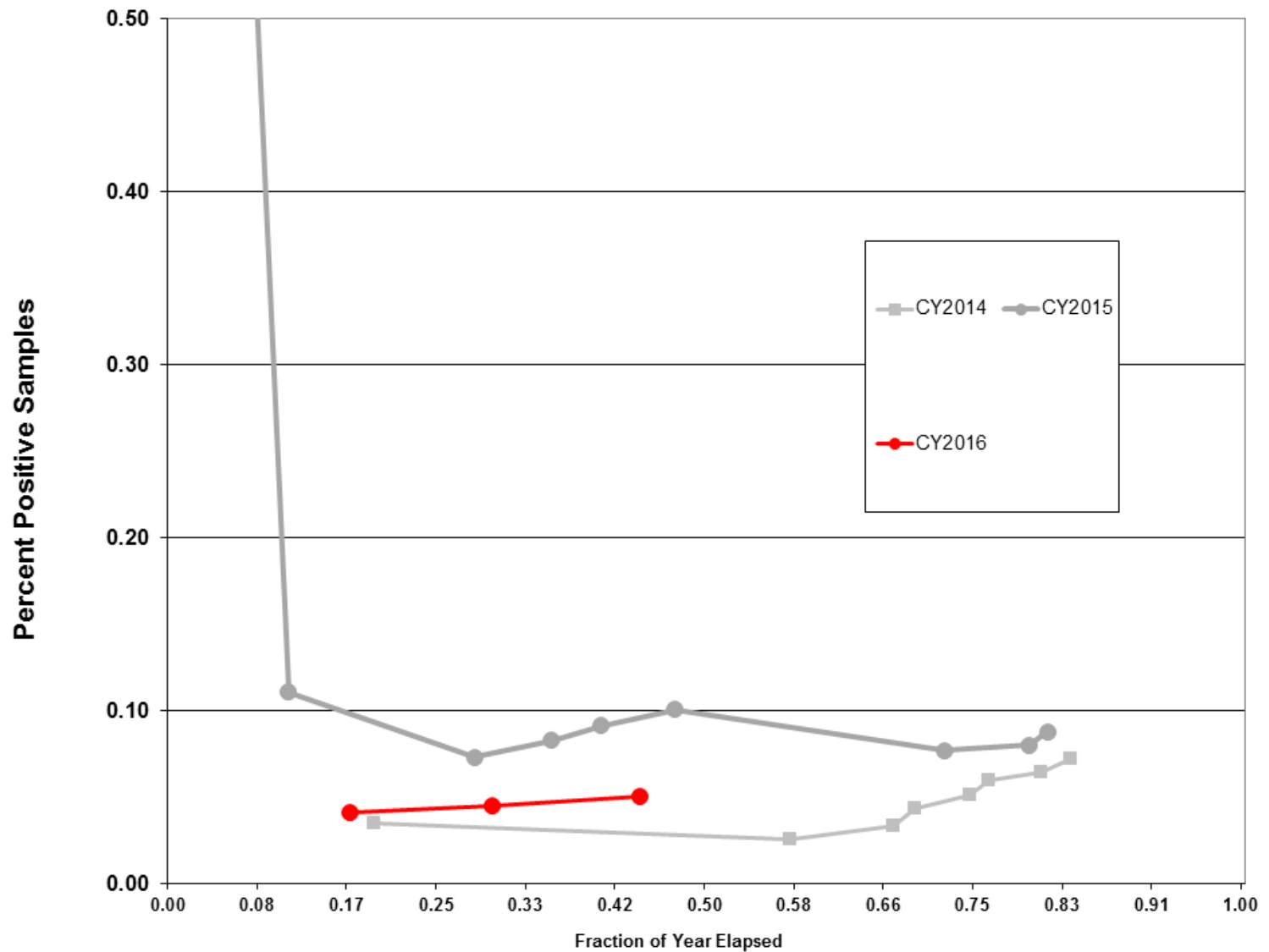
- Antimicrobials reduce but do not eliminate pathogens.
- Even after 1800 seconds (30 min) not all pathogens were eliminated.
- Most require extend time to show max effect (do not wash off)
- Prevalence vs. quantification
- The further processors' dilemma (Supplier's verification program).

# Noteworthy Observations

# High Event Period

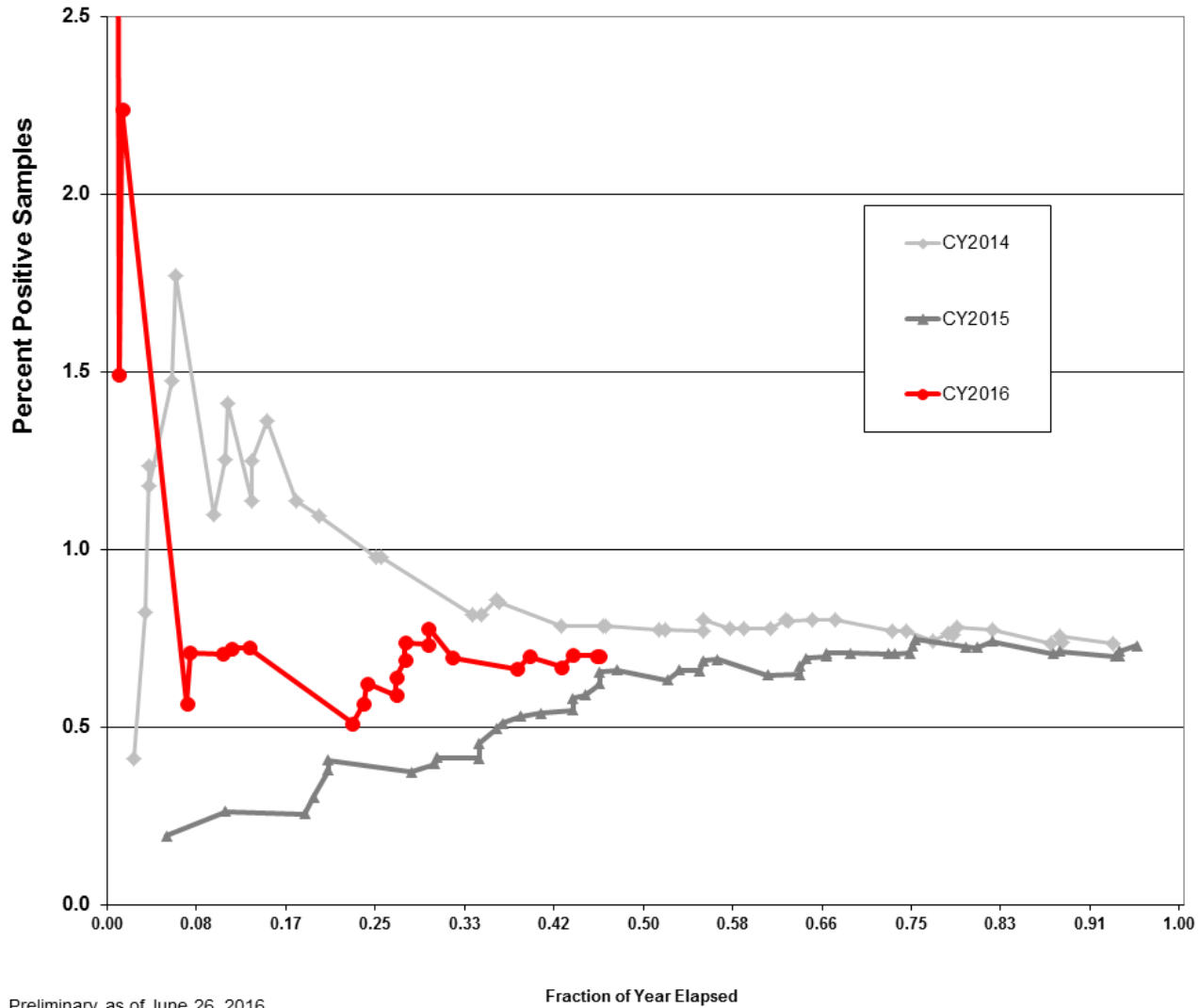
- One of the main remaining challenge for the beef industry
- I see issues with the written programs and particularly the implementation of the program regularly.
- There is confusion even at FSIS, particularly at the plant level and some districts.
- Because there is no increased in the number of recalls or FSIS baseline prevalence, the problem must be either limited, very low level of contamination or not detected.

**FSIS Raw Ground Beef  
Running Percent Positive *E. coli* O157:H7  
(2014 - 2016)**



Preliminary as of June 26, 2016

FSIS RGB Components (Trim)  
Running Percent Positive *E. coli* Top7 Serogroups  
(2014 - 2016)



Preliminary as of June 26, 2016

# Addressing Deficiencies in HEP

- A good written program that is *specific to the establishment*.
- No copying and pasting or getting someone to write the program for you.
- Only the people in charge of the plant's food safety can determine the possible products that needs to be removed in a HEP case.
- HEP is nothing but when the failure of the food safety system and how to address the failure.

# Addressing Deficiencies in HEP

- What is the purpose of the trim testing program?
- “You cannot test your way to food safety”
- Trim testing is final verification of the food safety system.
- XF and “untested trim for cooking only”
- It is not uncommon to find plants that do not test 40 or more % of their trim.
- How can you determine if your food safety systems worked based on limited information?



# Consequences of Unsupervised Food Safety

- Case 1:
  - Good written program
  - Good sampling program
  - Questionable test (detection) program
  - Did not hold any product with a positive CoA
  - When asked why “no one was looking”
  - This went on for months!
  - Where is the plant GM?
  - Where is the FSIS?; Do they not have any weekly meetings?
  - Lab role and why did not have illness related to release of “contaminated” product into commerce.

# Consequences of Unsupervised Food Safety

- Received a call from a beef plant asking for help
- “I have an event day and want to test subprimals per my program.”
- We discussed how to sample the subprimals.
- Send me the lab results so I can further assist you.
- Some subprimal lots tested positive for ECH7
- I saw the results for the same lots the next day
- Emailed and found out he was treating positives with lactic acid and re-sampling (rework).
- Of course you cannot do that! A positive results in the end of the story.

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## Research Note

# Evaluation of Lactic Acid as an Initial and Secondary Subprimal Intervention for *Escherichia coli* O157:H7, Non-O157 Shiga Toxin–Producing *E. coli*, and a Nonpathogenic *E. coli* Surrogate for *E. coli* O157:H7

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# The Design

- Chilled beef subprimals
- Inoculated with 6.0 logs CFU/cm<sup>2</sup> of surrogates, *E. coli* O157 and non-O157 *E. coli*
- Treated with lactic acid
- Treated again with lactic acid (rework)

# Results (Starting load = 6.0 logs CFU/cm<sup>2</sup>)

Inoculum	Log CFU/cm <sup>2</sup> After the 1st	Reduction	Log CFU/cm <sup>2</sup> After the 2nd	Reduction
Surrogates	3.6	1.4	2.6	1.0
<i>E. coli</i> O157	4.4	1.6	3.2	1.2
Non-O157 <i>E. coli</i>	4.4	1.6	3.6	0.8

Both the initial and secondary lactic acid treatments effectively reduced counts of pathogenic and nonpathogenic strains of *E. coli*. Repeated application of the same intervention is justified.

# Results (Starting load = 6.0 logs CFU/cm<sup>2</sup>)

Inoculum	Log CFU/cm <sup>2</sup> After the 1st	Reduction	Log CFU/cm <sup>2</sup> After the 2nd	Reduction
Surrogates	3.6	1.4	2.6	1.0
<i>E. coli</i> O157	4.4	1.6	3.2	1.2
Non-O157 <i>E. coli</i>	4.4	1.6	3.6	0.8

Reduced does not mean eliminate!  
It is NOT a kill step

# Results (Starting load = 6.0 logs CFU/cm<sup>2</sup>)

Inoculum	Log CFU/cm <sup>2</sup> After the 1st	Reduction	Log CFU/cm <sup>2</sup> After the 2nd	Reduction
Surrogates	3.6	1.4	2.6	1.0
<i>E. coli</i> O157	4.4	1.6	3.2	1.2
Non-O157 <i>E. coli</i>	4.4	1.6	3.6	0.8

The level of reduction is a function of the load.

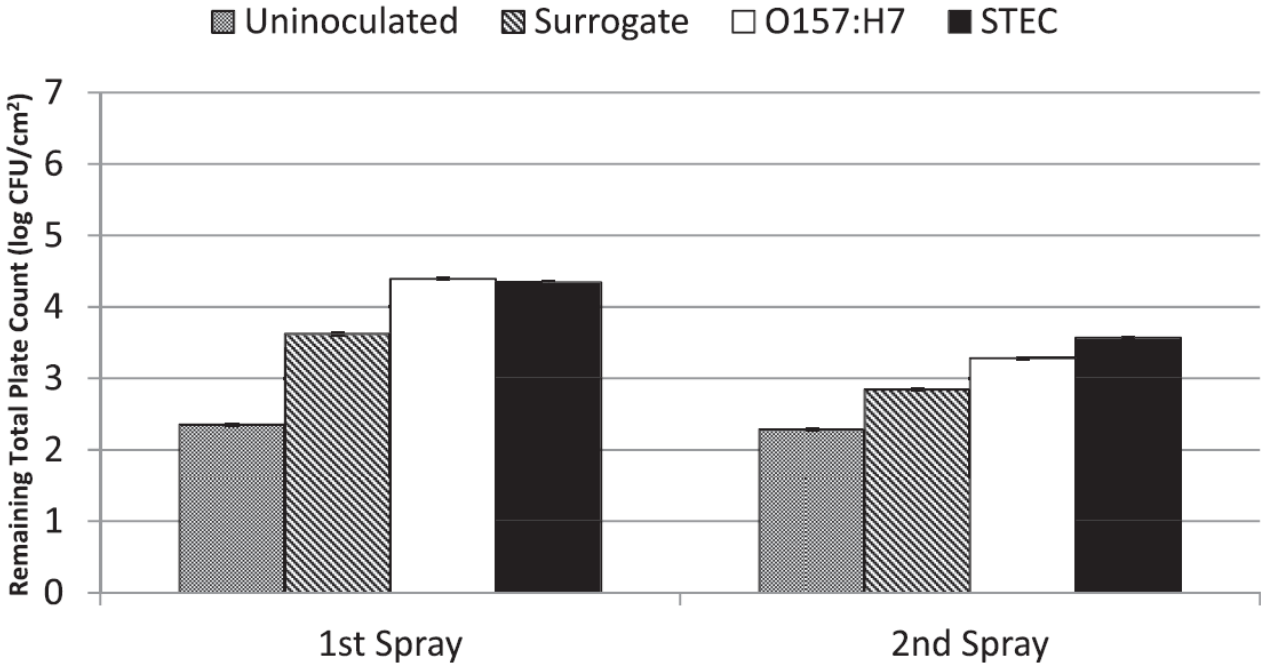


FIGURE 1. Differences in total plate counts after the first and second lactic acid application on sections of chilled beef briskets and peeled beef knuckles inoculated with cocktails of *Escherichia coli* surrogates, *E. coli* O157:H7, or Shiga toxin-producing *E. coli* (STEC) at initial levels of 6.0 log CFU/cm<sup>2</sup>.



# Case 3

- A person in charge of food safety for a beef plant calls and has questions about test results and whether he/she should run culture confirmation.
- After learning about the testing platform, I recommend that he should not.
- What does your program say? He did not know!
- What are these samples? Bench trim! (@40% of the lots tested positive)!
- Subprimals?
- Validated intervention?
- Over 70% of the subprimal lots tested positive
- Source of subprimals?
- What would have happened if he/she had not called?

# Bench Trim

- Options:
  - Do not test – send to cooker
  - Test only if microbiological independence has been established. (by applying a validated intervention AFTER trim is generated) If not, a validated intervention after trimming.
  - Medium to small processors probably do not have a good understanding the subject.

# When to Notify FSIS

- ?
- In the spirit of transparency, as soon as