Intervention Strategies for Control of *Campylobacter* during Poultry Processing

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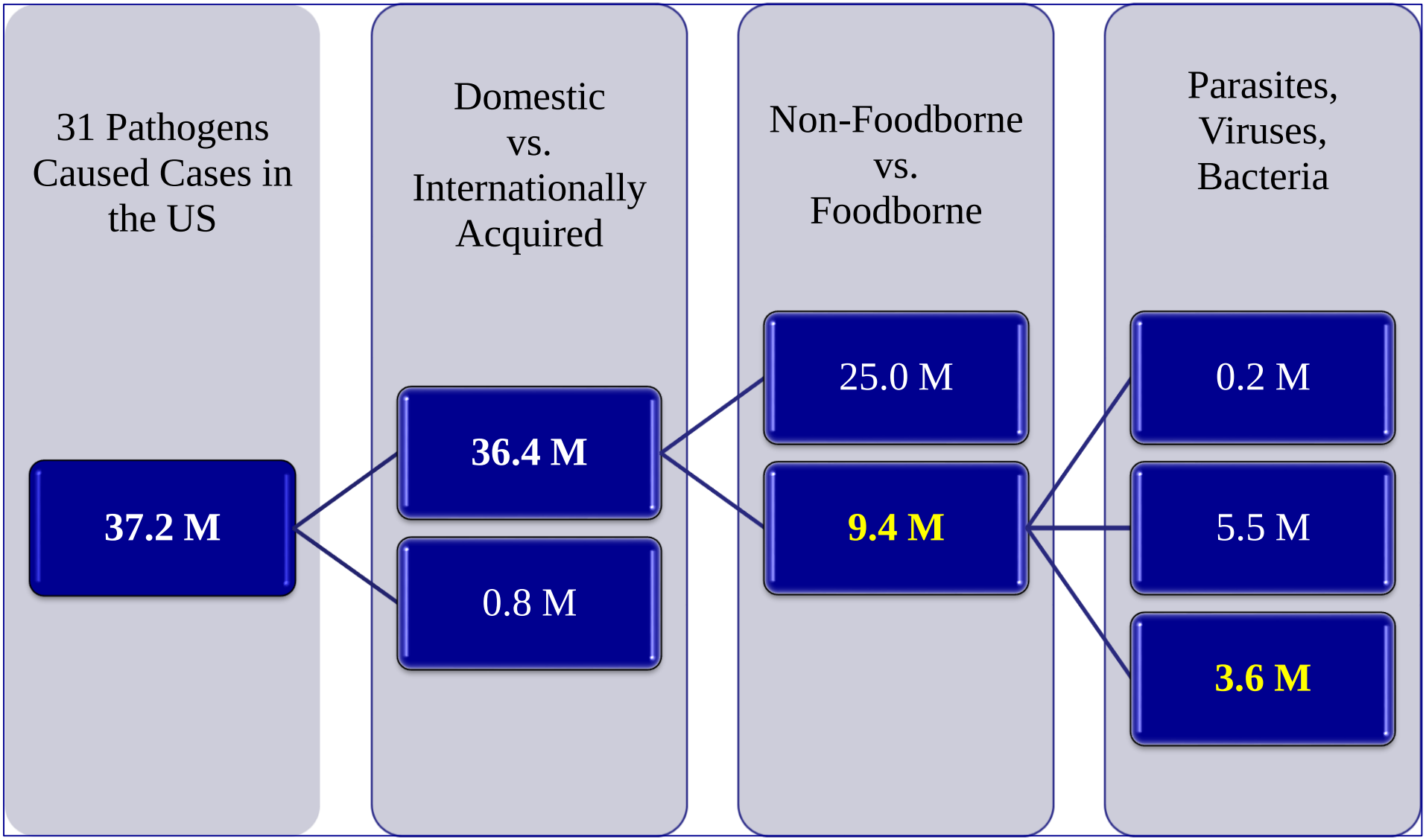
CDC Estimates



Scallan *et al.*, 2011

Why Poultry ?

- Contaminated poultry has the greatest public health impact among foods
- A few facts as per published reports on poultry:
  - Estimated $2.4 billion in annual disease burden
  - 1.5 million illnesses (17% of total)
  - 11,952 hospitalizations (22% of total)
  - 180 deaths (13.5% of total)
- Appears twice in the top 10 as a source of significant disease burden
  - *Campylobacter* and *Salmonella*

(Batz et. al, 2011)

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Ranking the Disease Burden of 14 Pathogens in Food Sources in the United States Using Attribution Data from Outbreak Investigations and Expert Elicitation†

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ABSTRACT

Understanding the relative public health impact of major microbiological hazards across the food supply is critical for a risk-based national food safety system. This study was conducted to estimate the U.S. health burden of 14 major pathogens in 12 broad categories of food and to then rank the resulting 168 pathogen-food combinations. These pathogens examined were *Campylobacter*, *Clostridium perfringens*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, norovirus, *Salmonella enterica*

Poultry-related campylobacteriosis

- *Campylobacter*–contaminated poultry responsible for $1.3 billion in costs of illness annually.

- *Campylobacter* in poultry causes more than 600,000 estimated cases of illness annually ~ 72% of the poultry related illnesses.

Emerging Pathogens Institute, University of Florida 2011

Campylobacter spp.

- Gram negative, short rods
- Motility
  - Cork screw motility
  - Changes with age of culture
- Thermophilic (42-43°C)
  - Grows in the GI tract of poultry
  - Body temperature ideal for growth
- Microaerophilic conditions (5%-O_2, 10%-CO_2, 85%-N_2)
- Difficult to culture and isolate – VBNC
  - Coccoid shape

Campylobacter Infection

- Fecal-oral route
- No immune response elicited in poultry
  - Serves as a good host
- Typical symptoms:
  - Diarrhea, fever, cramping, bloody stool, no nausea
  - Incubation 2-10 days
  - Duration 2-7 days
- Implicated in Guillain-Barre Syndrome
  - Severe cases (1 or 2 out of 100,000)

Poultry Meat Consumption

- Recent growth due to:
  - Negative press associated with beef industry
  - High beef prices
- U.S. menu items with poultry as an ingredient has increased 12% in past three years
  - (Mintel Menu Insights, May 2012)

✓ **Safety of these products is still crucial!**

Time to act on it !!!!

PERFORMANCE STANDARDS

- Effective July 2011
  - New performance standard for *Campylobacter*
    - 15.6 % (8 out of 51 sample set)- Post-chill in young chicken
    - 0.79% for turkeys (4 out of 56 sample set)
- Plant shut down?
  - Data published online
  - Down time

What to do? And….. How?

Recommendations to monitor, evaluate, and revise → critical components for kinds of innovations undertaken by FSIS

Where are the issues?

Farm?

- *Campylobacter* is found in the tract of most poultry.
- No symptoms of infection, easily within flock.
- Wide variety of sources of contamination (insects, rodents, soil, water, farm animals, human traffic).
- Extremely difficult to prevent *Campylobacter* from infecting new poultry flocks.

Where are the issues?

Consumers?

- No methods to test for *Campylobacter* contamination in purchased raw poultry.

- Poultry is assumed safe when cooked.
- Source of infection may be out of consumer's control – Restaurants etc….

Where are the issues?

<u>*Campylobacter* control falls on processing plants</u>

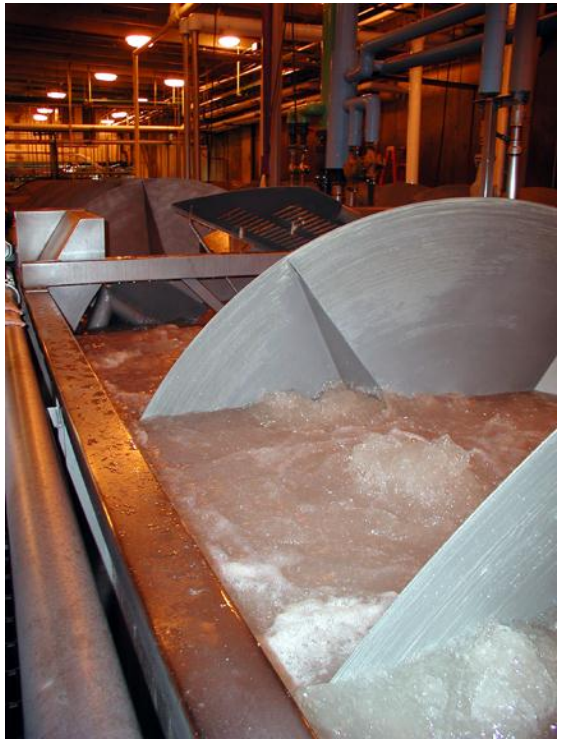
- Cross contamination at a minimum.
- Regular testing for prevalence and levels of *Campylobacter*.
- Antimicrobial interventions can be applied to raw product.

Current Plant Treatment Points

- Scalders
- Inside-Outside Bird Washers
- Pre-chillers
- Main chillers
- Post-chill interventions

Carcass Chilling

- Reduce carcass temperature below 40°F/4.4°C within 4 hours of slaughter
  - Immersion
  - Air chilling
- Three main types:
  - Drag
  - Screw/Auger
  - Rocker



- Most chillers are counter-flow or counter-current
- Eliminate product pile-ups

!!!! The Challenge !!!!

Opportunity for cross-contamination!!!!

Need for reduction in bacterial accumulation and hence product contamination

- Chiller management
  - Temperature
  - pH
  - Water quality
- Antimicrobials

- No dripping/ lesser contamination
- Investment
- Lesser volumes of production

Commonly used antimicrobials

- Chlorine
- Other halogens – Bromine compounds
- Tri Sodium Phosphate
- Per Acetic Acid (PAA)
- Cetylpyridinium Chloride

INJURY vs. KILL

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Comparison of antimicrobials, application methods and processing steps against *Campylobacter* in processing plants

Treatments

- Solutions prepared and chilled to 10°C
  - DBDMH (50, 75, 100, 200, 300 ppm)
  - Sodium Hypochlorite (25 and 50 ppm)
  - Peracetic acid (100 and 200 ppm)
  - Negative & Positive Control
  - Hach Pocket Colorimeter II

Procedure

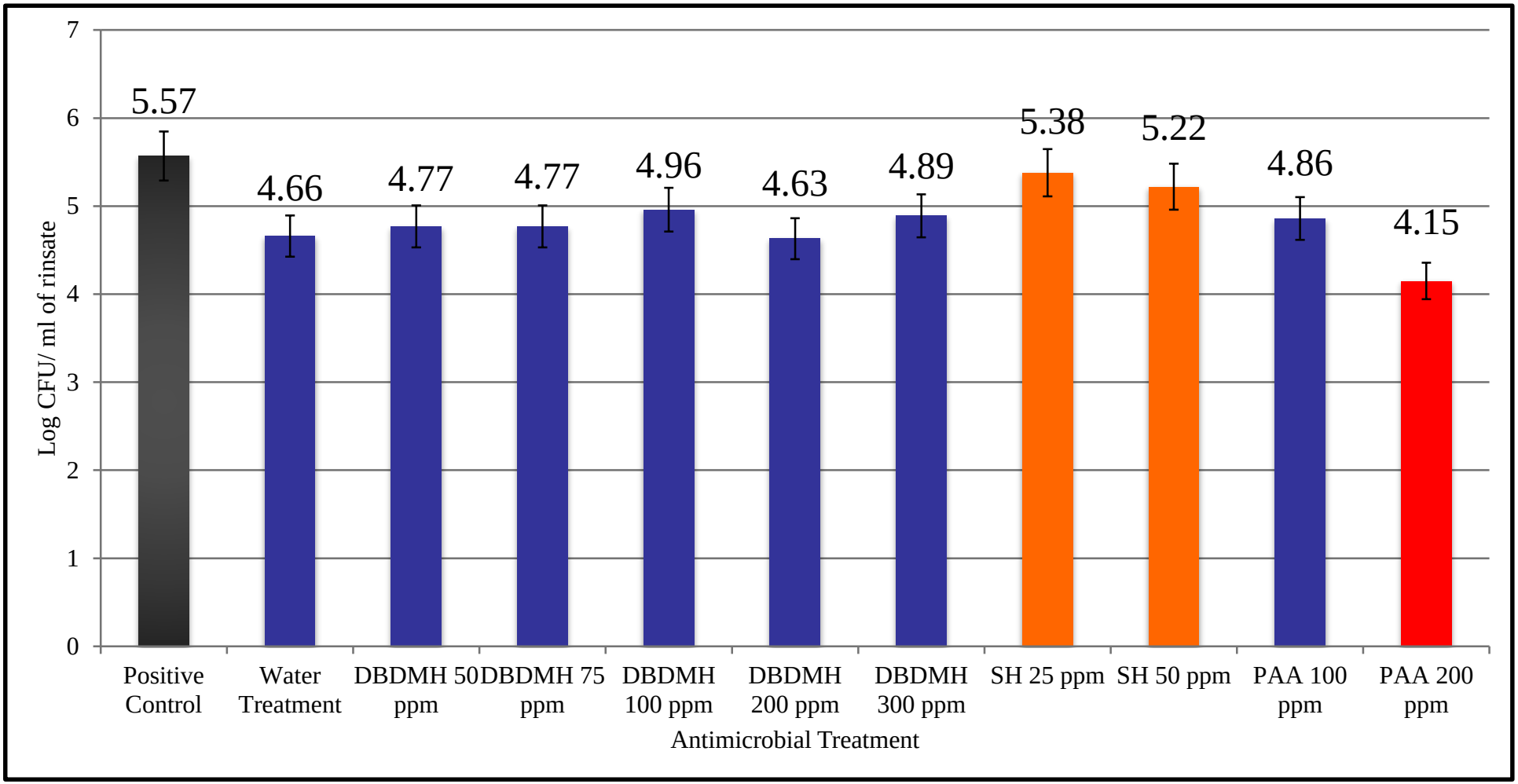
Inoculation: 10 mL *C. jejuni* (10^7 CFU/mL); 30 min attachment

Treatments: DBDMH (50, 75, 100, 200, 300), SH (25, 50), PAA (100, 200)

Immersion Application	Spray Application
• Immersed individually in a 5 gallon bucket • 6.05 L of antimicrobial • Time: 0, 30, 60, 90, 120 s • 0.25 mL plated onto *Campylobacter* Cefex agar	• Garden Sprayer with fan nozzle • 460 mL of antimicrobial • Carcass suspended in fume hood • 60 s of spray application

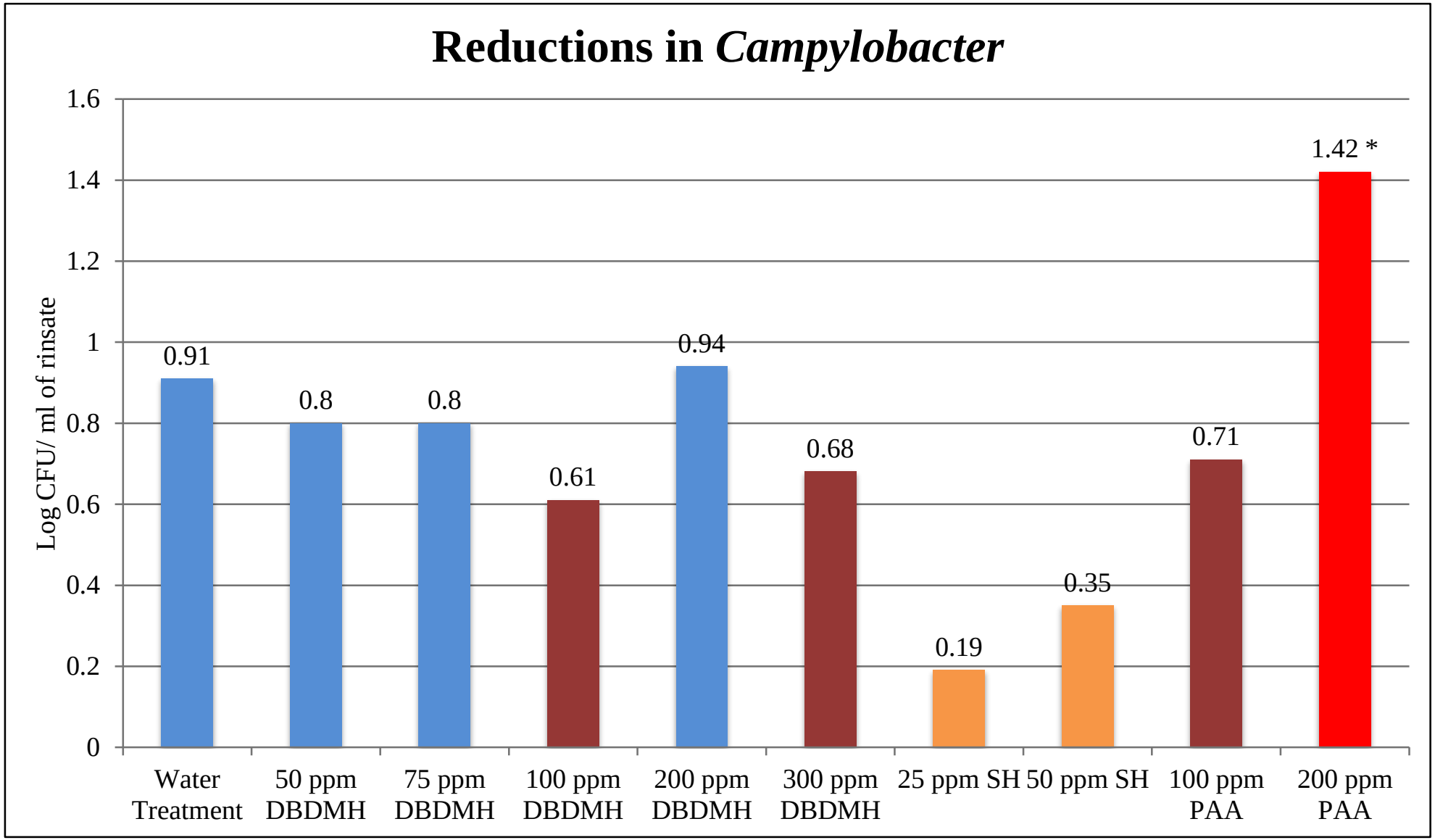
- 200 mL carcass rinse after application of antimicrobial

Immersion Application

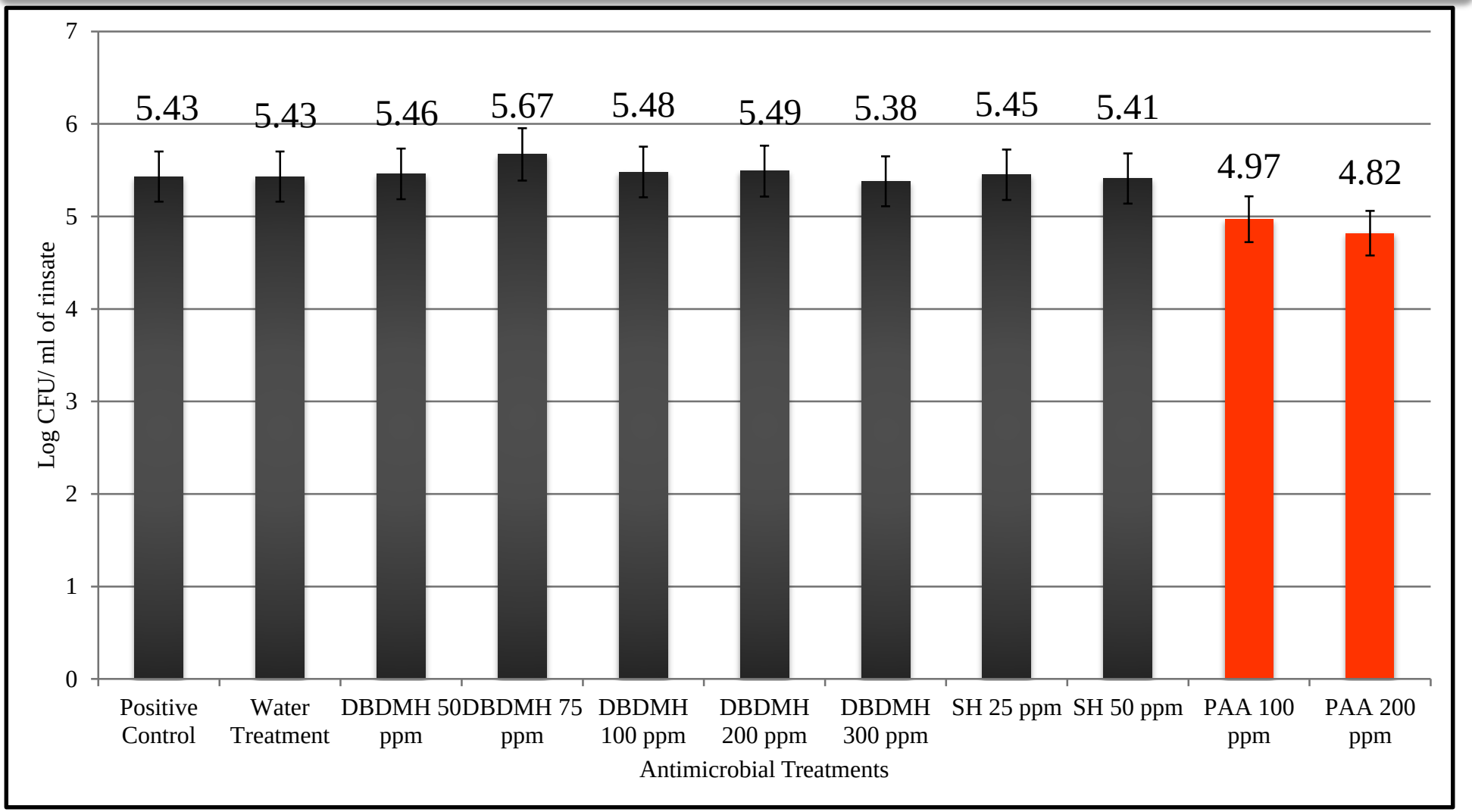


Survival populations ($\log_{10}$ CFU/mL of rinsate) of *Campylobacter jejuni* on chicken carcasses following immersion application with various antimicrobials.
DBDMH = 1,3-Dibromo-5, 5-Dimethylhydantoin; SH = Sodium Hypochlorite; PAA = Peracetic Acid; ppm = parts per million

Immersion Application



Spray Application

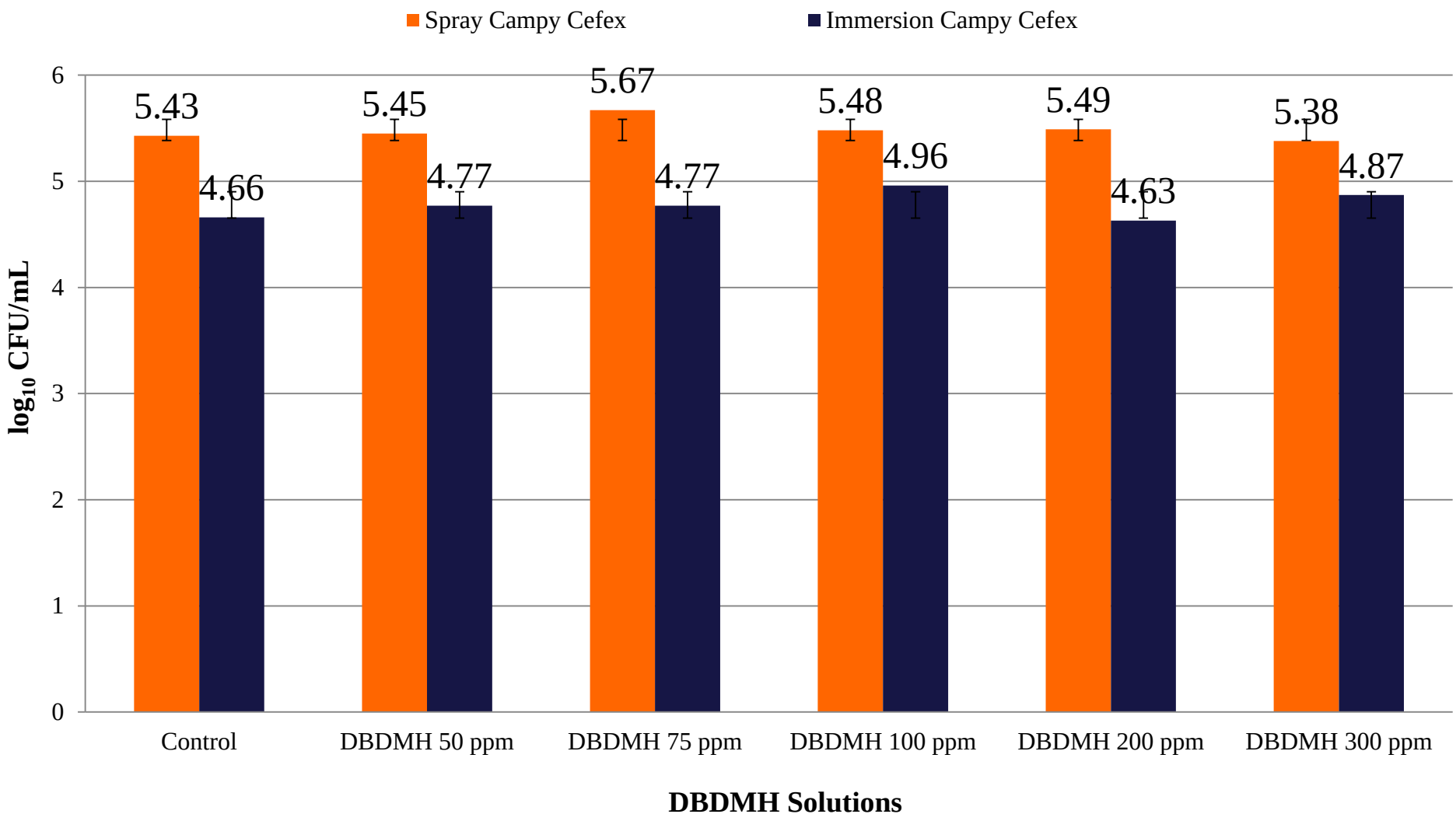


Survival populations (log_{10} CFU/mL of rinsate) of *Campylobacter jejuni* following spray application with various antimicrobials

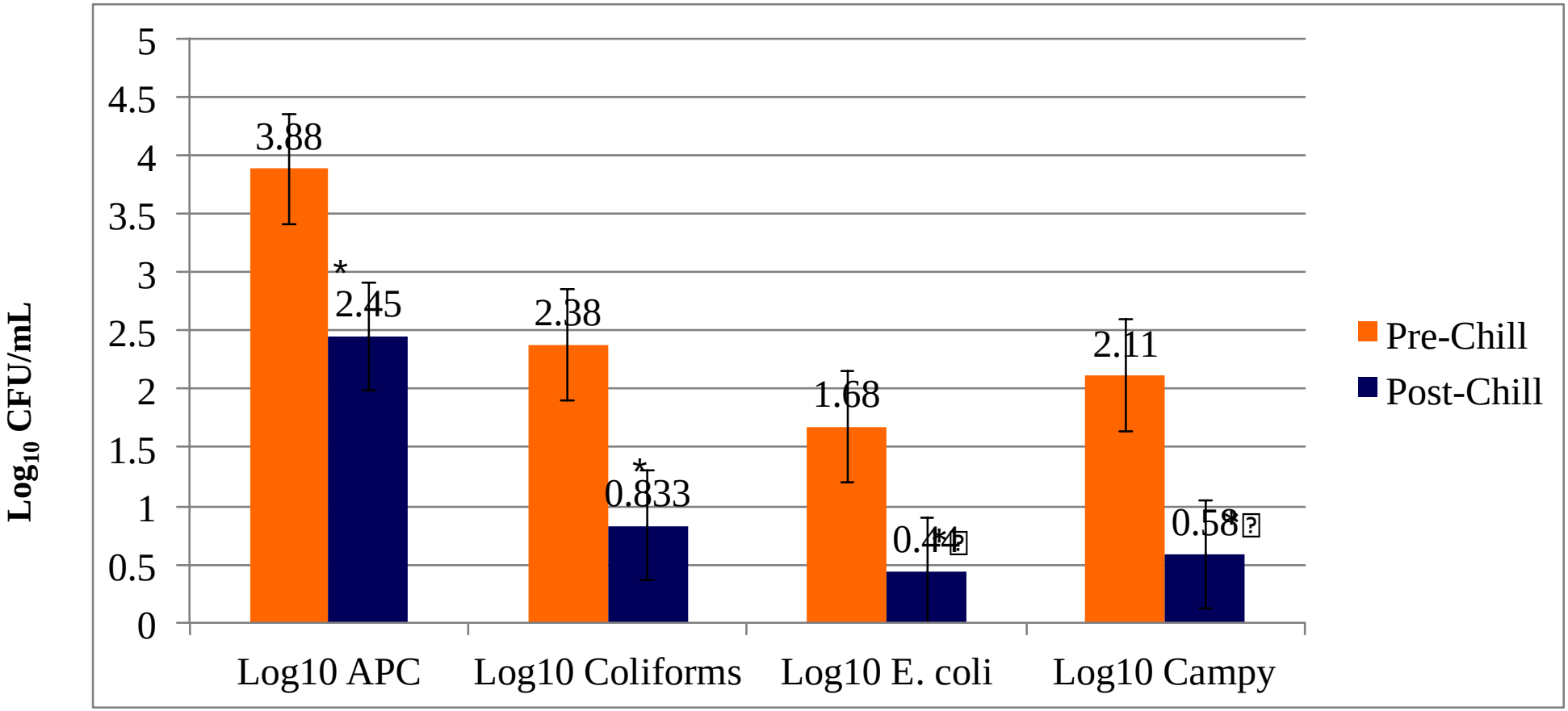
DBDMH = 1,3-Dibromo-5, 5-Dimethylhydantoin; SH = Sodium Hypochlorite; PAA = Peracetic Acid; ppm = parts per million

Spray v/s Immersion - DBDMH

Reduction of *Campylobacter jejuni* populations on poultry



DBDMH Chiller Field Trial



* Means are significantly different at (P > 0.05)

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Salmonella and Campylobacter Reduction and Quality Characteristics of Poultry Carcasses Treated with Various Antimicrobials in a Post-Chill Immersion Tank

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In Press, Accepted Manuscript — Note to users

Salmonella and *Campylobacter* Reduction and Quality Characteristics of Poultry Carcasses Treated with Various Antimicrobials in a Post-Chill Immersion Tank ☆

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http://dx.doi.org/10.1016/j.ijfoodmicro.2013.05.016, How to Cite or Link Using DOI

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Highlights

- Chicken carcasses were treated with antimicrobials in a post-chill immersion tank.
- Sensory analysis was done on chicken breast meat from each treatment.

Bibliographic information

Citing and related articles

Related articles

Farm and environmental distribution ...
2013, Research in Veterinary Science
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Pathogens on meat and infection in a...
2006, Meat Science
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Fitness of antimicrobial-resistant Ca...
2006, Microbes and Infection
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Workspace

Conclusions

- Immersion application significantly reduced aerobic bacteria compared to spray ($P \leq 0.05$)
  - 300 ppm immersion showed greatest reduction of *C. jejuni*
- Spray treatment showed no significant effect on *Campylobacter* ($P > 0.05$)
- Field trials showed significant reductions post-chill compared to pre-chill

Further Efforts

Develop a risk based approach to mitigate *Campylobacter* during poultry processing

Plant Surveys

- Six poultry processing plants to determine:
  - Production yield
  - Sanitary practices
  - Processing line design
  - Antimicrobial levels and steps
  - Pathogens tested
  - Corrective actions
- Survey Analysis:
  - Sampling procedure for each plant
  - Focus on microbial load throughout the processing lines

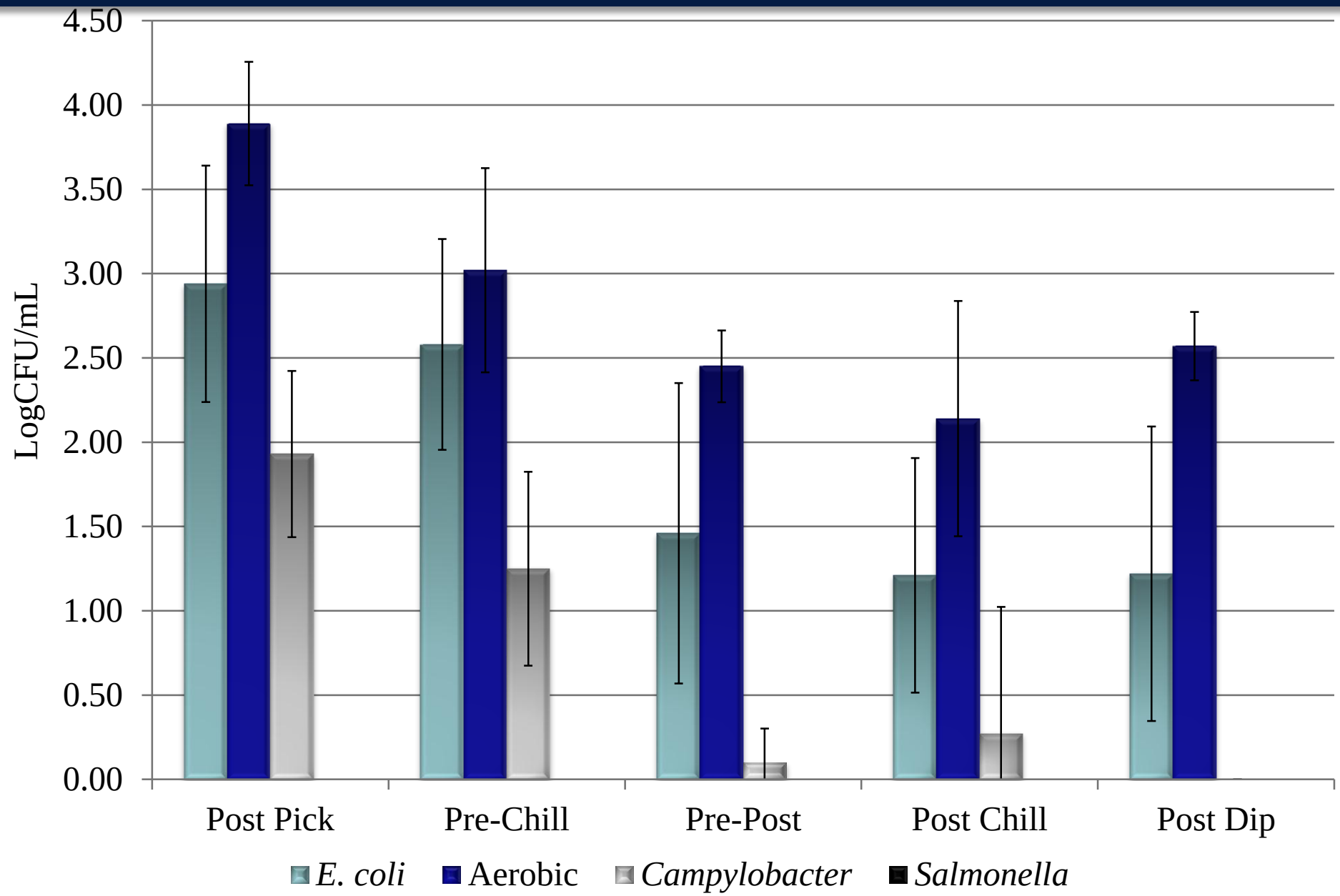
In-plant Sampling

- Sampling locations for bird rinses:
  - Post-Pick: After evisceration, before birds have enter the Inside-Outside Bird Washer
  - Pre-Chill: After birds have exited the IOBW, before entering the pre-chiller
  - Pre-Post: After birds have exited the pre-chiller, before they enter the main chiller
  - Post Chill: After birds have exited the main chiller, but before any post-chill intervention
  - Post Dip: After birds have exited the post-chill intervention

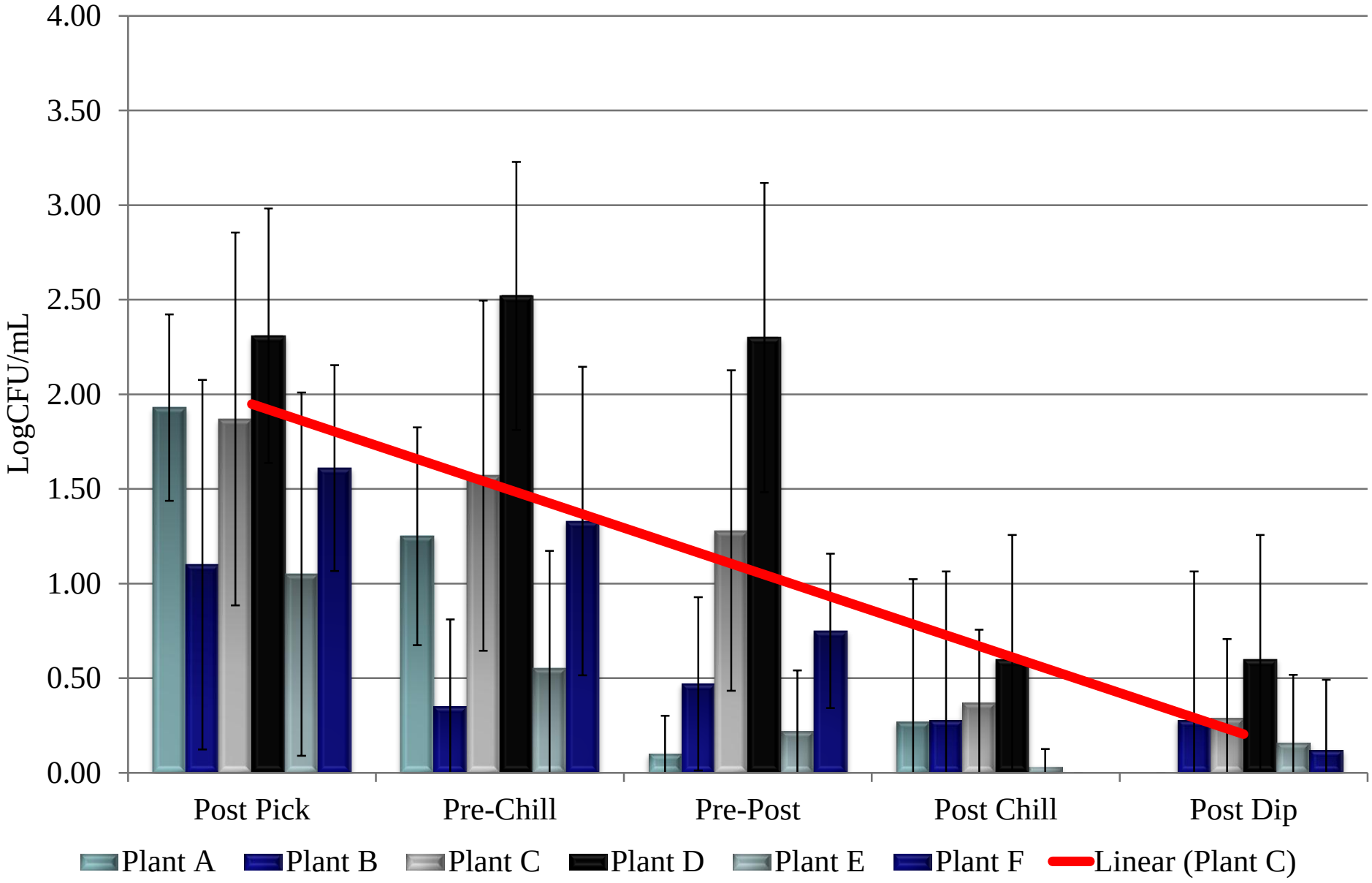
Sample Analysis

- Samples were transported back and analyzed within 4-6 h
- Plated on XLT-4, PCA, VRBA, and Campy-Cefex agar
- Enrichments Bolton Broth and re-streaked to determine prevalence of *Campylobacter*

Pathogen tracking



Campylobacter tracking



Overall Results

- *Salmonella* growth was inhibited by the antimicrobial measures in all plants
  - Initial plate counts only showing *Salmonella* colonies in manure and scalder samples
  - Enrichment showed *Salmonella* on several bird samples before any antimicrobial treatment, but no *Salmonella* was detected post-intervention

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Overall Results

- All plants showed significant reductions ($p<0.05$) of *Campylobacter* after antimicrobial treatment

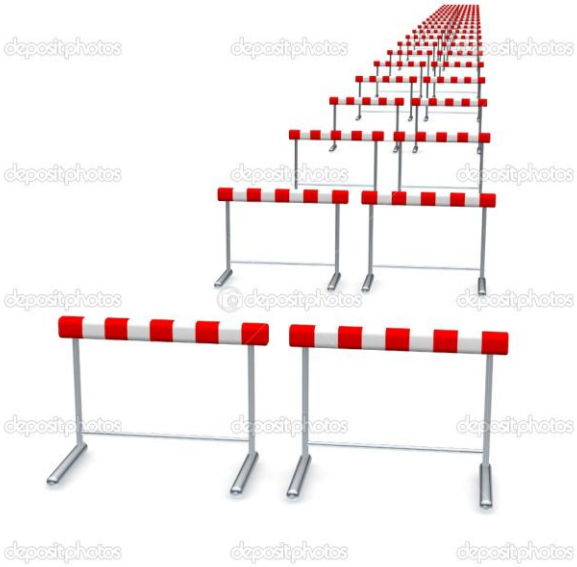
- Aerobic growth was also significantly ($p<0.05$) reduced by the antimicrobial treatment in all plants

Summary

- Plants are doing a good job with *Salmonella* control
- Irregular levels of *Campylobacter* on the birds and in the plant environment make it a challenge for control
- Water is a major source of contamination of the carcasses in poultry processing – VERY COMMONLY OVERLOOKED

Summary

- Not a one step fix:
  - Multi-hurdles approach
- Evaluate ongoing practices to maximize results:
  - Validations
  - Verifications
- Understand high risk areas – implement interventions



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