

Antimicrobial Interventions

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Food Safety Challenges

Microorganisms are everywhere

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



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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?



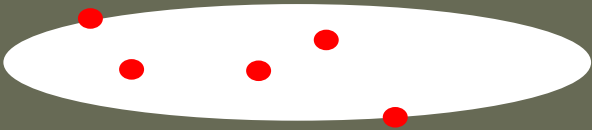
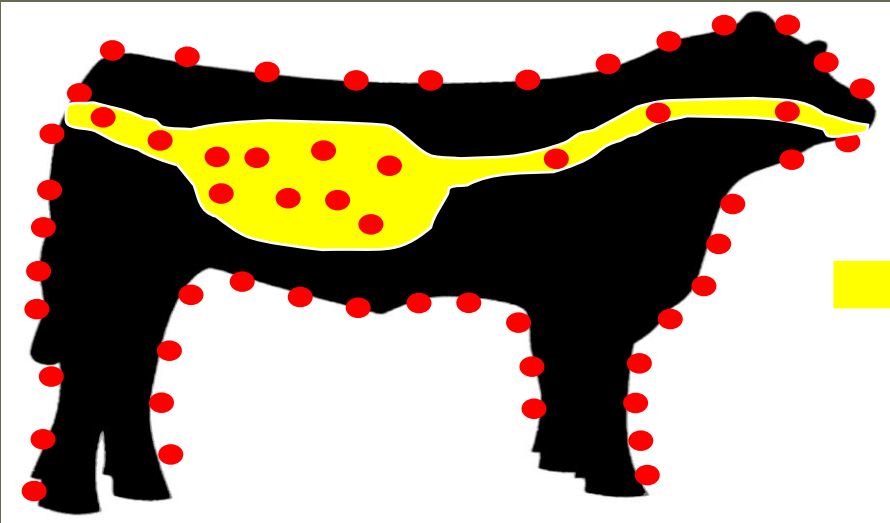
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Hide Interventions

Muscle of healthy animals is sterile

- Natural barriers:
 - ✓ Skin or hide
 - ✓ Walls of digestive and respiratory tracts





Importance of Prerequisites

- 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



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Importance of Prerequisites

- 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



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Importance of Prerequisites

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



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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



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- 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



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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



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Hide Interventions

Dehairing

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



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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



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Carcass Interventions

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



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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



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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



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Carcass Interventions

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



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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



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



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Trim Interventions

- 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



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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



Trim Interventions

- 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, Bifscop
(2009)



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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)



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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, Bifsc (2009)



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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, Bifasco (2009)



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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

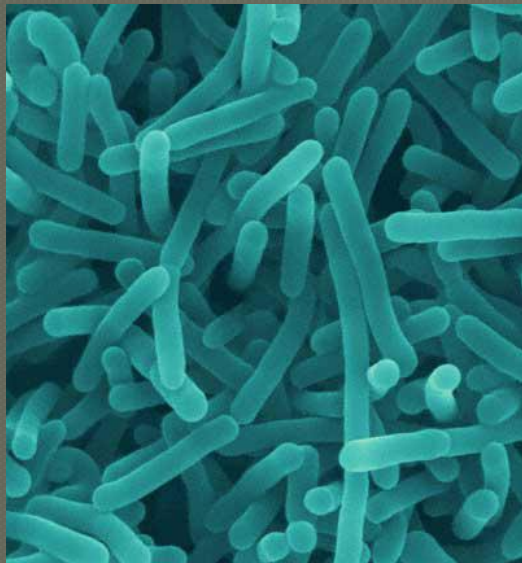
Best Practices : Pathogen Control During Tenderizing/Enhancing of Whole Muscle Cuts, Bifscio (2009)



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RTE Product Interventions

- 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



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RTE Product Interventions

- Once cooked these products will typically not undergo another lethality step
- Problem during further handling following lethality step
 - Peeling
 - Slicing
 - Packaging



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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)



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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)



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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*



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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



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RTE Product Interventions

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 HACCP plan



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RTE Product Interventions

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



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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



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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*



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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



RTE Product Interventions

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



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RTE Product Interventions

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



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Further Processing Interventions

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



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Further Processing Interventions

High Pressure Pasteurization (HPP)

- Considered a cold process
- Packaged food is placed in a 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



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Further Processing Interventions

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



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Further Processing Interventions

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



Further Processing Interventions

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



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Further Processing Interventions

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



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Further Processing Interventions

Ozone

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



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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



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Sited Documents

- 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
“Antimicrobial Spray Treatments for Red Meat Carcasses Processed in Very Small Establishments”
<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.bifsc.org
- “Best Practices: Pathogen Control During Tenderizing/Enhancing of Whole Muscle Cuts”
www.bifsc.org



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Thank you for your time!

Questions?

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