## EVALUATION OF VARIOUS TREATMENTS TO REDUCE CONTAMINATION ON CARCASS TISSUE

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### Background

Following a highly publicized outbreak of foodborne disease caused by *Escherichia coli* O157:H7 in the U.S., there has been increased consumer awareness and interest by regulatory authorities and the industry to improve sanitary conditions and the microbiological status of meat in slaughter and processing plants. One action taken by the Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA) was the "Cattle Clean Meat Program" (i.e., the "Zero Tolerance" policy) of 1993, which instructed inspectors to strictly enforce the requirement of knife-trimming for removal of all visible physical contaminants from beef carcasses prior to washing and chilling. In addition, new meat and poultry inspection regulations were approved in the U.S. which include operation under the hazard analysis critical control point (HACCP) system. These developments renewed interest in meat decontamination procedures, which have been investigated for 25 years (Sofos, 1994).

### Objectives

The objective of this paper is to present data from studies that have evaluated decontamination technologies such as, steam-vacuuming of contaminated carcass spots, and application of sprays or rinses on carcass tissue.

### Methods

We evaluated spot-carcass decontamination with two commercial steam-vacuuming systems (Units A and B) as they were applied in commercial operations by plant personnel (Kochevar *et al.*, 1997). Unit A (Kentmaster Manufacturing Company, Inc., Monrovia, CA) drew a vacuum of –0.0093 bar (1 bar=100 kPa) while a water nozzle inside the vacuum head sprayed hot water (≥82° C) at 0.34 to 1.03 bar. Unit B (Jarvis Products Corporation, Middletown, CT) drew a vacuum of –0.0093 bar, while steam (82° C) was sprayed out of the hand wand (no nozzle) at a pressure of 1.03 bar, thus loosening the soil from the carcass surface and transporting it to a waste-water holding tank (Kochevar *et al.*, 1997). During the study, the vacuuming process was applied to the sample area (2.5 cm maximum size) in downward, vertical motions that were parallel to the length of the carcass, with a contact time of approximately 5 to 10 sec. The number of times of application (passes) and the total contact time depended on the extent of fecal contamination, ease of its removal, and speed of each application by the operator.

Studies by our laboratory have evaluated spraying or rinsing processes for decontamination of beef tissue samples that were uninoculated or inoculated with fecal material and/or bacterial cultures. Variables evaluated in the spray-washing decontamination studies included chemical agent (water, and solutions of acetic acid, trisodium phosphate, chlorine, hydrogen peroxide, and ozone), temperature of spraying solutions, spraying pressure, extent of contamination, and time of exposure to the decontaminating treatment. The studies were conducted in model, custom-built spray-washing units or in commercial chambers operating in major plants (Gorman *et al.*, 1995a,b; Cabedo *et al.*, 1996; Kochevar *et al.*, 1997).

Table 1. Mean total plate counts and visible fecal contamination scores before and after use of two steam-vacuuming units (A and B) or knife-trimming of beef carcasses evaluated in commercial slaughtering plants.

| Decontaminating process | | Mean visual scores[a] | | |
|---|---|---|---|---|
| Knife-trimming | Steam-vacuuming | Before | After | Mean aerobic plate counts (log CFU/cm$^2$) |
| No | No | 3.2-4.2 | 3.2-4.2 | 4.3-5.5 |
| Yes | No | 3.2-4.3 | 0-0.5 | 2.9-4.5 |
| No | Yes (A) | 3.3-4.4 | 0.1-0.5 | 2.4-4.4 |
| No | No | 4.0-4.5 | 4.0-4.5 | 4.6-5.1 |
| Yes | No | 4.0-4.7 | 0.1-0.6 | 2.9-3.5 |
| No | Yes (B) | 4.3-4.9 | 0.2-0.3 | 2.8 |

Kochevar *et al.* (1997a); [a]Score of 5: dense/visible fecal contamination; score of 0: no visible fecal contamination.

Table 2. Removal of visible and microbiological contamination from inoculated (with a fecal paste containing a streptomycin-resistant *Escherichia coli* culture) beef brisket tissue decontaminated by spraying with water (35ºC) of different pressures.

| | | Streptomycin-resistant microorganisms (log CFU/cm$^2$) | |
|---|---|---|---|
| Item | Visual scores[a] | Inoculation site | Adjacent site |
| Neither trimmed nor sprayed | 5.0[b] | 6.9[b] | 4.7[b] |
| Knife-trimming | 1.2[c] | 4.7[c] | 4.7[b] |
| 2.8 bar spraying | 1.1[c] | 5.1[c] | 4.3[c] |
| 13.8 bar spraying | 0.9[d] | 4.9[cd] | 4.2[cd] |
| 20.7 bar spraying | 0.6[e] | 4.8[d] | 4.1[d] |
| 27.6 bar spraying | 0.4[e] | 4.5[e] | 4.0[d] |

Gorman *et al.* (1995a); [a]Score of 5: dense/visible fecal contamination; score of 0: no visible fecal contamination.
[bcde]Means within a column bearing uncommon superscript letters are different (P≤0.05).

### Results and Discussion

Steam-vacuuming (Kochevar *et al.*, 1997) reduced aerobic plate counts of treated carcass spots (2.5 cm diameter) to an extent similar to knife-trimming (Table 1). The control counts of 4.3 - 5.5 and 4.6 - 5.1 log CFU/cm$^2$ were reduced to 2.9 - 4.5 and 2.9 - 3.5 by knife-trimming, and to 2.4 - 4.4 and 2.8 log CFU/cm$^2$ by steam-vacuuming, respectively. Furthermore, steam-vacuuming removed visible soil and cleaned the treated carcass surfaces to an extent similar to that of knife-trimming (Table 1).

Table 2 contains data showing the effect of spraying pressure on extent of decontamination of beef brisket tissue inoculated with feces containing a streptomycin-resistant *Escherichia coli* inoculum (Gorman *et al.*, 1995a). As the pressure of spraying increased, extent of decontamination increased, but above 13.8 bar the increases in decontamination were minor. Therefore, unnecessary high pressures should be avoided in order to reduce the potential of bacterial penetration into the tissue. Microbiological counts from areas adjacent to the inoculated site of the spray-washed tissue, indicated that, under the conditions of this study, there was no spreading of bacteria to the immediately adjacent areas (Table 2).

Time of exposure to contamination before application of decontamination treatments may influence bacterial attachment and efficacy of the decontamination process. The number of bacteria removed or inactivated by various spray-washing treatments decreased (Table 3) as the time lapse between exposure of beef carcass tissue to contamination and application of the decontamination treatments increased (Cabedo *et al.*, 1996). This may be a concern in operations where inspection to assure the adherence to "zero tolerance" trimming requirement may result in delay of application of carcass spray-washing treatments. In addition, the data of Table 3 demonstrate the efficacy of varying water temperatures (35°C, 74°C) and chemical agents (2% acetic acid, 5% hydrogen peroxide, and 12% trisodium phosphate) used as rinses on beef following spraying (20.7 bar, 12 sec) with 35°C water. The most effective decontamination treatment was hot (74°C) water. The extent of decontamination of beef carcass tissue achieved by spraying/rinsing with decontaminating agents such as water of variable temperatures (35°C, 74°C) and chemical solutions such as acetic acid (2%), hydrogen peroxide (5%), trisodium phosphate (12%) and ozone (5%) is also shown in Table 4. Water of 74°C was found to be the most effective decontaminating agent, while at lower temperatures the chemical agents were also effective (Gorman *et al.*, 1995b).

Table 3. Removal of microbiological contamination from inoculated (with a fecal paste containing a streptomycin-resistant *Escherichia coli* culture) beef brisket tissue decontaminated by spray-washing (35°C water, 20.7 Bar, 12 sec), and rinsing with various treatments following 0, 2 and 4 hours of storage (21°C) after inoculation.

| | Uninoculated | Inoculated | | | | | |
|---|---|---|---|---|---|---|---|
| Storage time (hr) | Water (35°) spray | No spray | Water (35ºC) spray | Water (74°C) rinse | Hydrogen peroxide (5%) rinse | Acetic acid (2%) rinse | Trisodium phosphate (12%) rinse |
| 0 | $3.0^{a}$ | $5.0^{a}$ | $1.9^{a}$ | $1.4^{a}$ | $1.9^{a}$ | $1.7^{a}$ | $1.8^{a}$ |
| 2 | $3.2^{a}$ | $5.0^{a}$ | $3.3^{b}$ | $1.5^{ab}$ | $2.1^{a}$ | $1.6^{a}$ | $2.9^{b}$ |
| 4 | $3.2^{a}$ | $4.6^{a}$ | $3.7^{b}$ | $2.5^{b}$ | $4.2^{b}$ | $4.1^{b}$ | $2.9^{b}$ |

Cabedo *et al.* (1996); [ab]Means within a column bearing uncommon superscript letters are different ($P \leq 0.05$)

## Conclusions

Decontamination technologies such as steam-vacuuming and spray-washing/rinsing were found effective in cleaning and reducing contamination on carcass tissue. However, the microbial status of the resulting meat will also be affected by subsequent handling, exposure to additional contamination, and application of further decontamination or preservation treatments.

Table 4. Removal of visible and microbiological contamination from inoculated (with a fecal paste containing a streptomycin-resistant *Escherichia coli* culture) beef brisket tissue decontaminated with various treatments.

| Decontaminating treatments | | | Streptomycin-resistant microorganisms (log CFU/cm$^2$) | |
|---|---|---|---|---|
| First treatment | Second treatment (wash[b]) | Visual score[c] | Inoculation site | Adjacent site |
| None | | 5.0 | 6.3 | 4.4 |
| Knife-trimming | | 0.4 | 4.2 | 3.8 |
| Water (35°C)[a] | Water | 0.0 | 5.4 | 4.8 |
| | Acetic acid (2%) | 1.1 | 4.3 | 3.8 |
| | Trisodium phosphate (12%) | 0.2 | 3.4 | 4.1 |
| | Hydrogen peroxide (5%) | 0.0 | 4.2 | 3.1 |
| | Ozonated water (0.5%) | 0.1 | 3.7 | 3.0 |
| Water (74°C)[a] | Water | 0.1 | 3.2 | 3.2 |
| | Acetic acid (2%) | 0.3 | 3.2 | 3.1 |
| | Trisodium phosphate (12%) | 0.3 | 3.5 | 3.6 |
| | Hydrogen peroxide (5%) | 0.1 | 3.2 | 2.9 |
| | Ozonated water (0.5%) | 0.2 | 3.2 | 2.9 |

Gorman *et al.* (1995b); [a]Pressure of 20.7 bar; exposure time of 12 sec; [b]Temperature of 16°C; pressure of 1.4 bar; exposure time of 12 sec. [c]Score of 5: dense/visible fecal material; score of 0: no visible fecal material.

## References


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