

## **Intervention strategies for further processed products and innovative packaging materials**



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## **Topics**

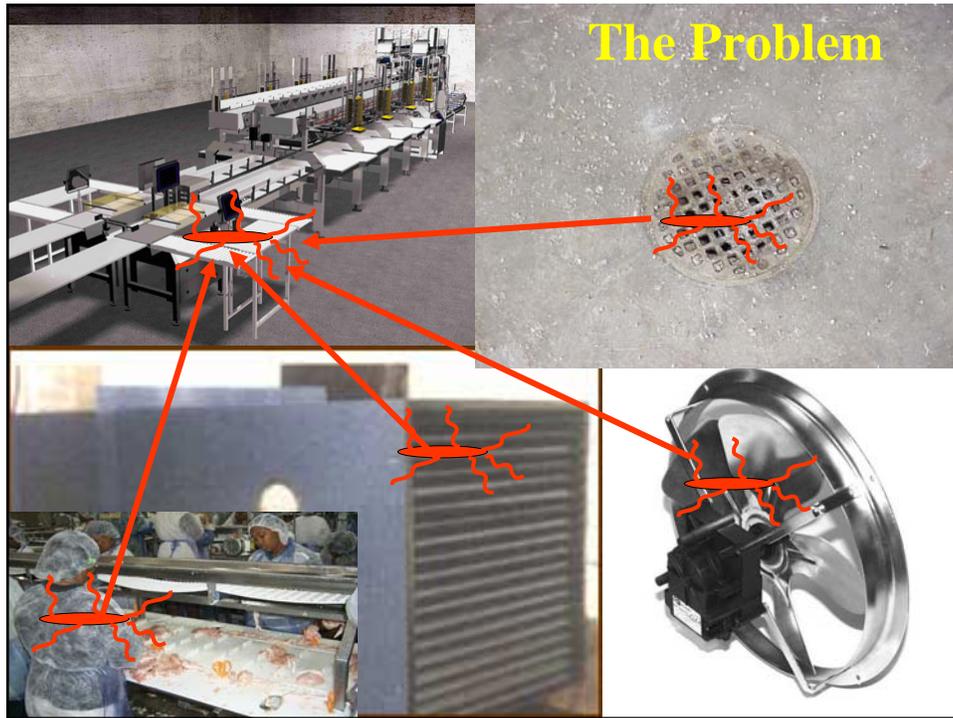
- **Regulations**
- **How the problem occurs**
- **Electrostatic spraying**
- **Clean rooms**
- **Employee hygiene**
- **Drain treatment**
- **Biofilm abatement**
- **Innovative surface materials**
- **In-process sanitation**
- **Novel packaging materials**
- **Microbial testing**

## The USDA recently enacted new legislation concerning *Listeria*

- The USDA stated that “Official establishments that produce ready-to-eat meat products must prevent product adulteration by the pathogenic environmental contaminant *Listeria monocytogenes*”
- The new directive (10,240.4) requires that each facility conduct verification procedures to ensure that the company is satisfying the *Listeria monocytogenes* regulation and microbial sampling of ready-to-eat (RTE) products for the FSIS verification testing program

## The USDA enacted legislation concerning *Salmonella*

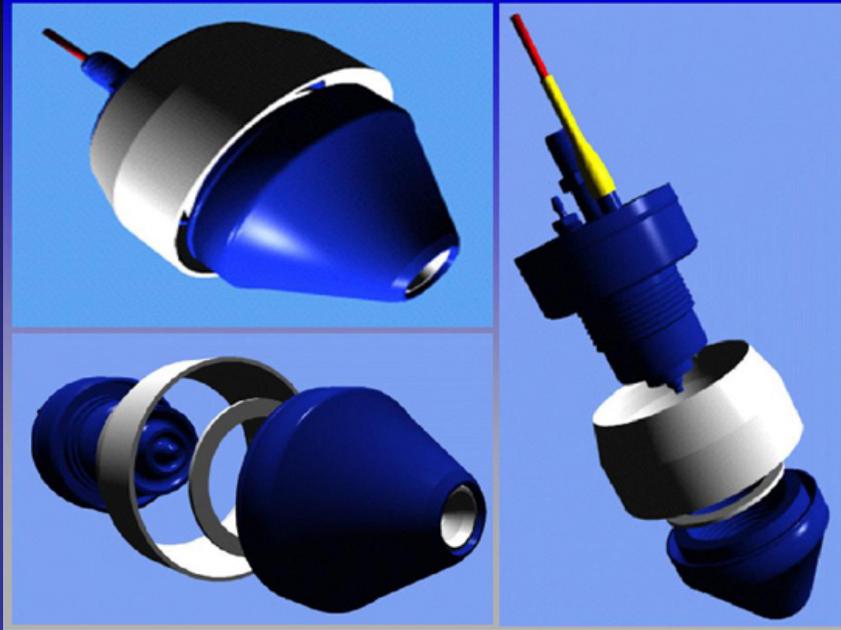
- §381.150 Requirements for the production of fully cooked poultry products and partially cooked poultry breakfast strips
- (a) Fully cooked poultry products must meet the following performance standards:
- (1) *Lethality*. A 7-log<sub>10</sub> reduction of *Salmonella* or an alternative lethality that achieves an equivalent probability that no viable *Salmonella* organisms remain in the finished product, as well as the reduction of other pathogens and their toxins or toxic metabolites necessary to prevent adulteration, must be demonstrated to be achieved throughout the product



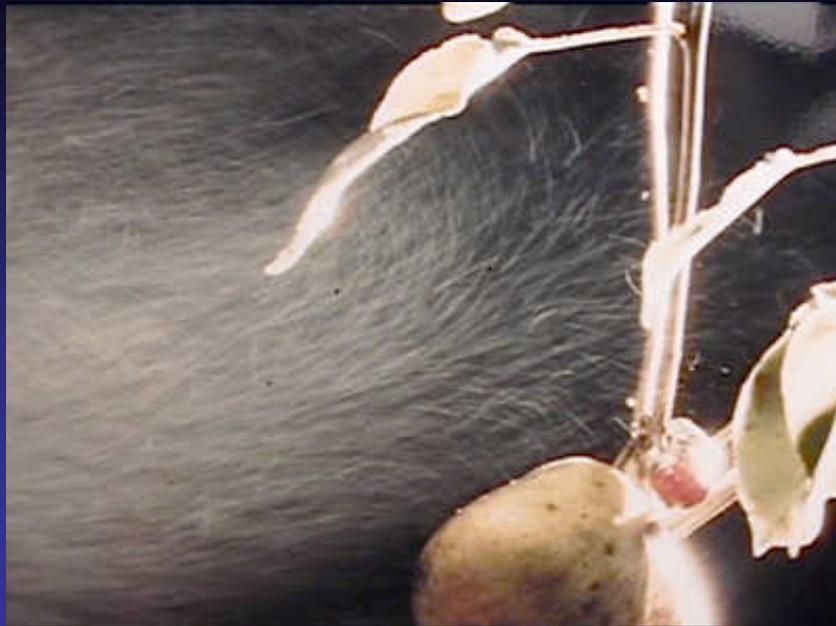
## Novel Method for Equipment Sanitation

- Electrostatic Spraying

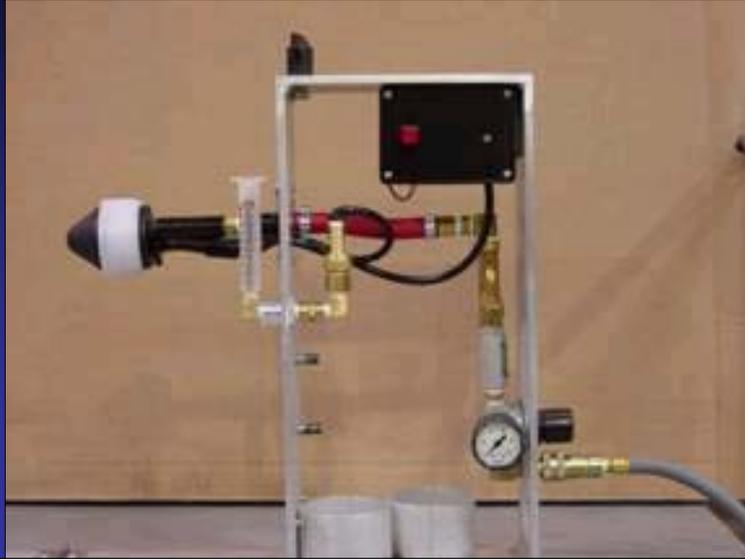
## Electrostatic Spraying Nozzle



## Electrostatic Application



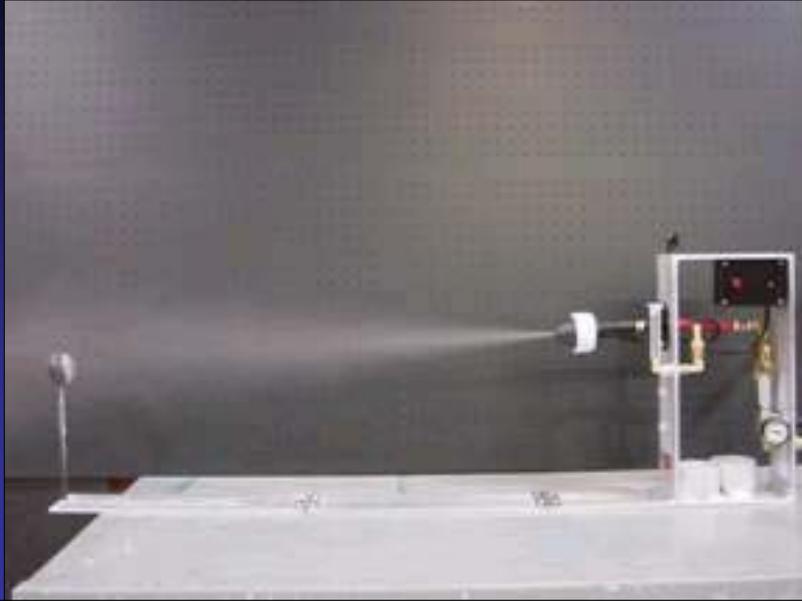
## Demo Electrostatic Sprayer



**A black ball was used and placed 24 inches from electrostatic sprayer**



## Spraying the black ball



**Black ball after spraying with  
electrostatic charge off  
(mimics coverage with  
traditional sprayer)**



**Black ball after spraying with electrostatic charge off (mimics coverage with traditional sprayer)**



**The increase in spray coverage is easy to see**

Original black ball



Electrostatic sprayer is turned off



Electrostatic sprayer is turned on



-Using this method, sanitizer can be applied into every crack and crevice in poultry processing equipment, allowing for much more effective disinfection  
-We were able to disinfect a 75'x75' room with 400,000 eggs with 1 gal

# Clean Rooms

Oven

**IQF  
Freezer**

- Evaluated for biofilm formation
- Extra effort to remove biofilms
- Special anti-biofilm agents

**Clean Room**

- No water on floor
- No employees from raw
- Clean, sanitized clothes, boots each day
- Sanitized every 2 hours
- No opening to outside
- Hepa filtered air
- Evaluated for biofilm formation
- Extra effort to remove biofilms
- Special anti-biofilm agents

# Employee Hygiene

- **Requirements**
  - Mandatory handwash/sanitizing stations
  - Frequently changed hand dips
  - No access to restrooms through plant
  - Clean, long smocks, hairnets, boots, etc.
  - Examine employees daily for illness
  - Question returning foreign employees (carriers)
  - Make sure that employees are familiar with American hygiene customs in restroom

## Drain Treatment

- **Dr. Mike Doyle, Professor, UGA**
- Selected two commonly used competitive exclusion bacteria
  - *Lactococcus lactis* subsp. *lactis*
  - *Enterococcus durans*
  - Treated floor drains in a poultry processing plant
  - Results over a 5-week period showed a several log reduction in *Listeria* at temperatures of 4 to 37 °C
- Ecolab is working with UGA to license the technology, and requests have been received from many major meat and poultry processors to use the cultures in their facilities

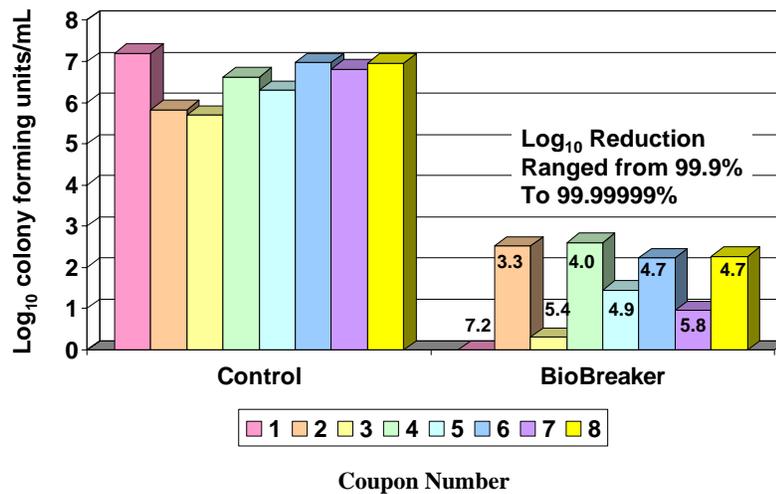
## Biofilm Abatement

- Parkar et al. (2003) reported that the polysaccharide matrix of the biofilm must be broken up to kill the bacteria
- Lysozyme was effectively used to kill bacteria in a biofilm and was able to prevent the attachment of any bacteria exposed to the surface (residual impact)

## Biofilm elimination recommendations

- Gibson et al. (1999) found that mechanical methods were most appropriate for removing biofilms
- High pressure spray and a mechanical floor scrubber were most effective
- Cleaning trials with biofilms of *Pseudomonas aeruginosa* or *Staphylococcus aureus* showed that spraying at pressures of 17.2 bar was required
- Acidic and alkaline products do affect the viability of *Staph. aureus* and *Ps. aeruginosa*, minimizing the potential for the spread of contamination

### The Effect of BioBreaker on *Listeria monocytogenes* in a fully formed biofilm



## In Process Sanitation

- **Some companies that produce fully cooked chicken:**
  - Shut the line down every 2 hours
  - Remove all product from the area
  - Spray down equipment with highly concentrated quaternary ammonium
  - Equipment is rinsed
  - Production continues for 2 more hours

## Innovative Surface Materials

- **AlphaSan<sup>®</sup> (Milliken and Westlake)**
  - Russell (2002) found that the presence of AlphaSan significantly reduced the growth of bacteria on plastic cutting boards
  - In situations where a growth medium (TSB) was present, the effect of AlphaSan was greater
  - Abrasion, as would occur in industrial situations, greatly improved the impact of AlphaSan
  - In even as little as 1 hour the effect of the AlphaSan could be observed
  - At 16 hours, a tremendous increase in efficacy was observed for AlphaSan incorporated coupons
- **HabaGUARD<sup>®</sup>**
  - Dr. Sheldon (unpublished) found that *Salmonella*, *Listeria*, *Campylobacter*, *E. coli* O157:H7 were inhibited
  - range of inhibition was from 3.6 to 7.7 logs

## **Novel Edible Films**

- Krochta and Fransen reported that film and coating materials currently used include lipids (oil, waxes, emulsions), resins (shellac, rosin), carbohydrates (celluloses, pectins, chitin, starches, gums) and proteins (milk, soy, collagen/gelatin, wheat, corn, peanut)
- When choosing an antimicrobial to add to the edible film, the target microorganism is of primary importance
- Currently used antimicrobials include: organic acids (acetic, benzoic, lactic, propionic, sorbic), fatty acids, parabens, bacteriocins (nisin, pediocin, streptocin), sulfites, sucrose esters, and other natural antimicrobials (natamycin, lysozyme)

## **Novel Packaging Films**

- Antimicrobial packaging film prevents microbial growth by direct contact of the package with the surface of foods
- Bacteriocins (bacterial antibiotics) are incorporated into the film
- Bacteriocins are released from a packaging film to the food surface to prohibit growth and kill bacteria

## Novel Packaging Films

- Two methods have been commonly used to prepare packaging films with bacteriocins
  1. Incorporation of bacteriocins directly into polymers
    - Siragusa et al. (1999) incorporated nisin into polyethylene-based plastic film
    - Nisin retained activity against *Lactobacillus helveticus* and *Brochothrix thermosphacta*
    - An initial reduction of 2- $\log_{10}$  cycles of *Brochothrix thermosphacta* was observed
    - After 20 days of storage at 4 or 12 °C, *Brochothrix thermosphacta* populations were significantly less than controls
    - Coma et al. (2001) incorporated nisin into edible cellulosic films
    - Inhibitory effect could be demonstrated against *Listeria innocua* and *Staphylococcus aureus*

## Novel Packaging Films

2. Coating or adsorbing bacteriocins to polymer surfaces
  - Nisin/methylcellulose coatings for polyethylene films
  - Adsorption of nisin on polyethylene, ethylene vinyl acetate, polypropylene, polyamide, polyester, acrylics and polyvinyl chloride
  - Bower et al. (1995) showed that that nisin adsorbed onto silica surfaces inhibited the growth of *Listeria monocytogenes*
  - Cells on surfaces that had been in contact with a high concentration of nisin (40,000 IU/ml) exhibited no signs of growth and many displayed evidence of cellular deterioration
  - In another study by Ming (1997), pediocin was coated onto cellulose casings and plastic bags and was found to completely inhibit growth of inoculated *Listeria monocytogenes* in meats and poultry through 12-week storage at 4°C

## Microbiological Testing

- Some companies are conducting up to **80** rapid tests **per day** on fully cooked chicken for:
  - *Salmonella*
  - *Listeria*
  - *Staphylococcus aureus*
  - APC
  - *E. coli*
- Rapid methods greatly assist them in reducing labor, time, and money involved in testing
- Companies also test product contact surfaces, coolers, freezers, etc. for *Listeria* on a regular basis using rapid methods
- Using rapid methods, these companies can **release products** based on microbiological test results and thus, not have to **undergo a recall (\$150,000,000 to \$190,000,000/yr according to USDA)**

## Conclusions

- Companies must meet the USDA-FSIS regulations regarding *Salmonella* and *Listeria* on fully cooked products
- Electrostatic spraying is an excellent means of applying sanitizer
- Clean rooms greatly reduce the risk of incidental contact with environmental *Listeria*
- Employee hygiene is essential to preventing cross-contamination
- Novel treatments for drains are being developed
- Novel biofilm abatement procedures are being developed
- Innovative surface materials are now being used
- In-process sanitation is a means of controlling growth
- Novel packaging materials now exist, but are slow to be incorporated due to cost
- Rapid microbial testing is essential for a data based release program to prevent recall