**Project Title:** Application of Antimicrobial Treatments in a Commercial Simulation to Reduce *E. coli* O157:H7 and *Salmonella* spp. in Beef Trim and in Ground Beef

**Principle Investigator(s):** Mark Miller, Ph.D., Chance Brooks, Ph.D. and Mindy Brashears, Ph.D.

**Institution(s):** Texas Tech University

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## Background

The digestive tracts of animals are natural reservoirs of foodborne pathogens including *Salmonella* spp. and *Escherichia coli* O157:H7. The muscles of a healthy animal are essentially sterile, but even under the most stringent conditions, they can become contaminated during the slaughter process from the environment, hide or from direct contact with the intestinal tract contents. This contamination can lead to human illness if the processor or end-users do not appropriately handle the product. For processors that specialize in further fabrication, especially grinding facilities, pathogens are of great concern for both safety and economic reasons. Processors, including grinders, are responsible for conducting routine testing of products they procure, and must recall any fresh product that tests positive for *E. coli* O157:H7. Currently, there are very few safety interventions that can be applied to beef trimmings or ground beef.

This study was designed to determine methods for effectively reducing *E. coli* O157:H7 and *Salmonella* spp. in beef trim and ground beef. Previous research has demonstrated the effectiveness of applying lactic acid and acidified sodium chlorite in reducing pathogen loads on beef carcasses and to a limited extent, on beef trim. The Food and Drug Administration (FDA) has recently approved the use of acidified sodium chlorite (ASC) as a food additive to reduce pathogen loads on both pre-chill and post-chill meat and poultry products. The use of antimicrobials on beef trim has not however, been extensively documented in peer-reviewed research.

The objectives of this study were to validate the effectiveness and application of acidified sodium chlorite (1,000 parts per million, or ppm), acetic and lactic acids (2 percent and 5 percent) and sterile water in reducing *Escherichia* coli O157:H7 and *Salmonella* spp. on beef trim prior to and after grinding in a simulated processing environment. The researchers also determined the effect of the treatments on sensory quality and the biochemical composition of ground beef.

## Methodology

Antimicrobial Interventions
The antimicrobial effects of organic acids and acidified sodium chlorite were evaluated by inoculating beef trim with *Escherichia* coli O157:H7 or *Salmonella* spp. and allowing for pathogen attachment. Beef trim (80 percent lean and 20 percent fat) was obtained from a commercial packing facility and was sampled prior to inoculation. Half of the 360 pounds of beef trim was inoculated with *Escherichia coli* O157:H7 and the remaining half was inoculated with *Salmonella* spp. The trim was treated with one of six antimicrobial treatments: 1) 2 percent acetic acid, 2) 5 percent acetic acid, 3) 2 percent lactic acid, 4) 5 percent lactic acid, 5) acidified sodium chlorite (1,000 ppm), or 6) sterile water.



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Samples were collected before treatment with an intervention (control) and at the following points during production: 1) 20 minutes after treatment, 2) immediately after grinding (six hours), and 3) 24 hours after grinding.

Sensory Evaluations
The antimicrobial interventions were applied similarly to the ground beef as in the intervention study. None of the beef trim in this portion of the study was inoculated with *Escherichia coli* O157:H7 or *Salmonella* spp. Ground beef patty samples were collected immediately after patty production and 24 hours after patty production.

Beef trim (480 pounds) was also collected from a commercial packing facility. Sixty pounds were used as the control treatment and the remaining trim was divided into five 20-pound portions to undergo antimicrobial treatments. The experimental groups were treated with one of the five antimicrobial treatments 1) 2 percent acetic acid, 2) 5 percent acetic acid, 3) 2 percent lactic acid, 4) 5 percent lactic acid, 5) acidified sodium chlorite (1,000 ppm). After being sprayed with the antimicrobial treatments, the trim was ground and formed into patties.

Patties were cooked on a belt grill and were evaluated by an untrained sensory panel to detect differences between the patties treated with an antimicrobial intervention and those that were not. Visual color in a retail display case was also evaluated by a trained sensory panel and objectively with a spectrophotometer. These factors were used to determine the color and shelf-life differences among the antimicrobial treatments.

## Findings

Antimicrobial Intervention Efficacy
The antimicrobial treatments on the surface of the beef trim showed no measurable reductions for *Escherichia coli* O157:H7 immediately after application. For *Salmonella* spp., the 5 percent acetic acid and acidified sodium chlorite (1,000 ppm) on the surface of the beef trim showed significant reductions.

All of the antimicrobial treatments significantly reduced *Escherichia coli* O157:H7 in ground beef when compared to the control samples immediately after grinding. The 5 percent lactic acid showed the most effectiveness. The 2 percent acetic acid and acidified sodium chlorite (1,000 ppm) showed the most effectiveness in reducing *E. coli* O157:H7 24 hours after processing.

The antimicrobial treatments of sterile water, 2 percent lactic acid, 5 percent lactic acid, 2 percent acetic acid, 5 percent acetic acid and acidified sodium chlorite significantly reduced pathogen loads of *Salmonella* spp. on the ground beef both six and 24 hours after grinding.

Sensory Evaluations
The untrained sensory panel was unable to detect any differences between patties that had been treated with an antimicrobial intervention and those that were not. There were no color differences detected in the post-production sampling periods six hours and 24 hours after processing, but color differences were detected during the three days of retail case evaluations. Color uniformity differences occurred between the control samples, 2 percent acetic and lactic acid samples. Discoloration was significant for the samples treated with acidified sodium chlorite, 2 percent acetic acid and 5 percent acetic acid. Premature browning of lean meat color occurred for patties treated with acidified sodium chlorite and 5 percent acetic acid. There were no differences in the objective color measurements taken with the spectrophotometer.

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## Implications

Based on this study, the application of antimicrobial treatments to beef trim appears to be an effective way to reduce foodborne pathogens and does not appear to cause significant detrimental effects to product quality.

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