# Continuous Food Safety Innovation as a Management Strategy : Private Sector Perspective

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# Food Safety Innovation

- Food Safety and Brand Management
- Case Studies
  - *Salmonella* in poultry
  - *E. coli* 0157:H7 in ground beef
  - *Listeria monocytogenes* in RTE meats
- Public-Private alignment

# Food Safety and Brand Management

- Food safety is a “given”
- Systematic approach to food safety
  - Origination through consumption
  - Supply chain dynamics
- Public health focus
- Prerequisite programs
- HACCP

# *Salmonella*

- Centers for Disease Control (CDC) Data
  - 1.4 million illnesses caused by *Salmonella sp.*
    - 14,000 hospitalizations
    - 494 deaths
  - $3 billion annually
- FSIS Performance standards

# U.S. Poultry Industry Response

- Large variety of new/innovative *Salmonella* reduction strategies have been implemented
  - Pre-harvest
  - Processing plant

# Pre-harvest Interventions

- Goal is to reduce the carriage of pathogenic bacteria into the processing plant on the live animal
- Truly effective food safety programs must include pathogen control on the farm
  - Multi-hurdle approach is most effective

# Pre-harvest Interventions

- Salmonella-free pullet chicks
- Feed sanitation programs
- Biosecurity programs
- Pest control programs
- C & D programs
- Litter management programs
- Vaccination programs
  - Breeders and broilers
- Competitive exclusion products

# Pre-harvest Interventions

- Best Management Practices (BMPs)
- Good Manufacturing Practices (GMPs)
- Quality Assurance Programs
- HACCP-like Programs
- Voluntary (not federally regulated)
- Company specific
- **Effective interventions can achieve >50% reduction in *Salmonella* load**

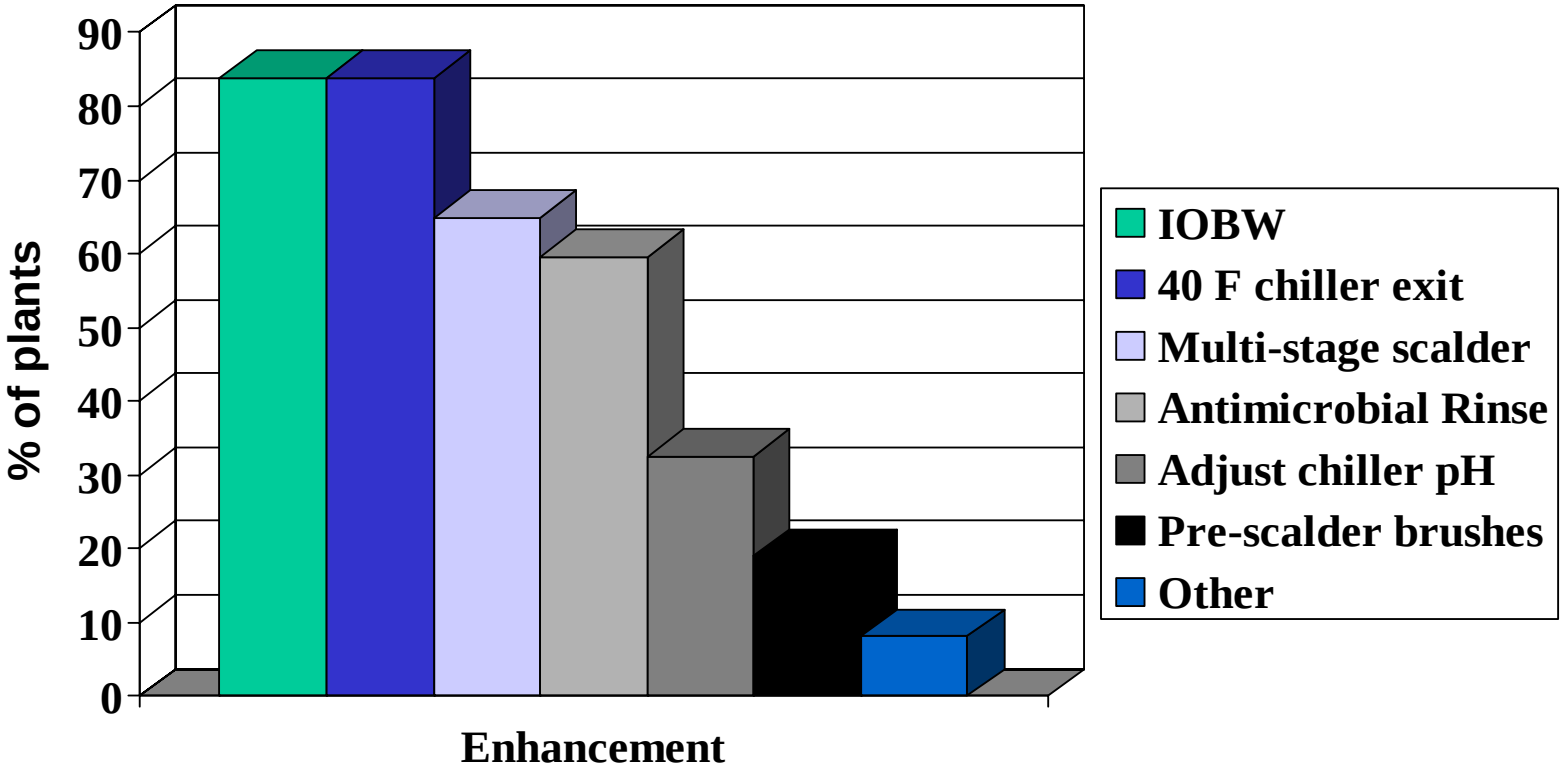
# Processing Plant Interventions

- Regulated by the US Department of Agriculture – Food Safety and Inspection Service (USDA-FSIS)
- Multi-hurdle approach to pathogen reduction
- **Effective in-plant interventions can achieve >50% reduction in *Salmonella* load post-chiller**

# US Broiler Plant
# Food Safety Enhancements

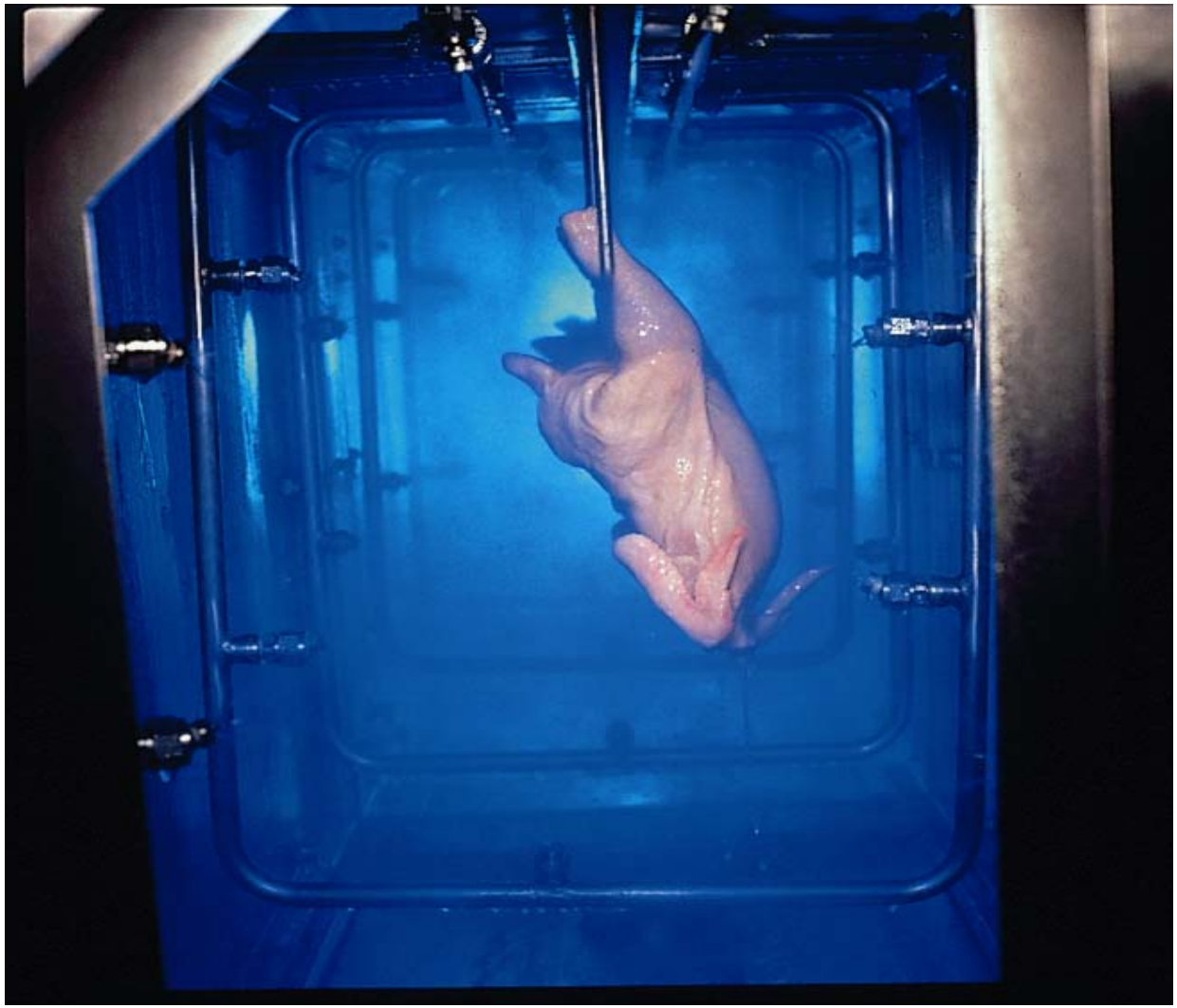
- Pre-scalder brush/rinse cabinets
- Multi-stage scalders
- Inside-Outside Bird Washers (IOBW)
- Pre-chill antimicrobial rinses other than chlorine
- Optimization of chiller chlorine levels and pH
- Immersion chillers achieving 40 F carcass temperatures post-chill

# Food Safety Enhancements



# Poultry Spray Cabinet

# SANOVA Poultry Carcass Spray system

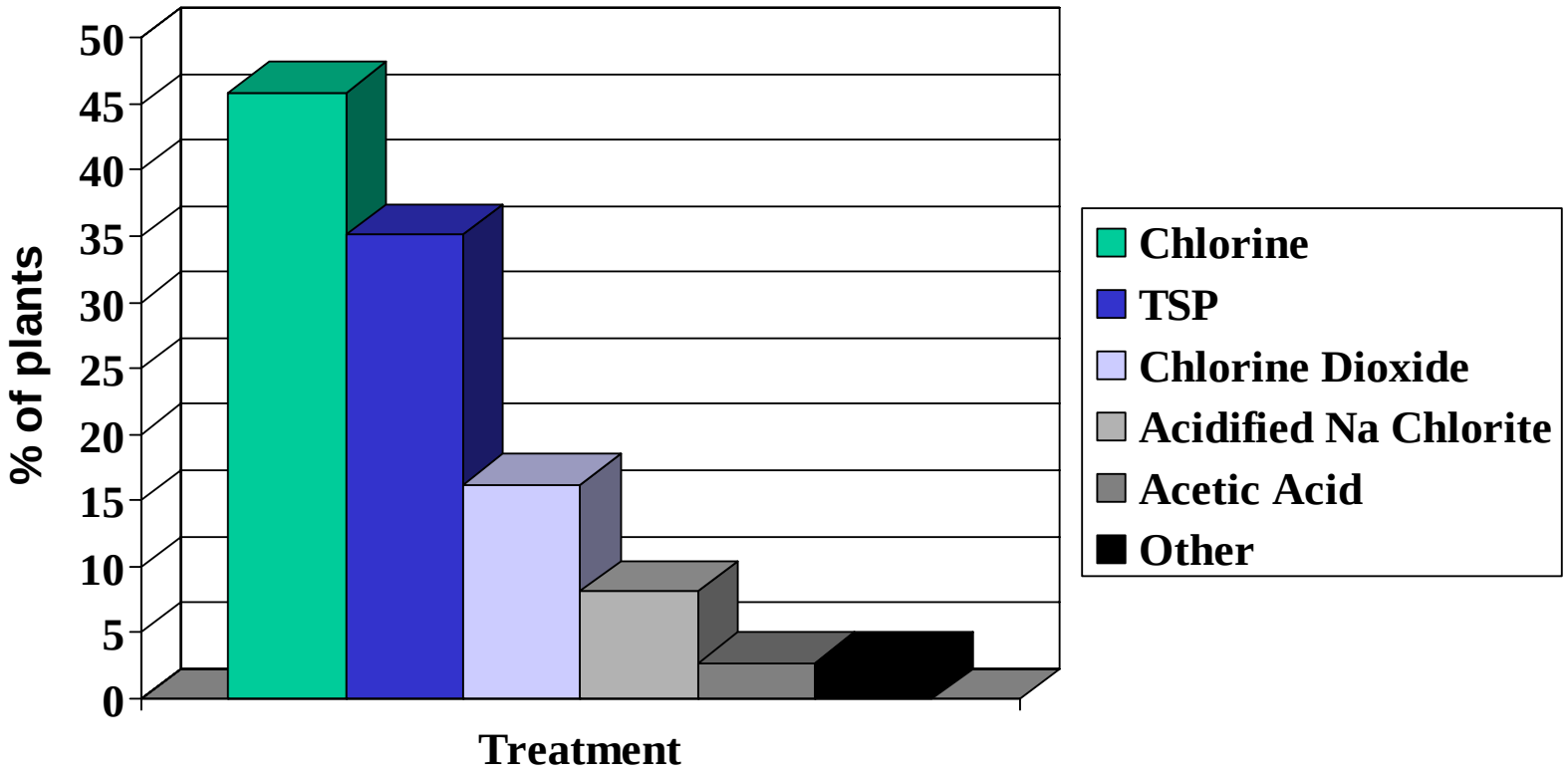


# Poultry Immersion Tank System

# US Broiler Industry
# Pre-Chill Carcass Antimicrobial Interventions

- Chlorine
- Trisodium Phosphate (TSP)
- Chlorine Dioxide
- Acidified Sodium Chlorite (Sanova)
- Acetic Acid

# Pre-chill Carcass Antimicrobial Treatments



# *E. coli* 0157:H7

- ***E. coli* O157:H7 zero tolerance policy initially stymied progress**
- **Industry initiatives to treat food safety as a non-competitive issue and share best practices led to improvement**
- **Regulatory policy modifications allowed industry to adapt and improve**

# 0157:H7 Background

- **Several large outbreaks associated with undercooked ground beef**
- **Zero tolerance for fecal contamination of beef carcass strictly enforced, 1993**
- ***E. coli* O157:H7 declared an adulterant in ground beef, 1994**
- **Initial industry reaction to onerous new regulatory policy was negative**
- **The zero tolerance policy created a 6 – 8 year window of reliance upon a faulty premise of end-of-line finished product testing**

# Data Leads to Understanding of the Problem

- FSIS zero tolerance policy established prevalence in ground product, assumed to be very low initially.
- Early focus of control was on carcass:
  - regulatory zero tolerance for fecal contamination,
  - trimming carcass to meet fecal zero tolerance,
  - testing carcass for generic *E. coli*,
  - carcass interventions were studied and implemented.

# Industry Initiatives Led to Change and Improvement

- Food Safety determined a non-competitive issue
- Significant investments in research on *E. coli* O157
- Implementation of valid interventions
- Customer-Supplier audits
- Expanded and robust *E. coli* O157 trim testing programs

# Developed and Implemented Best Practices

- **Sanitary practices continually improved and implemented**
- **Significant challenges to modify practices or physical processes:**
  - **Management commitment**
  - **Employee willingness**
  - **Likely capital expenditures**
- **Cooperation among all segments of value chain**

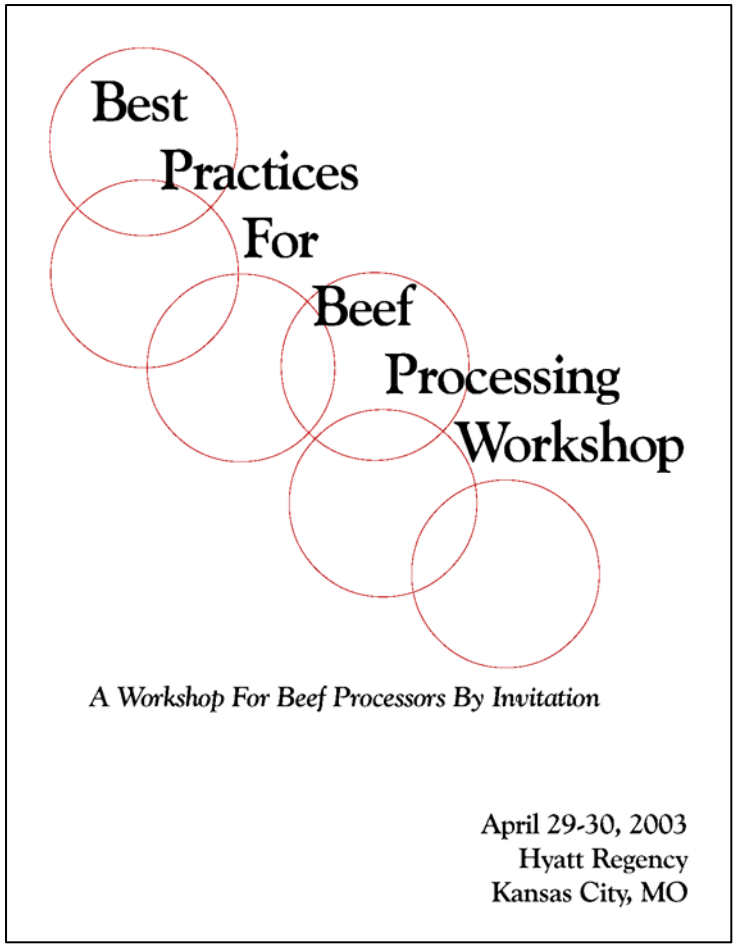
# Beef Best Practice Efforts

- Developed by the Beef Industry Food Safety Council (BIFSCO)
  - Best Practices for Producer Resource Guide
  - Best Practices for Beef Slaughter
  - Best Practices for Processing Raw Ground Beef Products
  - Best Practices for Vacuum-packed Sub-primals
  - Best Practices for Pathogen Control During Tenderization/Enhancing of Whole Muscle Cuts
  - Food Service Best Practice
  - Best Practice for Retail Operations Producing Raw Ground Beef

www.bifsco.org/bestpractice.aspx

# Post Harvest Technologies

- Sanitary slaughter practices
- Sanitary hide removal
- Spot cleaning
- Pre-evisceration organic acid rinse
- Thermal carcass treatment
- Chilled carcass treatments
- Hide Washing



## HARVEST

# Hide-on Carcass Wash

The first intervention in the battle against pathogens.

- First North American beef processor to install hide-on carcass wash equipment in all U.S. fed-cattle plants
- High-pressure, antimicrobial wash of external hide
- Process carefully monitored by computerized system
- Before-and-after test swabs indicate reduction in microbial load

## HARVEST

# Carcass Mapping

The most effective route to reducing microbes.

- Procedure designed by USDA scientists
- Carcass mapping utilized to monitor and control the food safety interventions in place

## HARVEST

# Hide Removal

Protecting our product, our people and your profitability.

- Employee safety
- Food safety

**HARVEST**

# Thermal Pasteurization

Heading off harmful pathogens at the source.

- Thermal pasteurization is one of the most effective antimicrobial interventions in the industry
- Cargill Meat Solutions co-developed this process*

# HARVEST

## VerifEYE®*

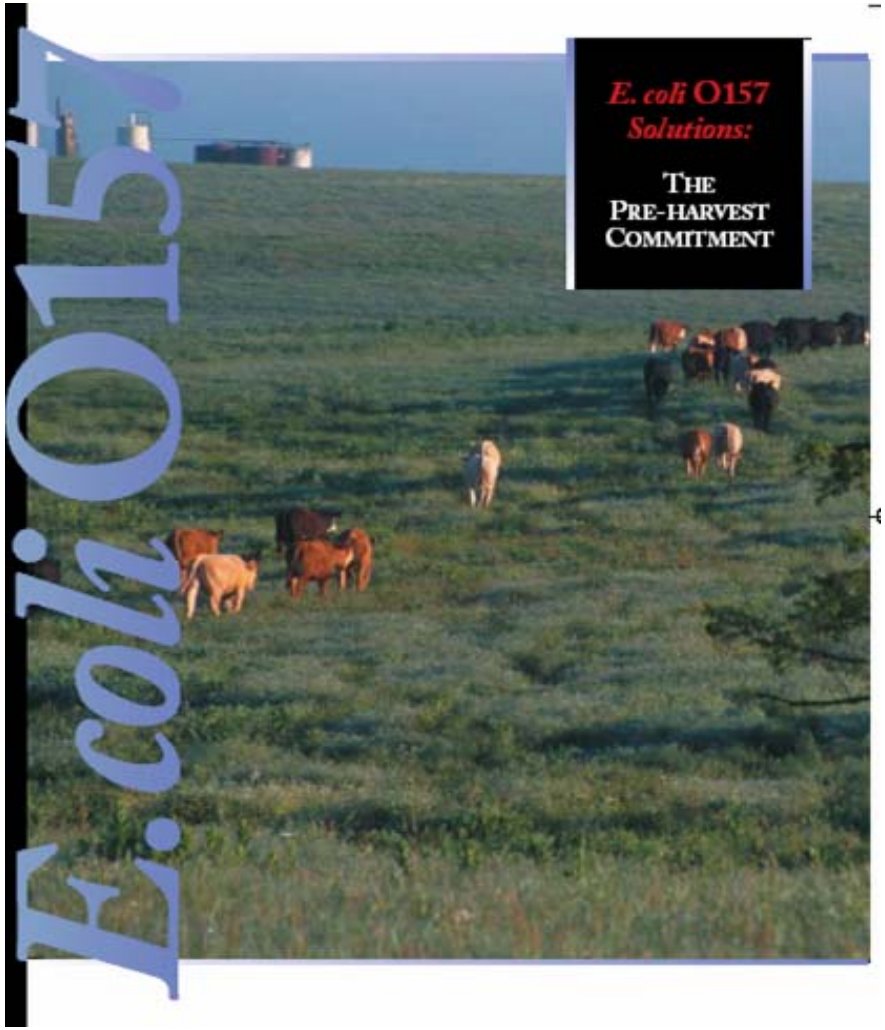
Final inspection reduces risk and increases peace of mind.

- First company to install VerifEYE® Carcass Inspection System™ technology
- Handheld devices enable precision inspection
- Fluorescence technology helps detect chlorophyll on meat surfaces
- High-tech image processing offers instant detection of contamination

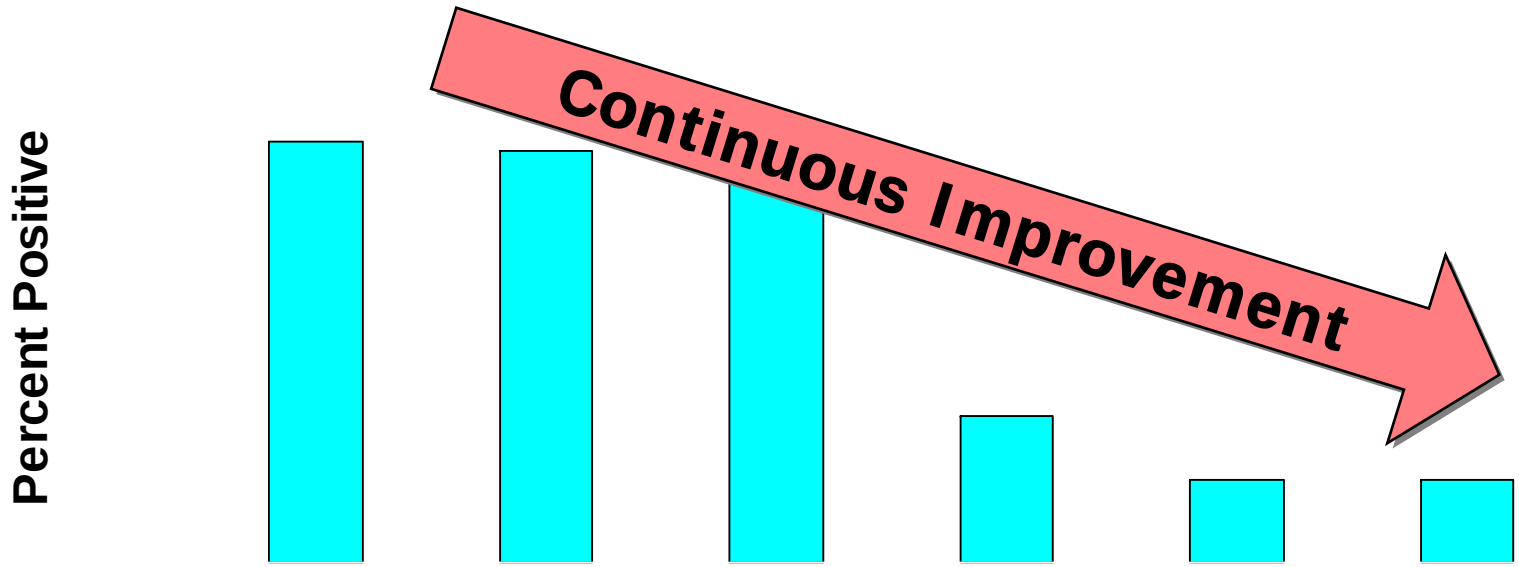
**VerifEYE® is a registered trademark of eMerge Interactive, Inc.*

# Pre-Harvest Actions

- AMIF, NCBA, USDA and others actively funding research
- BIFSCO E. coli Summit
- Basic info guide developed for producers
- Distributed through state BQA programs

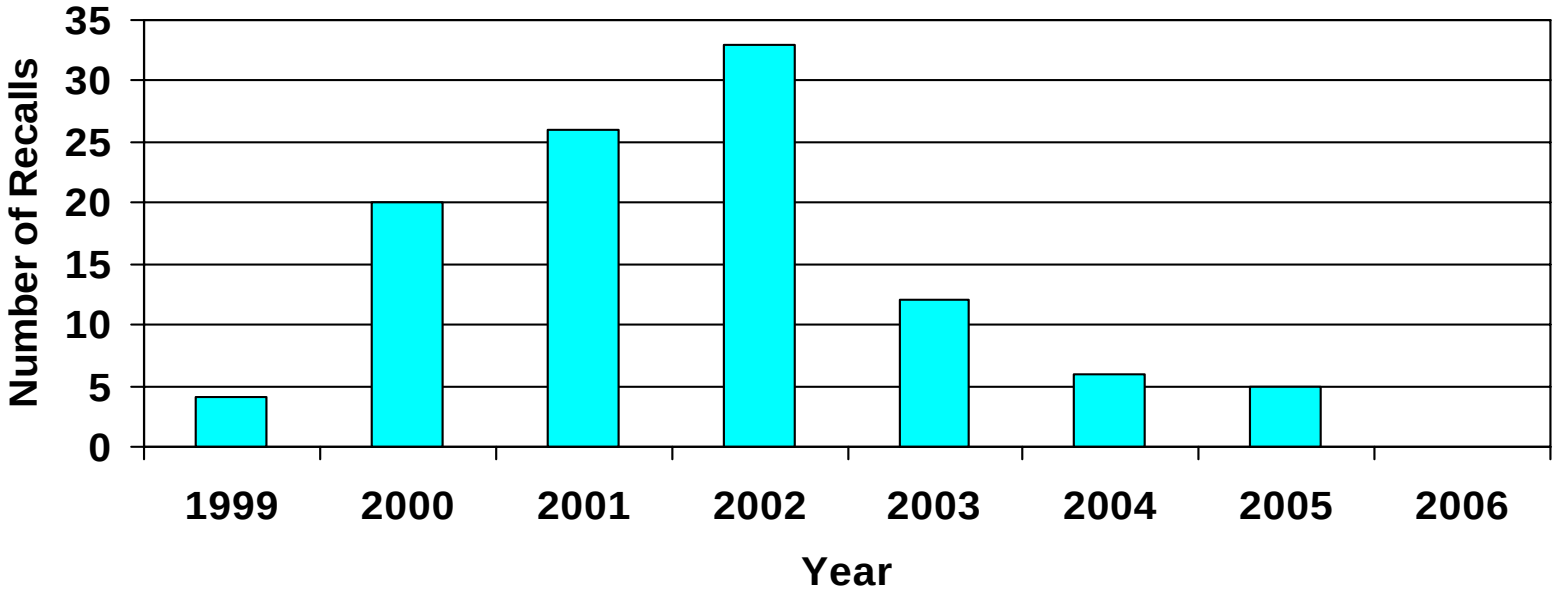


# Prevalence of *E. coli* O157:H7 in Ground Beef*



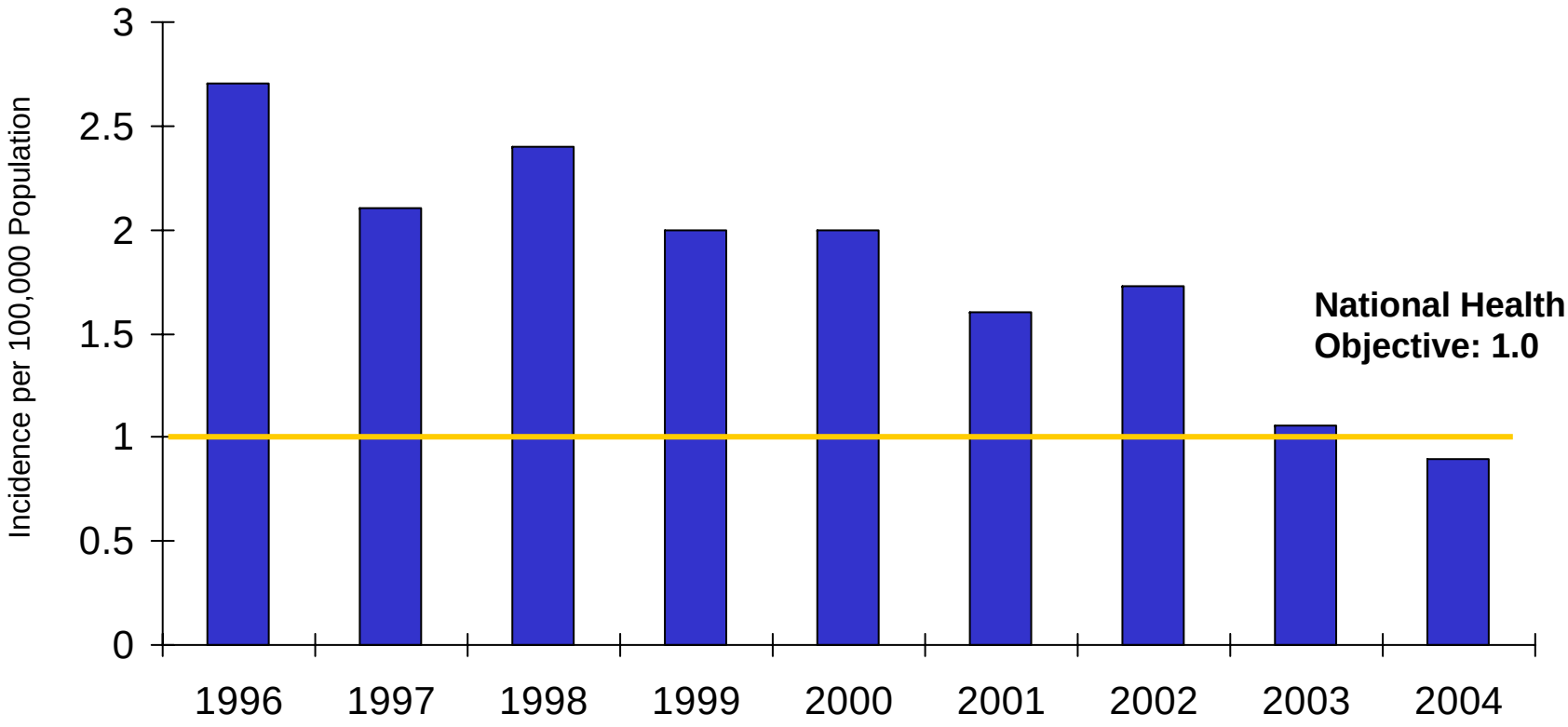

* **Results of raw ground beef products analyzed for *E. coli* O157:H7 in federal plants.**

# Recalls for Ground Beef
# *E. coli* O157:H7*




*No recalls for 2006 as of 2/17/06.

# Incidence of Foodborne Illness 1996-2004: *E. coli* O157*




*Preliminary FoodNet Data on the Incidence of Foodborne Illnesses --- Selected Sites, United States, 2004

# *Listeria monocytogenes* in RTE Meats

- *L. monocytogenes* (LM) contaminates ready-to-eat products after processing but before package closure
- If no LM multiplication, typically no health risk
- If no LM in the hermetically package, also no health risk (unless recontaminated!)
- Combination of growth-inhibiting formulation or process **and** post-lethality treatment results in the greatest reduction in risk

# Addressing the Risk of *Listeria monocytogenes*

- The Problem:
  - Characteristics of *Listeria*
  - Risks to consider
  - Products that support growth are high risk
- The Solutions: Control strategies
  - Focus on high-risk foods
  - Environmental control
  - Formulation changes
  - Retail/deli practices
  - Consumer education

# Methods to Reduce the Risk from *Listeria* in Food*

- Prevent inadvertent contamination
- Inhibit Growth
- Remove contamination

# What *NOT* to rely on for safety

- Finished product testing for pathogens
- Proper handling and refrigeration
- Modified atmosphere packaging
- Pasteurization or irradiation alone

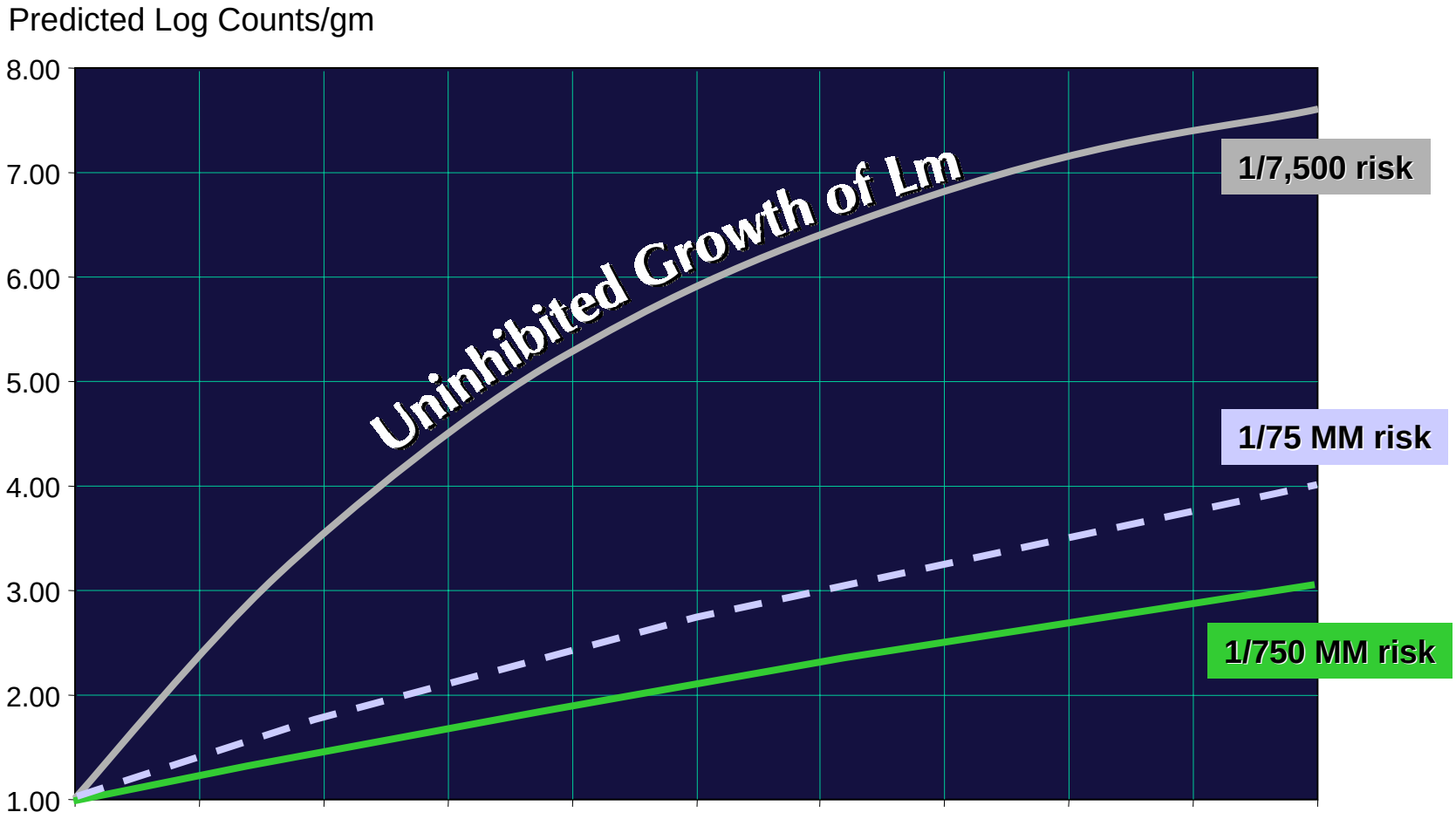
# Logic Behind Environmental Control Program

**Finished product testing has significant limitations.**

**Probability of Missing Contamination**

| *Number of Samples Tested* | *% Contamination in Lot* | | | |
|---|---|---|---|---|
| | *10%* | *2%* | *1%* | *0.5%* |
| 3 | 73% | 94% | 97% | 99% |
| 10 | 35% | 82% | 90% | 95% |
| 60 | <0.5% | 30% | 55% | 74% |
| 120 | <0.5% | 8.5% | 30% | 55% |
| 180 | <0.5% | 2.6% | 16% | 41% |
| 240 | <0.5% | 0.8% | 9% | 30% |

# *Listeria* Growth Inhibition
# Estimated Benefit to Public Health*




*Based on Growth Model and ***median*** mortality risk
for neonates published in FDA/USDA risk analysis Figure IV-5

# What we know about control

- Temperature
  - Pasteurization kills *Listeria* but recontamination is possible before packaging
  - Strict refrigeration <35°F reduces growth rate
- Atmosphere has little effect on growth
- Formulations inhibit growth
  - pH to <4.4
  - Salt/water activity  <0.92
  - Antimicrobials (diacetate, sorbate, benzoate)
  - Combinations of factors
    - e.g. pH <5.5 Aw <0.95

# “Low Risk” Foods

- 2004 Petition to allow tolerance for low levels of *Lm* in foods that do not support growth
- Prepared foods that:
  - Held at or below 30°F
    - Ice cream and frozen foods
  - pH $\leq$ 4.4
  - Water activity $\leq$ 0.92
  - Scientific evidence demonstrates food does not support growth
    - Combinations of reduced pH & Aw
    - Foods with added microbial inhibitors


# “High-Risk” Foods

- Support rapid growth
  - Aw>0.95, pH >5.5
- Ready-to-eat
- Require refrigeration
- Stored for extended periods
- Examples:
  - Smoked seafood
  - Deli salads
  - Dairy products made with unpasteurized milk
  - RTE meats without antimicrobials
    - Especially deli meats w/o nitrite

# Controlling *Lm* in High-Risk Foods

- *Kill all you can*
  - Thermal pasteurization or equivalent
  - Surface treatments
  - Post-packaging treatments
- *Keep them out*
  - Intensive environmental sampling + corrective action plan
- *Keep them from growing*
  - Limit storage time/temperature
  - Reformulate foods

*Per E.M. Foster, Professor Emeritus, UW-Madison*

# Product Formulation and Post Packaging Technology

- Applications will focus on RTE products
- Applications may also apply to  LM in raw product materials
- LM management is most critical in the RTE environment
- Issue is the **fact** that LM is an adulterant in RTE products

# How to start

- Predictive modeling
  - ARS Pathogen Modeling Program 6.0
    - www.arserrc.gov/mfs/PATHOGEN.HTM
  - Processed meats: Purac *Listeria* Control Model
  - Process Cheese: FRI model (JFP 1985 Tanaka)
- Published results for specific foods
- Verify with challenge testing
  - Closely replicate production conditions
  - Consider variation in presence/growth of spoilage microorganisms
  - FPA has published challenge guidelines
    - Scott et al, Guidelines for Conducting *Listeria monocytogenes* Challenge Testing of Foods, Food Prot. Trends., Vol. 25, No. 11, Pages 818-825, 2005

# Choosing Additives to Reduce Risk

- Regulatory
- Labeling, consumer acceptance, allergen potential
- Functionality, sensory
- Cost
- Packaging, processing, storage conditions
- Efficacy
  - Affected by formulation: nitrite, smoke, fat level

# Formulation Changes/Additions

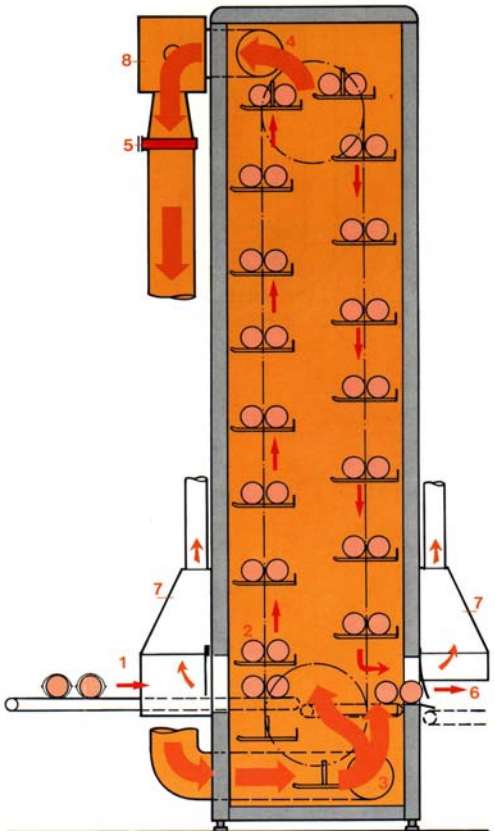
- Some products (bacteriostatic) will not support growth of LM
  - High acid concentration
  - Low water activity
  - High salt levels
  - Fermented products

# Formulation Changes/Additions

- Some additives (bacteriostatic or bacteriocidal) may control growth of LM
  - Acids
  - Smoke, liquid or natural
  - Spices, natural resins, oleoresins/glycerides
  - Preservatives
  - Bacteriocins

# Unitherm Post-Package Heat

# In-Package Pasteurization





**Stork RMS-Protecon (Townsend) Steam-Based Post-Process Pasteurization System**

# ALKAR Steam Surface Flash Pasteurization


**SSP module extends length by two indexes**

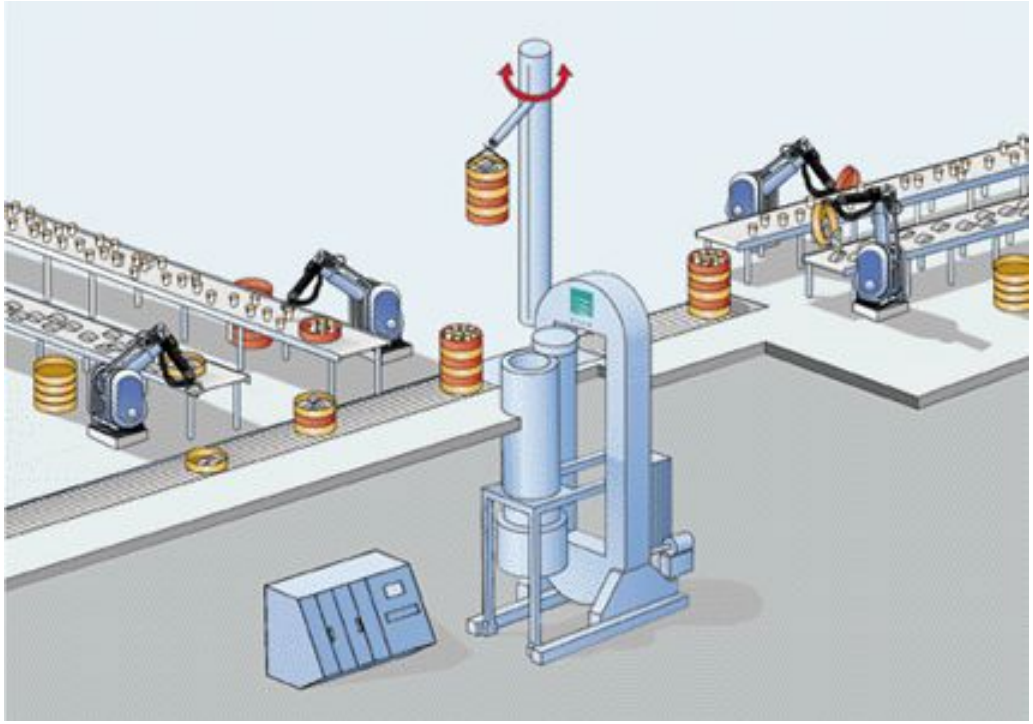
# Post Processing Heat/Pasteurization (Cont'd)

- Issues with heat pasteurization
  - May be capital intensive and a rate limiting step in production, expensive packaging materials
  - May cause undesirable attribute changes in product
    - Purge, Fat smears
  - May not always be effective, based on package style, microbial load, heat resistance of target bacteria, etc.
  - Difficult to manage if before packaging step
  - Must bring heat (and moisture) into a normally refrigerated environment, or else move product around

# High Hydrostatic Pressure

- Typical treatment is 87,000 PSI (600 Mpa) for 2 minutes
- > 5 log reduction of LM, but may be resistant strains, some tailing effects
- Significant shelf-life extension
- Considered by USDA to be a post-lethality treatment
- No change in most sensory attributes
- High capital cost, slow through-put, high repair costs lead to relatively high cost/lb
- Recent opportunities for third-party treatment

# Avure Robotic Batch High Pressure System



# Conclusions - Product Formulation and Post-Lethality Treatment

- Many additives are available, requires micro and organoleptic evaluation, products like uncured turkey breast are still problematic
- Post packaging heat pasteurization is effective for certain types of products
- Irradiation or high pressure may be viable alternatives
- Ultimate solution is probably in combination treatments
- An increase in product cost is inevitable; a change in product characteristics is likely

# *Listeria* Summary

- Minimize the risk of listeriosis in RTE Foods by:
  - Preventing post-processing contamination
    - Environmental controls/testing
    - Post-packaging treatment
  - Preventing growth before consumption
    - Modifying formulation to prevent growth
    - Strict temperature control
  - Providing education for high-risk consumers and their caretakers
  - Proper handling of RTE foods by retailers and food service establishments

# Public-Private Partnerships

- Strategic alignment around objectives
- Global focus
- Harmonized standards
- Risk assessment
- Data sharing
- Leverage collective resources
- Public health outcomes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