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Effects of Bacteriophage, Ultraviolet Light, and Organic Acid Applications on STEC O157:H7 and the "Big Six" in Beef Packaged Under Vacuum and Aerobic Conditions

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Objectives

Beef primals produced during high event periods (HEP) can also be affected by STEC contamination requiring microbial assessment. Commonly, primals are retreated with antimicrobials after removal from vacuum bags, then repackaged and tested for STEC. In this study, we evaluated the efficiency of bacteriophage, ultraviolet light, and organic acids on contaminated beef kept under vacuum and aerobic conditions.

Materials and Methods

The effects of antimicrobial interventions Peroxyacetic acid (PAA, 400 PPM), Ultraviolet light (UV, 30 s at 2.5 ± 0.3 cm height), Acidified Sodium Chlorite (ASC, 1200 ppm), and bacteriophage (P, 7 MS phages at 10^8 PFU/ml) against STEC (O157:H7 and O145, O121, O111, O103, O45, O26) were evaluated on beef. Fresh *m. cutaneous trunci* was fabricated into 100 cm^2 samples (n = 154), which were randomly assigned to 11 treatments including Control, P, UV, ASC, PAA, and combinations P+UV, P+PAA, P+ASC, UV+PAA, UV+ASC, PAA+ASC. Treatments were tested under vacuum and aerobic conditions. Samples were inoculated with a STEC cocktail comprised of 7 strains to yield 3 log CFU/cm^2. Samples were vacuumed or overwrapped with oxygen permeable film. Samples were unpackaged and treated with buffered peptone water (BPW, Control) or individual or combined antimicrobial treatments prior to re-packaging. After 1 h at 7°C, samples were swabbed, homogenized in 1 mL of BPW, serially diluted and spread-plated for bacterial enumeration. Data was analyzed using SAS as a completely randomized design.

Results

Overall, treatments including MS phages significantly decreased STEC populations in beef under vacuum and aerobic conditions ($P < 0.0001$). Under vacuum, individual phage application, combinations between phage and UV, ASC, and PAA plus UV+ASC provided optimal STEC reduction on beef surface. Phage and PAA combination led to the lowest STEC load (1.49 log reduction). When analyzing contrasts, treatments with phage significantly decreased STEC loads when compared to other treatments ($P < 0.0001$) and control ($P < 0.0001$). STEC loads recovered from treatments without phage and control were statistically similar at $P = 0.32$. Under aerobic conditions, individual treatments UV and ASC and combinations including UV+PAA, and PAA+ASC were statistically similar to the control. Inclusion of phage in treatments gradually decreased STEC loads when combined with ASC, PAA, and UV. Phage and UV combination led to the lowest STEC load (1.46 log reduction). Contrast analysis showed that treatments with phage significantly decreased STEC loads when compared to other treatments ($P < 0.0001$) and control ($P < 0.0001$). STEC loads recovered from treatments without phage and control were statistically similar at $P = 0.07$.

Conclusion

Individual or combined applications of MS phages on beef surface contaminated with STEC provided optimal antimicrobial effect under vacuum or aerobic conditions. Although organic acids and UV combinations did reduce STEC populations, treatments that included phage yielded the lowest STEC loads. Only phage interventions gave optimal reduction effects under vacuum conditions. Antimicrobial treatments based on individual phage cocktails and their combinations with ASC, UV, and PAA significantly reduce STEC when treating primals produced during HEP.