Antimicrobial Interventions

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Microorganisms are everywhere

- Dirt
- Air
- Wild Animals
- Insects and Rodents
- Domesticated Animals
  - Intestinal contents
  - Exterior of the animal - Hide
Sources of Contamination

- Environment - on farm and at processing facility
  - On-farm handling
  - Transportation
  - Pre-slaughter handling
  - Slaughter processes
  - Carcass handling

- Season differences in occurrence – warmer season = higher prevalence; wetter season = higher prevalence

- The cleanliness of the hide has a huge effect on the final product food safety
  - It is much harder to produce a clean carcass from cattle that come in with really dirty hides – Interventions do have a threshold
Pre-Harvest Interventions

- Vaccinations
  - *E. coli* vaccine
  - *Salmonella* vaccine

- Feed Additives
  - alter the diet prior to shipping and slaughter
  - probiotics added to diet prior to slaughter

- Water Treatments
  - Bacteriophages applied to hide/feathers just prior to slaughter
Pre-Harvest Interventions

- Costly

- Less effective – usually target specific pathogens (E. coli O157:H7); could lead to resistance?
Muscle of healthy animals is sterile

- Natural barriers:
  - Skin or hide
  - Walls of digestive and respiratory tracts
Interventions do not replace our prerequisite programs

Sanitary dressing procedures, GMPs and SOPs are still VERY much important and should be followed by all in the facilities

- Effectiveness of these must be ensured
- Revise if necessary

However, these programs can not, alone, provide the needed food safety protection
Contamination of the carcass can occur within the processing facility as well

- Equipment
- Employees
- Air
- Water

So your GMPs and SSOPs should address these as much as possible

- Proper SSOPs – before, during and after operations
- Proper hand washing techniques
GMPs on the Slaughter Floor

- Increased spacing between carcasses on the rail
- Use two knives while skinning – one in use and the other in the sterilizer between carcasses

Multiple Hurdle Concept = Best Option
Multiple Hurdle Concept

- Put barriers in front of microorganisms so that they are less likely to make their way into the final product
  - Antimicrobial Interventions
- Firewall concept
- Zero tolerance for fecal contamination implemented in 1993
Interventions are needed to ensure we are producing a safe food supply

**Intervention** – any chemical or physical process or technology that, when applied *effectively reduces or eliminates pathogenic microorganisms* from a product, process, or equipment surface.

List of approved substances – FSIS Directive 7120.1
Hide Interventions

Hide-on Wash

- High pressure water
- Fairly high temperature
- Antimicrobial compounds are applied to the hide in a wash cabinet
  - Chlorine
  - Hypobromous acid
  - Sodium Hydroxide
  - Trisodium Phosphate
  - Chlorofoam
  - Phosphoric Acid
  - Lactic Acid
  - Acetic Acid
Dehairing

- Chemical applied
- Costly - hide = most valuable offal
- Not proven at line speed
- Waste disposal issues
Carcass Interventions

- Knife Trimming
- Steam Vacuuming – target hide opening pattern
- Organic Acid Sprays
- Hot Water – often been shown to reduce bacterial more effectively than organic acids
- Steam Pasteurization
Carcass Trimming

- Usual part of slaughter process
- Final carcass trimming = required CCP; meet zero fecal tolerance requirement
- Focus on hide opening patterns
- Addresses only visible contamination – not usually considered an intervention
- Prepare carcass surface for interventions

Buege & Ingham, 2003; Cutter, 2005
Carcass Interventions

Carcass Washing

- Usual part of slaughter process – Not considered intervention
- Recommended temperature = 90-120°F
- Wash from the top down
- Wash each side for 2 minutes
- Allow for a 5 minute drip – prevent dilution of antimicrobial
- Prevent recontamination of previously washed carcasses
- Prepare carcass surface for interventions

Buege & Ingham, 2003; Cutter, 2005
Carcass Interventions

Lactic Acid Rinse

- Use a warm carcass wash prior to applying LA
- Maximum Concentration = 2.5%; typically used at 2%
- Can be applied at ambient temperature to 130°F – performs better when applied at a higher temperature
- Do not apply at a temperature over 130°F or the LA will evaporate out

Buege & Ingham, 2003; Cutter, 2005
Acetic Acid Rinse

- Use a warm carcass wash prior to applying AA
- Suggested solution concentration = 2%
- Can use just distilled white vinegar (usually 5% AA, but varies)
- Can be applied at ambient temperature to 130°F – performs better when applied at a higher temperature
- Do not apply at a temperature over 130°F or the AA will evaporate out

Buege & Ingham, 2003; Cutter, 2005
Carcass Interventions

Hot Water Rinse

- Temperature = 150-180°F (Check temperature at point of contact)
- The higher the temperature, the greater the antimicrobial effect
- Be aware of worker safety with hot water
- Condensation can be an issue with hot water

Buege & Ingham, 2003; Cutter, 2005
Carcass Interventions

Steam Pasteurization

- Carcass is placed in a chamber and steam is applied
- Rapidly raises the temperature of the carcass surface
- Carcass surface temperature is then quickly lowered

www.bircocorp.com
Main concerns = *E. coli* O157:H7, non-O157 STEC, and *Salmonella*

Bacterial load of incoming product should be addressed

More data on the prevention of O157:H7, but more and more research is being focused on the non-O157 STEC

Will the interventions that work for O157:H7 work on the non-O157 STEC?

✓ Some data already suggests YES
Trim Interventions

- **Lactic Acid**
  - Spray or dip
  - Dwell time required

- **Acidified Sodium Chlorite (ASC; Sanova®)**
  - Spray or dip
  - Can produce some discoloration and off-flavor at higher levels
  - Dwell time required

- **UV Light**
  - Affected by temperature, pH, and relative humidity
  - Lethal effect varies with intensity and length – if using a lower intensity, the exposure will need to be longer
Best Practices

- Obtain raw materials from a reputable source
- Track and trend unacceptable materials from suppliers
- *E. coli* O157:H7 test of raw materials – supplier or grinding operation

Grinding operations rely on purchasing specs programs and/or testing data to support decision to not make *E. coli* O157:H7 a hazard reasonably likely to occur

Grinding operations often times require a COA for each shipment stating that it has been tested for *E. coli* O157:H7 and the result was (-)

- Should also require their suppliers to provide documented proof that their system is validated (interventions are validated to reduce *E. coli* O157:H7)

*Best Practices for Raw Ground Products, Bifsco (2009)*
Non-Intact Product Interventions

- Blade tenderized
- Injected/enhanced
- Bacteria on the outside surface of the product is pushed to the inside
  - Often times these products are then cooked to lower degrees of doneness by the consumer (treated as a steak)
Non-Intact Product Interventions

- **Best Practices**
  - Raw material control
  - Temperature control
  - Purchase raw materials from a reputable source
  - Documented GMPs

- **Purchase specs often times used for these products**
  - COA
  - Letters of guarantee – including brine ingredients

*Best Practices: Pathogen Control During Tenderizing/Enhancing of Whole Muscle Cuts, Bifasco (2009)*
Non-Intact Product Interventions

- Many suppliers don’t test intact products that they are selling to facilities that will then produce a non-intact product from that raw material.

- Verification activities = required and very important
  - Auditing (purchasing establishment or third-party)
  - Are CCPs for *E. coli* O157:H7 in place and appropriate?

Best Practices : Pathogen Control During Tenderizing/Enhancing of Whole Muscle Cuts, Bifisco (2009)
Non-Intact Product Interventions

- Interventions
  - Knife trimming
  - Application of antimicrobial solutions to raw material
  - Treating brine solution with UV or filtration
  - Adding inhibitory substances to the brine
  - Intervention applied to the final product or packaging material

Best Practices: Pathogen Control During Tenderizing/Enhancing of Whole Muscle Cuts, Bifasco (2009)
Concerned with *Listeria monocytogenes* (*Lm*)

- *Lm* = Environmental pathogen – ubiquitous
- Very cold-stable – loves cold temperatures (i.e. coolers and processing rooms)
- Considered an adulterant in RTE meat products
Once cooked these products will typically not undergo another lethality step.

- Problem during further handling following lethality step
  - Peeling
  - Slicing
  - Packaging
RTE Product Interventions

Regulatory Requirements 9 CFR 430.4

- Final rule published June 2003
- Must control for *Lm* in HACCP plan or within SSOPs
  - If control is through SSOPs and not as a CCP in HACCP plan – must have supporting documentations stating why *Lm* hazard is not reasonably likely to occur
  - If control is through a CCP in HACCP plan – must validate and verify the effectiveness of control measures (9 CFR 417.4)
RTE Product Interventions

Regulatory Requirements 9 CFR 430

- Must comply with requirements in one of three alternatives
  1. **Alternative 1** – post-lethality treatment (A) + anti-microbial agent or process (B)
  2. **Alternative 2** – post-lethality treatment (A); OR anti-microbial agent or process (B)
  3. **Alternative 3** – sanitation program (C)
RTE Product Interventions

Regulatory Requirements 9 CFR 430

Post-lethality treatment (A)

- Applied to the final product or sealed package of product
- Reduce or eliminate the microorganisms on the product

Must:
- Identify *Lm* as a hazard reasonably likely to occur
- Point of treatment as a CCP
- Validated as effective in reducing or eliminating *Lm*
RTE Product Interventions

Regulatory Requirements 9 CFR 430

Anti-microbial agent (B)
- Substance that has the ability to either suppress or limit the growth of *Lm* throughout the shelf life of the product
  - Example = potassium lactate, sodium diacetate

Anti-microbial process (B)
- An operation that can suppress or limit the growth of a microorganism throughout the shelf life of the product
  - Example = freezing, fermenting
Regulatory Requirements 9 CFR 430

Anti-microbial agent or process (B)

- May not reduce *Lm* but is still effective through limitation of growth of organisms that survive the post-lethality process

- May be in the SSOP or prerequisite program

- May be in a validated HACCP plan

- Must document effectiveness either in SSOPs or HAACP plan
Regulatory Requirements 9 CFR 430

Anti-microbial agent or process (B)

- If utilized as the sole control measure in Alternative 2:
  - Test food contact surfaces
  - ID conditions under which hold and test procedures will be implemented following a positive test for *Lm* or an indicator organism
  - Frequency of test sampling
  - ID size and all food contact surface sampling sites
  - Justify the effectiveness of the testing frequency to control *Lm* or indicator organisms
RTE Product Interventions

Regulatory Requirements 9 CFR 430.4

Sanitation Program (C-1)

- Test food contact surfaces and keep records that match samples to corresponding test results
- IDs conditions under which hold and test procedures will be implemented following a positive test for \( Lm \) or an indicator organism
- Frequency of test sampling
- ID size and all food contact surface sampling sites
- Justify the effectiveness of the testing frequency to control \( Lm \) or indicator organisms
RTE Product Interventions

Regulatory Requirements 9 CFR 430
Sanitation Program – Additional (C-2)
Hotdog or deli-type product

- After first positive sample of a food contact surface, conduct follow-up sampling
- If there is a positive follow-up sample, hold product that may be contaminated until problem is corrected
- Test affected product lots with a sampling procedure that ensures the lot is not adulterated with *Lm*
RTE Product Interventions

Cooking Procedures

- Cook-in bag or cook-in casing products
  - Package will not be opened until consumer opens for consumption
  - No exposure of product to environmental pathogens – Lm
  - Surface colorants may have to be added to get a smoked appearance

- Impermeable casings
  - Product cooked in waterproof casing
  - Colorless
  - Smoke or color coated
  - Sell to end consumer without ever being exposed to the environment

Dr. Knipe, Ohio State University
Lactates

- Sodium and/or potassium lactate
- Approved at 4.8%
- Sodium lactate typically added at 2-3% in cured products
- Uncured product – use greater amount
- Bacteriostatic – inhibits the growth of Lm during the shelf life of the product
- Start with a high quality product – if high counts of Lm are already on the product it won’t kill the Lm
- Cannot replace GMPs

Dr. Knipe, Ohio State University
Diacetates

- Sodium diacetate
- Approved at 0.25%
- Inhibit bacterial growth by decreasing the pH inside the bacterial cell
- Bacteriostatic – inhibits the growth of Lm during the shelf life of the product
- Start with a high quality product – if high counts of Lm are already on the product it won’t kill the Lm
- Cannot replace GMPs
RTE Product Interventions

Lactic Acid Bacteria
- Byproduct inhibit other bacteria
  - Nisin
  - Pediocins
  - Lactobacillus
  - Pediococcus

Lauramide Arginine ethyl ester (LAE)
- Inhibits growth, but does not kill (bacteriostatic)
- Extend shelf life
- Antimicrobial agent or process – Alt. 2
- Applied as spray to final product or placed in package of product prior to sealing
RTE Product Interventions

Acidified Sodium Chloride
- Even more lethal to pathogenic organisms when used in combination with LA
- Residual activity against Lm

Post-Package Dip
- Dip packaged product in hot water (185°F)
- Package should remain in hot water for 6-8 minutes

Dr. Knipe, Ohio State University
High Pressure Pasteurization (HPP)

- Post-Package treatment

- Primarily for cooked and cured products
  - *Listeria monocytogenes* = 3.5 log reduction
  - *E. coli* and *Salmonella* = 5-log reductions

- Extends shelf-life
  - RTE products > 120 days

Meat & Poultry Magazine, March 2011; pg 98-104
High Pressure Pasteurization (HPP)

- Considered a cold process

- Packaged food is placed in a cylindrical pressure vessel and then pressurized
  - Up to 87,000 psi
  - Dwell time = 3 minutes

- Pressure is applied in all directions

- Destroys cellular structure of pathogens

Meat & Poultry Magazine, March 2011; pg 98-104
High Pressure Pasteurization (HPP)

- Considered environmentally friendly
- Dates back to 1884
  - Milk
- Meets consumer demands for minimally processed foods
  - Less consumer push-back
  - Can still produce cleaner labeled products

Meat & Poultry Magazine, March 2011; pg 98-104
High Pressure Pasteurization (HPP)

- Effective on both solid and liquid foods
- Each treatment cycle takes about 7.5 minutes
- Cost = 16 cents to 24 cents/lb
High Pressure Pasteurization (HPP)

- Challenge for raw meat products
  - Excess heat can deteriorate the color
  - Exposure to oxygen has to be limited to prevent oxidation

- Packaging must be able to withstand the pressure
  - Flexibility
  - Film properties
  - Specific challenge for MAP packaging

Meat & Poultry Magazine, March 2011; pg 98-104
Irradiation

- Approved for use in fresh and frozen red meat in 1997
- Considered a cold process
- Food is exposed to electron beams or gamma rays
- Low-dose whole carcass irradiation – refused as a processing aid by FSIS in 2011
- Expensive
- Consumer apprehension
Further Processing Interventions

Ozone
- Unstable form of oxygen
- Applied in solution with water
- Sanitize equipment
Bacteriophage

- Destroy specific types and strains of bacteria
- First approved for food in 2006 by FDA – *Listeria monocytogenes* in cheese
- USDA soon approved it for meat applications
  - Pre-Harvest – control *E. coli* O157:H7 on cattle hides
  - Approved for use in red meat parts prior to grinding – control of *E. coli* O157:H7
  - Post Processing – control *Listeria* on processed products; topical treatment
Buege & Ingham, 2003 - “Small Plant Intervention Treatments to Reduce Bacteria on Beef Carcasses at Slaughter”

www.meathaccp.wisc.edu

Dr. Cathy Cutter, 2005 – Penn State University

http://extension.psu.edu/food-safety

Dr. Wesley Osburn - Texas A&M University

Dr. Knipe – Ohio State University
Sited Documents

- “Best Practices for Raw Ground Products”
  www.bifsco.org
- “Best Practices: Pathogen Control During Tenderizing/Enhancing of Whole Muscle Cuts”
  www.bifsco.org
Thank you for your time!

Questions?

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