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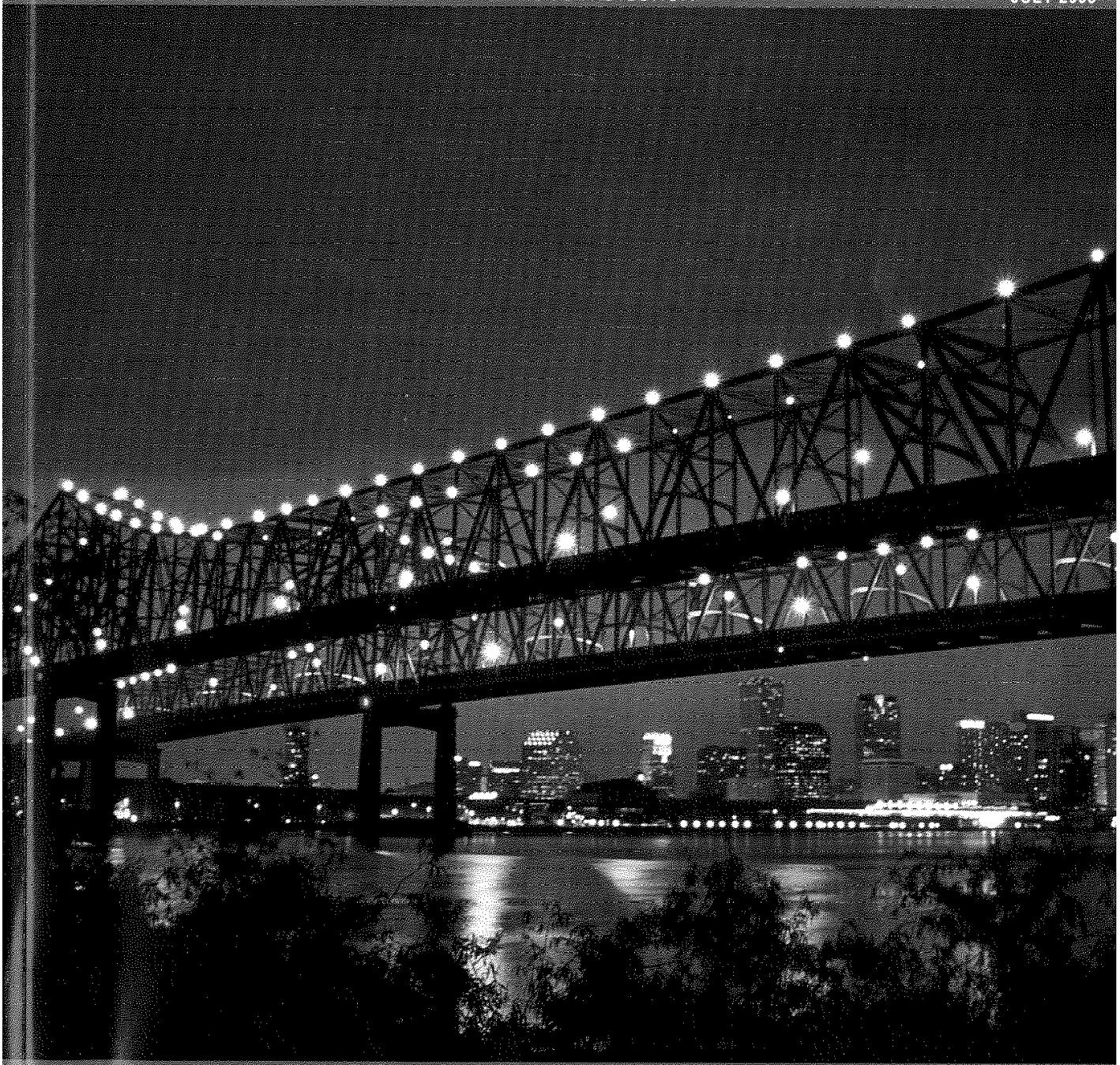

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# A Novel Intervention for the Reduction of Bacteria on Beef Carcasses

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## ABSTRACT

The Rinse & Chill™ Technology developed by MPSC, Inc., St. Paul, Minnesota involves the vascular transfer of a chilled solution of sugars and salts through the cardiovascular system. The solution removes most of the residual blood as it circulates throughout the carcass and drains. Rinse & Chill™ Technology is a process that ensures a consistent reduction in pH and internal temperature by vascular transfer of a chilled solution into the arterial/venous system and has been demonstrated to reduce significantly the number of microorganisms, particularly coliforms and generic *Escherichia coli*. Data collected from two separate commercial beef slaughtering facilities demonstrated reductions of a 40.3% ($n=180$; $P = 0.039$) and 41.2% ($n = 100$; $P = 0.009$) for aerobic microorganisms on rinsed carcasses, compared to controls. More importantly, the two commercial facilities demonstrated reductions of 99.3% ($n = 180$; $P = 0.125$) and 67.8% ($n = 100$; $P = 0.002$) in coliforms on the rinsed carcasses versus the controls. One of the facilities also demonstrated an 83.7% ($n = 100$; $P = 0.0008$) reduction in generic *E. coli* on the rinsed carcasses versus the controls. This study demonstrates that the Rinse & Chill™ Technology provides a novel intervention for improving microbial control of contamination on bovine carcasses.

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## INTRODUCTION

Because of increased consumer awareness and recent changes in the regulation of meat inspection, the meat industry has attempted to improve sanitary conditions and the microbiological status of meat in slaughtering and processing plants. In 1993, the "zero tolerance" policy, which requires knife trimming to remove all visible physical contamination from beef carcasses prior to washing and chilling *(2)*, was enacted. Since 1996, the Pathogen Reduction/HACCP Act requires meat and poultry slaughter establishments to implement sanitation standard operating procedures (SSOPs) and a hazard analysis critical control point (HACCP) system *(3)*. Microbiological performance criteria, with standards for generic *Escherichia coli* and *Salmonella,* as a means of verification of HACCP were also established. These regulations have led to more research into, and development and application of, meat decontamination technology, with the objective of helping the industry to meet or exceed regulatory requirements as well as providing consumers with a microbiologically cleaner and safer product *(5)*.

Rinse & Chill™ Technology is an enhanced bleeding technique that involves vascular transfer of a chilled isotonic solution of approved common substances (sugars and salts) through the cardiovascular system of beef animals during slaughtering. The purpose of Rinse & Chill™ Technology is to lower pH and temperature earlier and more rapidly and to more thoroughly remove residual blood from the animal. The objective of this study was to demonstrate that Rinse and Chill™ Technology can provide a novel intervention for improving control of microbial contamination on bovine carcasses.

## MATERIALS AND METHODS

### Slaughter

Cattle were slaughtered humanely in each commercial facility. They were assigned randomly to two groups, control or rinsed. For this study, animals were slaughtered and rinsed on seven sampling dates in Plant X; in Plant Y, animals were slaughtered and rinsed on three sampling dates. Cattle to be rinsed through the vascular transfer of chilled solution in the arterial/venous system were bled by severing both jugular veins. When the bleeding was nearly completed, an incision was made in the left carotid artery, and a catheter was inserted into the artery for the rinsing process. The rinsing solution (MPSC, Inc., St. Paul, MN) consisted of a dilute mixture of sugars and salts in water. Control groups were bled using the traditional method.

### Carcass sampling

Carcass sponge samples were taken either 2 hours (Plant X) or 24 hours (Plant Y) after carcasses were washed and placed in the coolers. Meat/Turkey Carcass Supply Kits from NASCO (Fort Atkinson, WI) were used to collect the carcass sponge samples, following the procedure described in the U.S. Meat and Poultry Inspection Regulation *(3)*. Ten ml of buffer was used to hydrate a sterile sponge. After the sample area was swabbed with the sponge, another 15 ml of buffer was added to the sponge in the bag, to bring the total volume to 25 ml. Swabbing consisted of 10 horizontal strokes and 10 vertical strokes in the template area of the brisket, flank and rump. The carcass sponge samples were immediately refrigerated (< 4°C) until they were shipped overnight, in a Styrofoam insulated shipping container with freezer packs, to the laboratory.

### Microbiological analysis

Aerobic plate counts (APC) were determined, using 3M™ Petrifilm™ Aerobic Count Plates (St. Paul, MN); coliforms and generic *E. coli* were enumerated, using 3M™ Petrifilm™ *E. coli* Count Plates. Each sample was stomached for 2 min. One millimeter of broth was then removed from the sample bag and placed onto the respective Petrifilm™ plate. The samples were plated in duplicate and the plates incubated at 37°C for 48 h.

### Statistical analysis

All bacterial counts were converted to $\log_{10}$ CFU/ml for statistical analysis. The statistical test used in this study was student's *t*-test (paired, two-tailed), with a significance level of $P \leq 0.05$. The calculations were performed with Microsoft® Excel Version 2002, statistical functions (Microsoft Corp., Redmond, WA).

## RESULTS

### Carcass sponge samples

The average aerobic plate counts and coliforms on beef carcasses from Plant X are shown in Fig. 1. For 180 beef carcasses (90 controls; 90 rinsed) that had been in the cooler for 2 h, carcass sponge samples showed that rinsing was associated with a 40.3% reduction in APC and a 99.3% reduction in coliforms. No generic *E. coli* were detected on either control or rinsed carcasses. The frequency of coliforms detection was 22/90 for controls and only 11/90 for the rinsed carcass samples (Table 1).

The average aerobic plate counts, coliforms and generic *E. coli* on beef carcasses from Plant Y are shown in Figure 2. For 100 beef carcasses (50 controls; 50 rinsed) that had been in the cooler for 24 h, carcass sponge samples demonstrated a 41.2% reduction in APC and a 67.8% reduction in

**TABLE 1. Analysis of APC and coliforms from 2-hour-cooler sponge samples from Plant X over 7 sampling dates**

| APC | N | Av. $Log_{10}$ CFU/cm² | % Reduction | | P value (95% = ≤ 0.05) |
|---|---|---|---|---|---|
| Control | 90 | 3.09 | | | |
| R&C | 90 | 2.86 | 40.3% | | 0.039 |
| **Coliforms** | **N** | **Av. $Log_{10}$ CFU/cm²** | **% Reduction** | **Frequency of coliforms** | **P value (95% = ≤ 0.05)** |
| Control | 90 | 1.99 | | 22/90 | |
| R&C | 90 | -0.155 | 99.3 | 11/90 | 0.125 |

**TABLE 2. Analysis of APC, coliforms and generic *E. coli* from 24-hour-cooler sponge samples from Plant Y over 3 sampling dates**

| APC | N | Av. $Log_{10}$ CFU/cm² | % Reduction | | P value (95% = ≤ 0.05) |
|---|---|---|---|---|---|
| Control | 50 | 2.76 | | | |
| R&C | 50 | 2.53 | 41.2% | | 0.009 |
| **Coliforms** | **N** | **Av. $Log_{10}$ CFU/cm²** | **% Reduction** | **Frequency of coliforms** | **P value (95% = ≤ 0.05)** |
| Control | 50 | 2.54 | | 41/50 | |
| R&C | 50 | 2.05 | 67.8 | 31/50 | 0.002 |
| **Generic *E. coli*** | **N** | **Av. $Log_{10}$ CFU/cm²** | **% Reduction** | **Frequency of generic *E. coli*** | **P value (95% = ≤ 0.05)** |
| Control | 50 | 2.47 | | 31/50 | |
| R&C | 50 | 1.68 | 83.7 | 16/50 | 0.0008 |

coliforms for rinsed carcasses, compared to controls. In addition, there was an 83.7% reduction in generic *E. coli*. The differences between the rinsed and control carcasses with respect to APC, coliforms and generic *E. coli* were significant, $P = 0.009$, $P = 0.002$ and $P = 0.0008$, respectively. The frequency of coliforms detected was 41/50 on controls versus 31/50 on rinsed carcasses. The generic *E. coli* frequency was 31/50 for controls versus only 16/50 on rinsed carcasses (Table 2).

## DISCUSSION

Contamination of beef carcasses occurs with the transfer, to the meat surface of material from the exterior of the live animal and/or from the environment *(1)*. Consumer concerns

**FIGURE 1.** $Log_{10}$ average aerobic plate counts and coliforms on beef carcasses from Plant X after 2 h in cooler. N = 180 (90 control; 90 rinsed). A significant difference was seen for APC ($P = 0.039$) but not for coliforms. A 40.3% reduction in aerobic plate counts and a 99.3% reduction in coliforms was demonstrated between controls and rinsed carcasses

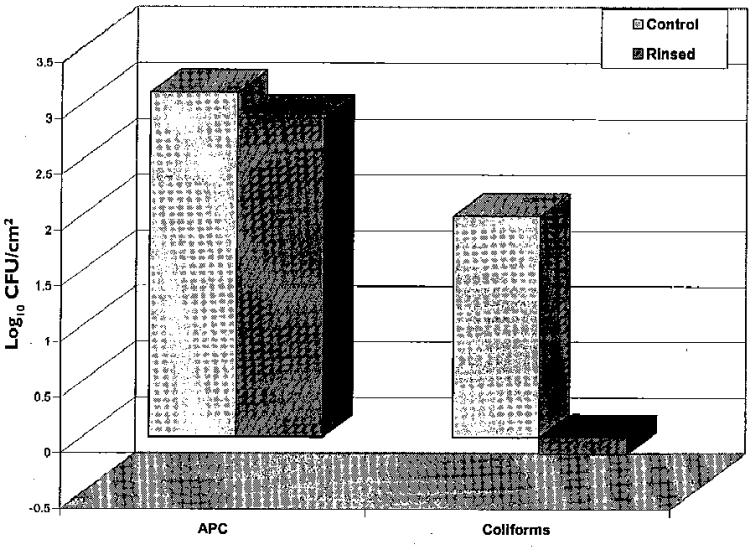
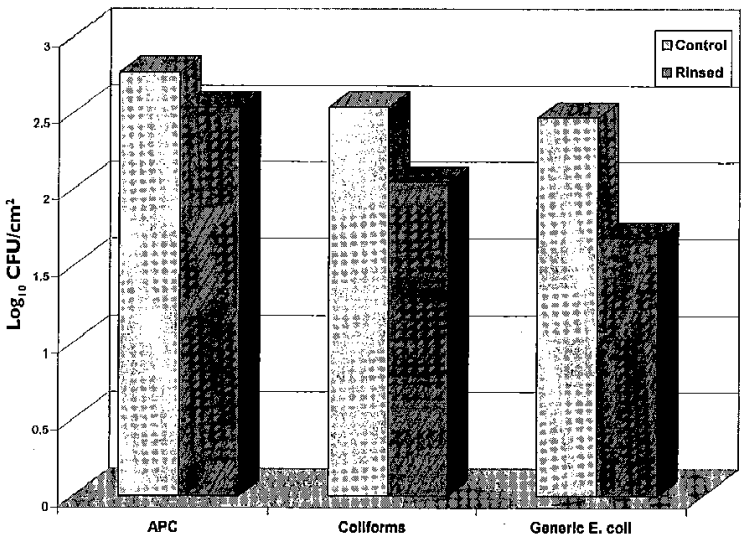



**FIGURE 2.** $Log_{10}$ average aerobic plate counts and coliforms on beef carcasses from Plant Y, comparing controls and rinsed carcasses after 24 h in cooler. N = 100 (50 controls; 50 rinsed). Significant differences between controls and rinsed carcasses were seen in APC, coliforms and generic *E. coli*, $P = 0.009$, $P = 0.002$ and $P = 0.0008$, respectively




over the safety of meat have mounted since 1993, when outbreaks caused by *Escherichia coli* O157:H7 and other microbial pathogens led to the initiation of new regulatory requirements by the USDA Food Safety and Inspection Service *(3)*. Meat and poultry facilities must knife-trim carcasses to remove all visible fecal contamination, comply with written sanitation standard operating procedures, implement hazard analysis critical control point (HACCP) systems and meet microbiological performance standards for generic *Escherichia coli* and *Salmonella*, to verify the effectiveness of HACCP and pathogen reduction procedures within the plant. A variety of methods have been developed and implemented to reduce the presence of bacteria on beef and increase microbiological safety *(4)*. These technologies include animal cleaning, spot cleaning of carcasses by knife-trimming or steam/hot-water vacuuming, and spraying/washing/rinsing of carcasses with water, chemical solutions and/or steam or hot water, before evisceration and/or before chilling.

The research presented here demonstrates the effectiveness of the Rinse & Chill™ Technology as a novel intervention for reducing bacterial populations on freshly slaughtered beef carcasses in two separate slaughter facilities. There was a statistically significant difference ($P = 0.039$ for Plant X and $P = 0.009$ for Plant Y) in aerobic plate counts when control and rinsed carcasses were compared. More importantly, there was a 99.3% reduction in coliforms in Plant X, as well as and a 67.8% reduction in coliforms and 83.7% reduction in generic *E. coli* in Plant Y, in rinsed versus control carcassses.

It is important to note that even though other intervention methods (steam vacuum, steam pasteurization and lactic acid rinse), were in place in Plant Y post-intervention contamination occurred in the coolers, and

yet the Rinse & Chill™ Technology continued to provide protection. In fact, a recent study has demonstrated that Rinse & Chill™ Technology provides ongoing protection against the growth of coliforms and *E. coli* O157:H7 in vacuum-packaged and tray pack ground beef (unpublished data, Feirtag, et al.).

The mechanism(s) involved in Rinse & Chill™ Technology that contribute to its effectiveness as a novel intervention technology for reduction of bacteria on beef carcasses is currently being assessed. The reduction in pH and internal temperature of the carcasses, in addition to removal of the blood with the vascular transfer of the chilled solution, may provide an unfavorable environment for growth and survival of bacteria. Also, Rinse & Chill™ carcasses allow for easier removal of hides, which may lead to less contamination on the surfaces of carcasses. In addition, there appears to be an antimicrobial effect of the solution itself. Further studies are being conducted to elucidate the mechanism of the protection afforded by the use of Rinse & Chill™ Technology on carcasses and further processed meat products.

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