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Quantitative Microbial Risk Assessment for the Selection of Pathogen Control Strategies during Ground Beef Processing: A Cost Effective Approach

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Objectives

Escherichia coli O157:H7 poses a significant health risk due to its ability to cause foodborne illness. It has been identified as the causative agent in numerous foodborne illness outbreaks linked to ground beef. As part of the commensal microflora of cattle, *E. coli* O157:H7 could easily contaminate beef carcasses, despite various decontamination treatments in place. Trims are commonly used in ground beef processing, which could result in increased risk of pathogen contamination. Furthermore, temperature abuse (> 5°C) of contaminated ground beef during retail could also influence pathogen growth. To lower contamination and consumer health risk, some ground beef processors have started using beef trim wash as an added intervention. Adding an intervention to existing production practices could increase the cost of production significantly. Quantitative Microbial Risk Assessment (QMRA), which assesses the risk of foodborne illness from current production practices and predicts the effectiveness of proposed interventions, without actual implementation, could help processors make an informed decision. Utilizing QMRA to choose interventions, therefore, would be more economic and efficient. The objective of the study was to use QMRA as a decision-making tool for predicting the impact of various beef trim interventions on the reduction of foodborne illness risk from ground beef consumption.

Materials and Methods

Experiments were conducted in triplicates to determine the efficacy of various beef trim interventions. Beef trim samples, inoculated with a cocktail of *E. coli* O157:H7 (6 $\log_{10}$ CFU/g), were used. Following bacterial attachment, the trims were spray-washed (20 mL) with either lactic acid (5%), peracetic acid (400 ppm), sterile distilled water or *E. coli* O157:H7 specific bacteriophage cocktail (9 $\log_{10}$ PFU/ml). Untreated positive (inoculated) and negative (non-inoculated) controls were also used. Treated samples and controls were ground and stored in PVC-wrapped styrofoam trays. To simulate refrigerated and abuse retail storage conditions, samples were stored at 4 and 8°C, respectively for 4 d. Pathogen survival in stored ground beef was determined on d 0, 1, 2, and 3. The data were modeled and incorporated in an established QMRA framework from the literature. The QMRA involved scenario analysis of beef trim interventions, retail-storage, and cooking-preference (rare, medium, and well-done). For each scenario, 100,000 iterations were simulated using Montecarlo simulations, employing @Risk-software.

Results

Experimental results revealed that at 4°C, there were no significant differences among treatments. However, at 8°C, the most effective treatment was found to be the phage cocktail. The QMRA predicted the baseline probability of illness from rare-cooked ground beef, stored at 4°C, to be nearly 3 illnesses in 1 million. At 4°C, the organic acids and phages were successful in reducing the probability of illness by 98%. At 8°C, only phage treatment reduced the risk by 98%. It was also revealed that if ground beef is well-done, beef-trim interventions are not required.

Conclusion

The findings recommend beef trim interventions as a necessary step to reduce the risk of foodborne illness from undercooked ground beef. The study also demonstrates usage of QMRA as a cost-effective method to plan and compare intervention strategies.

