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Antimicrobial effects of colloidal silver washes against Salmonella and Escherichia coli O157:H7 on fresh beef

Abstract

Beef carcasses and fresh fabricated beef products potentially can be contaminated with disease causing microorganisms (pathogens) via animal dressing procedures and contamination from the plant environment or workers. Concentrated efforts have been made by the meat industry to develop and implement a wide array of strategies to control such contamination. Spraying beef flank (Rectus abdominus) samples with 32 ppm colloidal silver (ASAP®, American Biotech Labs) solution for 20 seconds reduced Salmonella and Escherichia coli O157:H7 numbers by greater than 90% after 4 hours. Inoculated samples treated with 22 ppm colloidal silver, 22 ppm colloidal silver plus 1.5% hydrogen peroxide, 10 ppm colloidal silver, or 10 ppm colloidal silver plus potassium persulfate had moderate to slight pathogen reductions compared with those treated with 32 ppm colloidal silver. Although not yet approved for use on foods (but approved for other human health applications), a colloidal silver rinse implemented in conjunction with other antimicrobial intervention technologies during the beef carcass conversion and/or fabrication processes could be an effective strategy against Salmonella and E. coli O157:H7. Further studies should be conducted on colloidal silver's antimicrobial effectiveness on lean tissues versus adipose tissue, and on sensory and functional effects on fresh meat products during storage.

Keywords

Cattlemen's Day, 2005; Kansas Agricultural Experiment Station contribution; no. 05-144-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 943; Beef; Colloidal silver washes; Salmonella; Escherichia coli O157:H7

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ANTIMICROBIAL EFFECTS OF COLLOIDAL SILVER WASHES AGAINST *SALMONELLA* AND *ESCHERICHIA COLI* O157:H7 ON FRESH BEEF

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Summary

Beef carcasses and fresh fabricated beef products potentially can be contaminated with disease causing microorganisms (pathogens) via animal dressing procedures and contamination from the plant environment or workers. Concentrated efforts have been made by the meat industry to develop and implement a wide array of strategies to control such contamination. Spraying beef flank (*Rectus abdominus*) samples with 32 ppm colloidal silver (ASAP®, American Biotech Labs) solution for 20 seconds reduced *Salmonella* and *Escherichia coli* O157:H7 numbers by greater than 90% after 4 hours. Inoculated samples treated with 22 ppm colloidal silver, 22 ppm colloidal silver plus 1.5% hydrogen peroxide, 10 ppm colloidal silver, or 10 ppm colloidal silver plus potassium persulfate had moderate to slight pathogen reductions compared with those treated with 32 ppm colloidal silver. Although not yet approved for use on foods (but approved for other human health applications), a colloidal silver rinse implemented in conjunction with other antimicrobial intervention technologies during the beef carcass conversion and/or fabrication processes could be an effective strategy against *Salmonella* and *E. coli* O157:H7. Further studies should be conducted on colloidal silver's antimicrobial effectiveness on lean tissues versus adipose tissue, and on sensory and functional effects on fresh meat products during storage.

Introduction

The United States Department of Agriculture (USDA) Pathogen Reduction, Hazard Analysis Critical Control Point (HACCP) system final rule of 1996 mandates that meat- and poultry-processing plants implement and comply with HACCP programs. These programs strive to reduce and/or eliminate the risks associated with meat and poultry products through use of valid process controls and application of antimicrobial technologies during processing. The ruling focuses attention on the prevention and reduction of microbial pathogens on raw products. Many HACCP models call for an antimicrobial rinse to be used after a beef carcass has been eviscerated but before chilling. Antimicrobial rinses on chilled carcasses, fabricated raw beef subprimals, and beef trimmings are now being permitted by the USDA as critical control points in HACCP programs.

Colloidal silver is nanometer-size particles of silver produced by electrolysis in purified water. The antimicrobial properties of silver particles have been widely reported. Currently, silver is approved and used in water purification systems, medical bandages for burn victims, dental fillings, and as a lining in surgical catheters because it inhibits growth of infectious microorganisms. Colloidal silver solutions potentially could be used as antimicrobial rinses for raw beef products to reduce

the presence of pathogens and, thus, serve as a critical control point in HACCP programs. This study was conducted to evaluate the efficacy of a solution of 32 ppm of colloidal silver for inactivating pathogens on fresh beef tissue, and to evaluate colloidal silver's efficacy over a range of solution concentrations and formulas.

Procedures

Preparation of Bacterial Cultures. Bacterial cultures were obtained from the Kansas State University stock culture collection, cultivated in the laboratory, and mixed to form five-strain inoculation solutions of both *Salmonella* and *E. coli* O157:H7. Each inoculation solution contained 1 billion colony-forming units per ml (CFU/ml) of the respective pathogen cultures. These mixed inoculation solutions were diluted to 1 million or 10,000 CFU/ml and used as a spray to inoculate beef flank tissue surfaces.

Time Study. Beef flank samples (*Rectus abdominus*) were trimmed to 5 x 3-inch pieces and spray inoculated on the exterior surface with the five-strain mixture of *Salmonella* or *E. coli* O157:H7 at 1 million CFU/ml or 10,000 CFU/ml. The actual *Salmonella* densities achieved on the meat surface were 100,000 and 2,500 CFU/cm^2 for the high and low concentration inoculum solutions, respectively. For *E. coli* O157:H7, the respective meat surface inoculation densities were 16,000 and 8,000 CFU/cm^2.

The beef samples were hung vertically on hooks attached to a motorized track that pulled the samples through a model spray cabinet. Treatments of either 32 ppm of ASAP® (American Bio Tech Labs, Alpine, UT) colloidal silver or deionized water were applied at 20 psi from a distance of 5 inches in the model pressure-rinse cabinet for 20 seconds. The spray nozzle delivered approximately 20 ml of solution to the surface of each sample. Duplicate core samples were randomly drawn from the inoculated exterior surface of each beef sample at 0, 20, 60, and 240 minutes after treatment. Surviving bacterial concentrations on beef samples were enumerated on selective and recovery culture media. Bacterial reductions due to the antimicrobial treatments were calculated by subtracting the amount of residual bacteria on inoculated/treated samples at the specified sampling times from the original post-inoculation concentration on inoculated/untreated samples at 0 minutes.

Concentration Study. This study followed the same experimental design as the time study, except that treatments were 22 ppm ASAP® colloidal silver, 22 ppm ASAP® colloidal silver with 1.5% hydrogen peroxide, 10 ppm ASAP® colloidal silver, 10 ppm ASAP® colloidal silver with 10 ppm potassium persulfate, and deionized water only.

Results and Discussion

An initial lethal effect was observed when inoculated fresh beef samples were treated with 32 or 22 ppm colloidal silver solution, resulting in a greater than 95% reduction of *Salmonella* and *E. coli* O157:H7 within 4 hours. These two colloidal silver washes resulted in the greatest pathogen reductions of the treatments evaluated. Furthermore, colloidal silver was slightly more effective against *E. coli* O157:H7 than against *Salmonella* (Figures 1 and 2).

The 1.5% hydrogen peroxide colloidal silver formulation caused significant textural changes to the fat covering, and left a bleached appearance to the surface of the lean tissue. In terms of pathogen reductions, the performance of 22 ppm colloidal silver with 1.5% hydrogen peroxide formulation was not significantly different than the 22-ppm colloidal silver solution alone. The 10-ppm colloidal silver solution resulted in an 81% pathogen reduction. The addition of potassium per-

sulfate to this 10-ppm solution enhanced the reductions to approximately 90%.

Numerous chemical washes have been evaluated in similar laboratory and commercial studies. Pathogen reductions tend to be similar for most chemical treatments reported in literature (90 to 99% reductions). Washing with colloidal silver (22 or 32 ppm) provided pathogen reductions within this typical range. Chemical washes for beef operations are needed because some smaller processors cannot afford the thermal systems widely used by medium or large-scale processors, or have no room on the processing floor for their installation. Slaughter operations that use thermal technologies for decontamination of prechilled carcass sides would benefit from having an effective chemical wash to apply to chilled carcasses, subprimals, and beef trimmings.

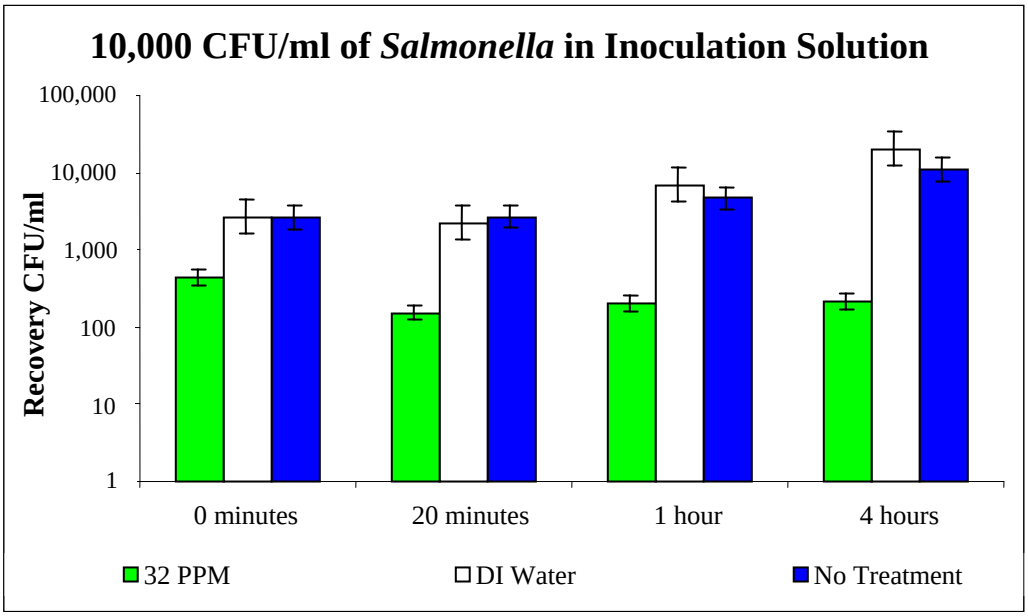

Figure 1. Residual Amounts of *Salmonella* Detected on Beef Flank Tissue After Spray Treatment with Deionized Water or 32 ppm of Colloidal Silver Solution.

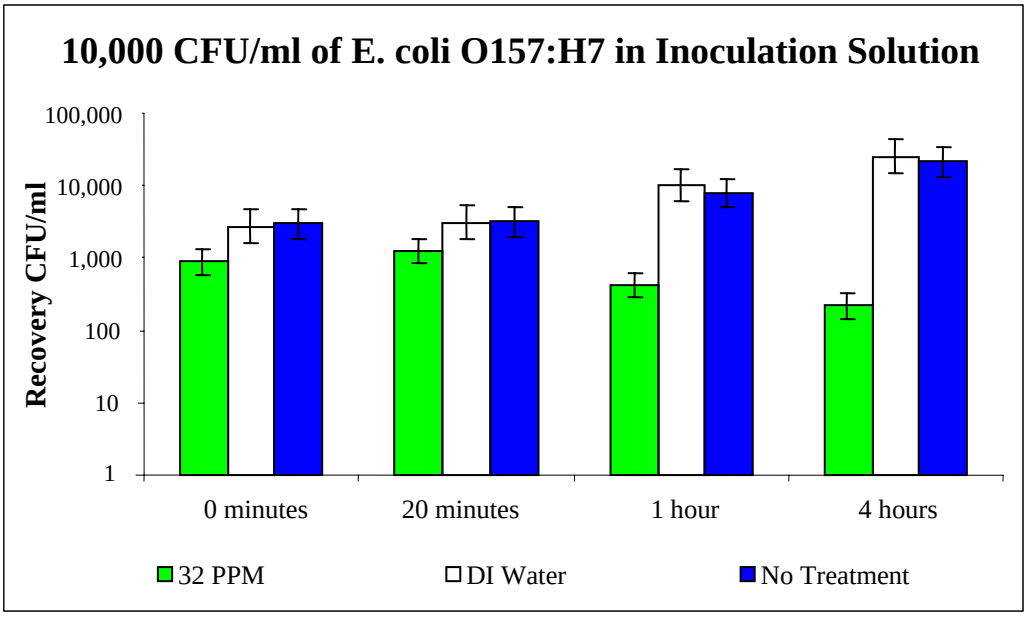

Figure 2. Residual Amounts of *Escherichia coli* O157:H7 Detected on Beef Flank Tissue After Spray Treatment with Deionized Water or 32 ppm of Colloidal Silver Solution.