Beef Trim and Wash Study

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Following an outbreak of foodborne illnesses in January 1993, in which *Escherichia coli* O15:H7 was found in undercooked ground beef, the USDA's Food Safety and Inspection Service mandated the trimming/removal of all physical contaminates from the surfaces of beef carcasses, prior to final washing of the carcasses. This zero-tolerance policy requires that carcasses containing any physical contamination must be side-railed on the slaughter floor until the contamination is trimmed and the carcass approved for final washing. The following studies were initiated to compare the effects of hand-trimming versus conventional spray washing on the bacterial levels of beef carcasses.

Phase One

Microbiological and visual evaluations were performed to compare the efficacy of hand-trimming and spray-washing treatments in the removal of bacteria and fecal material from beef adipose tissue. Subcutaneous fat samples, aseptically cut from the surfaces of briskets (obtained within 15 min postmortem), were inoculated with different amounts (0, 0.3125, 0.625, 1.95, 1.875 or 2.50 cm^2) of a bovine fecal paste containing a culture of streptomycin-resistant *Escherichia coli* (ATCC 11370). Then they were spray-washed, using a model spray-washing cabinet, with 35°C water at pressures of 2.76, 13.79, 20.68 or 27.58 bar, and at chain speeds equivalent to 100, 200 or 300 carcasses per hour. Aerobic total mesophilic plate counts and streptomycin-resistant bacteria plate counts were determined from 3.175-cm diameter tissue samples taken at the inoculation sites (spots "A"), as well as from positions immediately above and below (spots "B") the inoculated spots. Visual scores for fecal contamination were obtained immediately after spray-washing or trimming, by trained personnel.

The present study has shown that the most important factor in spray-washing with 35°C water was spraying pressure (2.76, 13.79, 20.68 or 27.58 bar). Pressures above 13.79 bar were more effective than lower pressures in reducing microbiological contamination and in cleaning the samples to remove visible fecal contaminants. Spray-washing at the highest pressure studied (27.58 bar) was more effective than hand-trimming (no washing) in reducing total plate and streptomycin-resistant bacteria counts on pieces of beef brisket fat. The influence of chain speed (100, 200 or 300 carcasses per hour) and size of fecal material contamination (0.3125, 0.625, 1.25, 1.875 or 2.5 cm^2) was less important than spray-washing pressure, under the conditions of this study. Reductions in microbiological contamination achieved by spray-washing were in the range of 1 -2 log CFU/cm^2. Effective spray-washing treatments were not different ($P< 0.05$) from hand-trimming in reducing microbiological counts and in removing visual fecal contaminants.

Two concerns with spray-washing treatments applied to remove contaminants from carcasses include whether the treatment either physically drives the microorganisms into the meat or spreads them across the surface of the carcass, thereby increasing the contamination of adjacent areas. The samples analyzed for microbiological contamination in this study were excised cores (not surface swabs) which were then macerated to release bacterial cells before plating for enumeration. The fact that bacterial counts detected in macerated samples after all spray-washing treatments were lower than counts present in macerated and non spray-washed control samples indicates that no embedding of bacterial cells occurred due to the spray-washing process.

The spray-washing treatments employed in this study did not translocate or spread the bacteria onto areas adjacent to the spot of artificial contamination with inoculated fecal material. The microbial counts found on the "B" locations (adjacent to the inoculation spot "A") were generally lower, both before and after spray washing, than counts at the inoculation sites ("A").

Based on the results of this phase, water pressure of 20.68 bar is recommended for spray-washing applications to remove fecal contaminants from beef carcasses.

Phase Two

This study compared various chemical solutions and hot water spray-washing interventions with hand-trimming and spray washing for their ability to remove fecal material and reduce bacterial contamination on beef brisket fat samples within 15 minutes post-mortem in a spray-washing cabinet. The brisket fat samples were inoculated with 2.5 cm^2 of a bovine fecal paste, containing a streptomycin-resistant strain of *Escherichia coli* (ATCC 11370).

Spray-washing was done in a model two-chamber cabinet. In the first part of this study, variables included slaughter chain speed (100 or 300 carcasses per hour), spray-washing pressure (2.76, 6.89 or 20.68 bar) and water temperature (16°, 32°, 66° or 74°C ± 5°C). In the second part, water plus chemical sanitizer were administered at 16°C, 1.38 bar, and 100 or 300 carcasses per hour. The sanitizers included 5% acetic

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acid, 12% trisodium phosphate, 5% hydrogen peroxide, 0.5% ozonated water and 0.3% of a commercial sanitizer (consisting of 3% decanoic acid, 3% nonanoic acid, 8.5% phosphoric acid, 9.5% sulfuric acid, 10% propionic acid and 66% inert ingredients). The hot water and chemical solutions were applied in two sequences. In the first sequence, the water treatment preceded the treatment. After treatment, brisket samples were evaluated visually by trained personnel. Microbial analysis was done for total plate counts and streptomycin-resistant bacteria counts.

Trimming alone or trimming followed by a single spray-washing treatment of plain water resulted in microbial count reductions of 1.44-2.50 and 1.41-2.29 log CFU/g for total plate and streptomycin-resistant bacteria counts, respectively.

Approximate reductions in bacterial counts achieved by a single spray-washing treatment using plain water were in the range of 1-2 log CFU/cm^2, with higher pressures (i.e., 20.68 bar) being generally more effective in reducing bacterial counts. These washing treatments (with no trimming) were nearly as effective (at higher pressures) as the trimming and washing combinations discussed above.

When water was applied first, followed by the chemical interventions, the most effective of the chemical interventions were 5% hydrogen peroxide and 0.5% ozonated water, achieving reductions of 2.87 and 2.72 log CFU/cm^2, respectively. The least effective chemical interventions were the commercial sanitizer and the 2% acetic acid, which resulted in 1.94 log CFU/cm^2 and 2.02 log CFU/cm^2 reductions, respectively.

Increasing the water temperature to 74°C increased removal or destruction of bacteria on the order of 3.0 log CFU/cm^2. However, the chemical interventions did not further enhance the decontamination above that achieved by the use of 74°C water. Also, hot water spray-washing (with no hand trimming) was more effective in decontaminating the beef fat surface than was hot water spray-washing (with hand trimming). Furthermore, spray-washing with hot water resulted in less variability in bacterial counts obtained after treatment compared to hand-trimming and/or spray-washing with water of lower temperatures. These data indicate that applications of hot water during spray-washing were effective means of reducing microbial counts on the external fat surfaces of beef.

When the sequence was reversed so that the applications of the chemical interventions preceded the water wash, hydrogen peroxide and ozonated water lost their activity. With this application sequence, 12% trisodium phosphate was the most effective in decontaminating beef adipose tissue; however, trisodium phosphate did somewhat discolor beef fat.

As in the first phase, there was no spreading of bacteria from the inoculated areas to adjacent areas due to the spray-washing action. All treatments eliminated visual fecal contaminants that had been placed on samples before processing.

The use of hot water (74°C) for spray-washing proved to be the most effective in decontaminating beef carcasses. Application of chemical interventions during spray-washing showed greatest potential when used with water sprays of lower temperatures (16° to 32°C).