EVALUATION OF THE GROVAC™ SYSTEM FOR DECONTAMINATION OF RETAIL BEEF TRIMMINGS TO CONTROL *E. COLI* O157:H7 AND *SALMONELLA*

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Summary

The Grovac™ intervention system was evaluated for its effectiveness in reducing *E. coli* O157:H7 and *Salmonella* inoculated on the surfaces of beef trimmings. Designed to be used in a batch process, the Grovac™ system involves treating beef trimmings in a mixture of citric acid and a hypotonic salt solution while tumbling under vacuum. Beef trimmings were inoculated with a five-strain cocktail of *E. coli* O157:H7 and *Salmonella*, then subjected to no treatment, water with a 1-hour drain treatment, water with an overnight drain treatment, Grovac™ with a 1-hour drain treatment, and Grovac™ with an overnight drain treatment. Data indicated that the Grovac™ system may be a viable method for retailers to use with in-house beef grinding operations to reduce *E. coli* O157:H7 and *Salmonella* risks. Reductions in these pathogen populations were 85 and 80%, respectively, after draining for 18 hours at 36°F.

Introduction

Since 1986, ground beef manufacturers, retailers, food service, and consumers have feared *E. coli* O157:H7 in their ground beef. The USDA and the ground beef industry have spent several years and millions of dollars working to combat this issue through the development of antimicrobial intervention strategies, the introduction of Hazard Analysis Critical Control Point (HACCP) systems, and consumer education programs. Most of these risk reduction efforts have been aimed at the beef manufacturing plants, particularly slaughter-level carcass decontamination systems, with a good degree of success. To best ensure the microbial safety of retail-ready ground beef, sequential intervention technologies (hurdles) throughout the production chain need to be developed and implemented. Although cooking beef to 160°F will eliminate the hazard of *E. coli* O157:H7 from the product, it does not eliminate the problems associated with cross-contamination that often occur in consumers' kitchens or in food service operations.

Commercial ground beef is produced by mixing pieces trimmed from larger beef cuts (subprimals) during fabrication processes and grinding fat and lean component streams into coarsely or finely ground wholesale products. The percentage of fat for each grind is obtained by mixing the proper combination of lean muscle meat with fat from trimmings. Thus, a production load of ground beef can contain meat from many different cuts of beef from various sources and of differing quality.

The manufacture of this product in centralized beef processing facilities ensures production under strict standards of hygiene and quality control. The retail butcher's shop faces many challenges in today's marketplace. They have the pressures of increased competition, a shortage of skilled meat cutters, and the risk associated with selling ground beef that may harbor *E. coli* O157:H7. At the retail store (butcher shop), the production of ground beef allows minimization of economic (yield) losses associated with trimming steaks and roasts. These table trimmings are generally

mixed with coarse ground chubs for final grinding, followed by retail case display for 1 to 2 days. Until now, there has been no antimicrobial intervention strategy available to the retail meat grinder that would allow him to minimize his risk of selling contaminated beef. This void in retail-level technology puts the entire beef production complex at risk of USDA action, recalls, negative publicity, and litigation in the event contamination occurs, especially if it affects public health. By placing a validated intervention technology at this final stage of ground beef production, where contamination with enteric pathogens would be expected to be infrequent and at very low rates, a significant hurdle would be in place that would further reduce the likelihood that pathogen-contaminated ground beef would reach the consumer.

The Grovac™ Intervention System is a simple and inexpensive method designed to decrease bacterial concentrations on ground beef while extending the shelf life of the product. The Grovac™ system is designed to be used as a batch process, and is adaptable to small volume situations often encountered in retail butcher shop operations. It involves treating the beef trimmings in a mixture of citric acid and a hypotonic salt solution while tumbling under vacuum. The citric acid lowers the pH on the outside of the beef to a level that kills most disease-causing meat-borne bacteria and acts as an antioxidant in the final product, delaying the conversion of oxymyoglobin to metmyoglobin. This stabilizes the bright red color for a longer period of time.

The Grovac™ system has been commercially tested and is now in use in fresh seafood and poultry processing facilities. At Kansas State University, this system was evaluated with encouraging results against meat-borne pathogens inoculated onto beef trimmings. Since those studies, in-house studies at Costco Wholesale have led to an adjustment (optimization) in processing parameters of the beef trimmings in the Grovac™ system. In these Costco studies with the Grovac™ system, generic microbial reductions have remained good and the shelf-life stability (color) of retail ground beef has been enhanced. Based upon the success of the previous KSU studies and preliminary Costco studies, the initiated current studies were initiated to formally evaluate the efficacy of the optimized Grovac™ system against *Salmonella* and *E. coli* O157:H7 in laboratory-based inoculation studies.

Procedures

Preparation of Cultures. Five strains each of *Salmonella* and *E. coli* O157:H7 were activated from frozen storage, and all five strains of each pathogen were mixed in a single, sterile, spray bottle for use in meat inoculation. The target inoculation solution concentration was 10 million colony forming units (CFU) per ml.

Inoculation of Beef Trimmings. Beef trimmings were obtained from a Costco Wholesale location (Kansas City, MO). Trimmings were generated from store operations the previous day, stored at < 32°F, and delivered by 10 a.m. the next morning to the K-State Food Microbiology Laboratory. Beef trim samples were chopped in a sterile food processor, and duplicate subsamples were placed into sample bags with sterile diluent. These subsamples were homogenized in a lab blender and plated by using APC and ECC Petrifilm to establish native microbiological quality of the beef trimmings. For inoculation, beef trimmings (18 lb) were placed onto white butcher's paper so pieces were not touching, and then placed inside a sealed Plexiglas inoculation chamber. The mixed inoculum was sprayed through a hole in the chamber onto the exposed surfaces of the beef trimmings. After allowing the inoculated beef to sit inside the inoculation chamber for 5 minutes, the chamber was opened and the beef trimmings were turned to expose the side that originally faced the paper. The chamber was

resealed and the alternate side of the trimmings was inoculated as previously described. Then, trimmings were placed inside a sterile plastic bag and hand mixed to uniformly distribute the surface inoculum. The bag was held at 50°F for 30 minutes to allow microbial attachment. Trimmings were randomly selected from the bag after 30 minutes of chilled storage and chopped in a sterile food processor, and duplicate subsamples were placed into sterile bags with sterile diluent. These subsamples were homogenized for 2 minutes, serially diluted, and plated onto selective media to establish pathogen inoculation rates. An inoculation rate of 100,000 CFU/gram was targeted. The rest of the inoculated trimmings was subjected to specified treatments.

Application of the Grovac™ Decontamination Process. The Grovac™ decontamination process consists of 2 minutes of tumbling of trimmings under vacuum (25 inches of Hg) in a 2.27% citric acid/0.45% sodium chloride solution. A water only treatment application served as the process control. The Grovac™ and water-only processes occurred in a Biosafety Level-2 food processing laboratory set at 50°F, and the solution temperature was ambient. Each test batch of inoculated trimmings was treated in the described manner, removed from the Grovac™ chamber, and allowed to drain for 1 hour. Half of the Grovac™-treated beef trimmings were placed into 36°F storage in a plastic container overnight [approximately 18 hours; *overnight sample*], whereas the other half were analyzed immediately after the 1 hour of draining [*1-hour sample*]. The overnight sample container had holes in the bottom to allow for drainage of residual moisture overnight. Portions of the 1-hour and overnight sample trimmings were aseptically removed, placed into a sterile food processor, and chopped to provide homogeneous samples. From each sample, duplicate subsamples were drawn, placed into sterile bags with diluent, and mixed for 2 minutes, and serial dilutions were plated to enumerate the amounts of residual pathogens. Selective agars were used to allow separate enumerations of *Salmonella* spp., injured *Salmonella*, *E. coli* O157:H7, and injured *E. coli* O157:H7. The average counts from these duplicates were calculated, and the overall pathogen reductions due to the treatments were determined.

Results and Discussion

The Grovac™ system was effective in reducing both *E. coli* O157:H7 and *Salmonella* counts on beef trimmings, although the reductions were only moderate (65 to 90% using an overnight drain procedure). The retail beef industry has very few options available to choose from in the way of intervention strategies. Over the past 10 years, retailers have vigorously pursued consumer education and outsourcing of ground beef production as methods to reduce the risk of *E. coli* O157:H7 contamination in beef. The Grovac™ system may be a viable method for retailers to use for in-house beef grinding operations.

Reductions in *Salmonella* counts were observed with both the water treatment and the Grovac™ treatments after 1 hour of draining (55 and 62% reductions, respectively). Samples from both the water and Grovac™ treatments showed more reductions in *Salmonella* numbers (78 and 85%, respectively) when samples were allowed to drain overnight. When comparing the Grovac™ treatment to the water-only treatment, the Grovac™ treatment led to greater bacterial reductions than the water-only treatment did in all instances.

After 1 hour of draining, both water and Grovac™ treatments resulted in 60% reductions in *E. coli* O157:H7 populations. These reductions increased to 63% for water and 80% for Grovac™ after 18 hours of draining.

The Grovac™ system did not produce large reductions in bacterial numbers, but the reality of the typical microbial quality of beef

in the retail market must be kept in mind. When a subprimal cut reaches the retail market, it has likely been exposed to at least one microbial intervention process, so the bacterial load on that piece of meat is typically quite low and the chance of high concentrations of a pathogenic organism on that beef is negligible. Removing greater than 80% of the initial bacterial population, which this Grovac™ system was able to do, is substantial to the meat industry. If the initial count of *E. coli* O157:H7 or another pathogen is 100 CFU/gram or less, after treatment with an intervention process like the Grovac™ system, 10 or less CFU/gram theoretically will remain. The Grovac™ system is an appropriate microbial intervention to be used at this level of the food chain, adding yet another barrier to microbial contamination of beef.