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Effectiveness of Trimming and/or Washing on Microbiological Quality of Beef Carcasses

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ABSTRACT

Beef carcass sides (n = 48) were selected randomly on three different days in a commercial processing facility and microbiologically analyzed before being moved to the cooler. Four types of samples were obtained per side from the inside round area: no trim and no wash (NTNW); trim, but no wash (TNW); trim and wash (TW), and no trim but wash (NTW). A flame-sterilized knife, forceps, and scalpel were used for each trimming treatment and sampling. Significant differences ($P < 0.05$) were observed in mean aerobic plate counts (APCs) between treatments. The greatest reduction in APC ($\log_{10}$ colony forming units [CFU] per cm^2) was observed in TNW samples followed by TW and NTW, with the corresponding mean APC reductions relative to NTNW being 3.0, 0.9, and 0.3, respectively, indicating that trimming can be an effective control point in reducing bacterial contamination in the slaughter process. Although TNW samples, had the lowest counts, samples from the same location after wash (TW) had counts 2 log cycles higher than TNW samples. These results indicate that washing spreads contamination to adjacent carcass sites. However, washing of carcasses was effective in lowering microbial populations relative to the NTNW treatment. *Escherichia coli* and coliform counts in all samples were low (0.03 to 0.4 $\log_{10}$ CFU/cm^2); however, the mean *E. coli* or coliform count in NTNW samples was higher ($P < 0.05$) than those in the rest of the treatments.

Key words: Beef, meat, trimming, washing

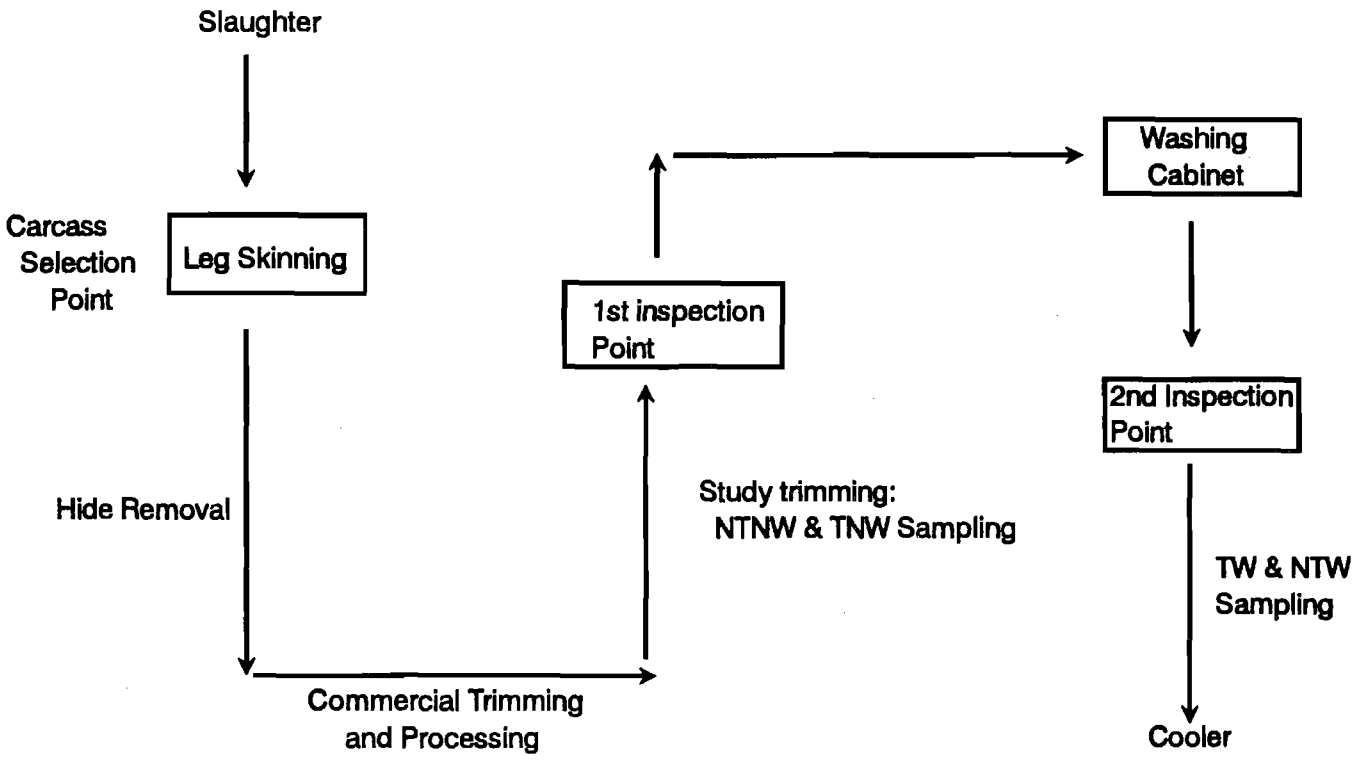
Although the presence of microorganisms on beef carcass surfaces immediately below the hide is not expected, contamination of this layer during slaughter and dressing operations is unavoidable. This has been an area of much attention relative to finding ways to minimize bacterial contamination on carcasses, thus providing higher quality and safer meat products. Several methods including the use of cold or hot water washes or sprays, application of chlorinated water, and organic acid rinses have been investigated and were reviewed by Dickson and Anderson (*3*). In combination with these approaches, trimming of visible contamination followed by washing has been the standard commercial practice and is regulated by USDA in an effort to minimize physical and microbial contamination. Because the surface of freshly dressed beef carcasses is the first to be contaminated during slaughter and dressing operations, the USDA's consideration in implementing the "zero tolerance" policy (*5*) for any amount of fecal matter has placed more emphasis on trimming of physical contaminants. However, trimming is a highly variable operation, with its efficacy primarily related to the individual line worker and the technique involved. Several studies have identified equipment, such as knives, gloves, and aprons, as reservoirs of bacteria in the abattoir (*7, 8*). In addition, the possibility that carcass washing may spread contamination from one area of a carcass to another must be considered (*4*). Actually, no data are available concerning the magnitude of microbial reduction as affected by combinations of trimming and/or washing practices routinely applied to carcasses before they are moved to the holding cooler. Several laboratory-scale studies have used fecal material as a contaminating agent in washing studies (*1, 2*); however, no in-plant studies have been reported that evaluate the efficacy of combinations of trimming and/or washing in reducing the microbial contamination of carcass surfaces. Therefore, the purpose of this study was to evaluate the effectiveness of trimming and/or washing processes on the microbiological quality of beef carcasses in commercial processing facility.

MATERIALS AND METHODS

Carcass selection

Twenty-four beef carcasses (USDA Choice, Yield Grade 1 to 3) were selected randomly on 3 days (in three replicate groups of eight carcass each) from a slaughter line in a large commercial processing plant. Carcasses were selected at the leg-skinning station of the processing line (Fig. 1). Each carcass side was tagged and the entire inside round was outlined with edible ink as a designation for line workers to refrain from knife trimming procedures in that area. Therefore, for each replicate, eight carcasses yielded 16 sides. All sides subsequently moved through the commercial processing line in a routine manner, with the exception of no knife trimming in the designated inside round area.

Figure 1. *Diagram of the commercial processing line and sampling sites.*



Carcass treatment and sampling

To minimize microbial variation due to carcasses differences, samples for all treatments were obtained from the inside round area of the same carcass side (Fig. 2). This sampling location was chosen because it typically receives the least carcass-to-carcass contact while sides move along the rail, thus minimizing microbial spread from one sampling location to another.

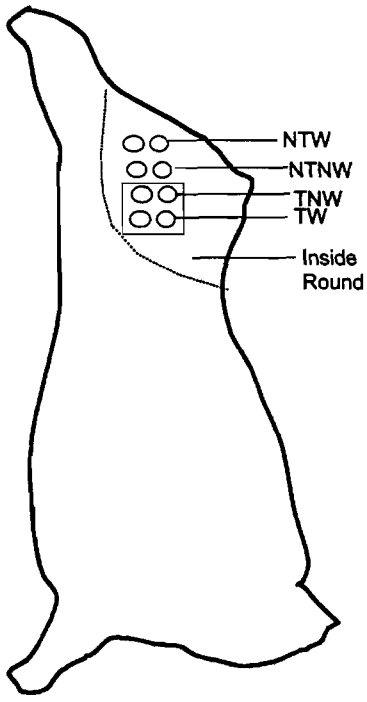
Each carcass side yielded four treatments: (i) no trim and no wash (NTNW); (ii) trim, but no wash (TW); (iii) trim and wash (TW); and (iv) no trim, but wash (NTW). All samples designated as trimmed (TNW and TW) were taken at the first inspection point (Fig. 1). Trimming was carried out by making only one surface cut of approximately 400 cm^2 (1.5 mm thick) of surface area from the inside round area of each carcass side (Fig. 2) with a sterilized knife and forceps.

Sampling for each treatment was accomplished by excising two 11.4-cm^2 surface areas (2 mm thick) from the inside round area of each carcass side with sterile metal coring device, scalpel, and forceps. The two 11.4-cm^2 surface area cores obtained from each treatment were then combined by placing them into sterile stomacher bag with a filter (Spiral Biotech. Inc., MD). The stomacher bag was rolled and secured with a rubber band and then stored on dry ice while on the slaughter floor. The sampling pattern for each treatment is shown in Fig. 2. At the first inspection point (Fig. 1), the NTNW (two 11.4-cm^2 surface areas) samples were taken from each inside round prior to any trimming. Then, a total surface area of approximately 400 cm^2 (1.5 mm thick) of the inside round was trimmed aseptically just below the NTNW sampling area, and the TNW samples were obtained from that trimmed area (Fig. 2). Samples for the remaining two treatments were obtained at the second inspection point (Fig. 1) after carcass sides had received a conventional wash. Samples for the TW treatment were taken from just below the TNW sampling site. NTW samples were obtained from outside of the trimmed area above the NTNW sampling site. Following sampling, all samples were transported frozen (on dry ice) to the Kansas State University meat microbiology laboratory for microbiological analyses. Because on-site analytical facilities were not available, samples for each replicate were stored frozen for 3 days before microbiological analyses. Although it is possible that slight reductions in microbial populations occurred as a result of freezing and transportation of samples, all samples were handled similarly and thus, the relative magnitudes of microbial reductions should be proportional.

Microbiological analyses

Samples were analyzed for aerobic plate counts (APCs), coliforms, and *Escherichia coli*. Thirty milliliters of sterile 0.1% peptone diluent (Difco) were placed into each sterile filter stomacher bag containing a composite of two sample cores and then stomached for 2 min in a Stomacher-400 (Tekmar® Company, Cincinnati, OH). APCs were determined by plating 1 ml of the sample homogenate and appropriate tenfold dilutions of the same either by the pour plate method using plate count agar (Difco) or the spiral plate method (Spiral Plater Model DU-2; Spiral Biotech. Inc., Bethesda, MD). These plates were incubated at 32°C for 48 h. For enumeration of coliforms and *E. coli*, Petrifilm™ *E. coli* count plates (3M Health Care, St. Paul, MN) were used. These plates were incubated at 32°C for 24 h.

Figure 2. *Diagram of the sampling plan for inside round.*



Statistical analyses

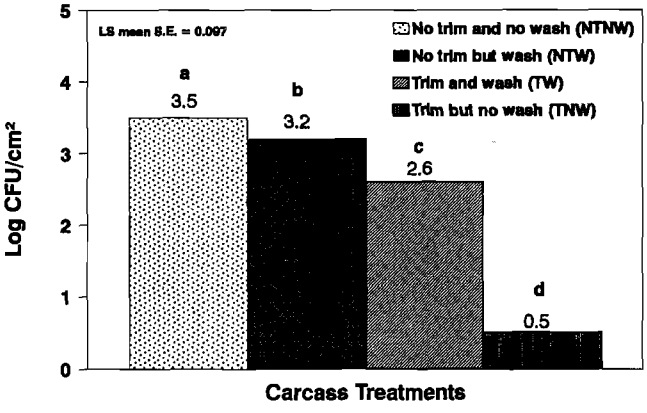
Differences in microbiological counts between treatments were compared by the general linear models procedure. When significant ($P < 0.05$) differences were observed, mean separation was performed by the Least Square Means Procedure (*6*).

RESULTS AND DISCUSSION

Enumeration of aerobic bacterial populations (Fig. 3) showed that the mean APCs ($\log_{10}$CFU/cm^2) from all carcass treatments were significantly different ($P < 0.05$). As expected, treatment NTNW had the highest total microbial counts, whereas treatment TNW had the lowest counts, followed by the TW and NTW treatments. When compared to treatment NTNW, the log-unit reductions in total microbial counts in treatments TNW, TW, and NTW were 3.0, 0.9 and 0.3, respectively (Fig. 3).

Because the trimming process in this study involved the removal of a pre-defined surface area (a single cut of approximately 400 cm^2 and 1.5 mm thick) using a sterile knife and forceps, samples obtained from the area immediately after trimming (treatment TNW) had very low microbial counts, as expected. However, APCs of samples taken from the same trimmed area after washing (treatment TW) had microbial counts as high as 2 log CFU/cm^2 more than corresponding TNW samples (Fig. 3). This indicated that the washing step can spread microbial contamination from one location to another on carcasses. In addition, bacterial counts of samples from the wash-only treatment (NTW) were even higher than (as high 7 1% more) and statistically different ($P < 0.05$) from TW samples (Fig. 3). When compared to NTNW treatment, the percentage reductions in microbial counts with NTW or TW treatments were 50 and 87%, respectively (Fig. 3). This observation showed that even if the washing step can spread or dilute bacterial contamination from one area to another on a carcass, the effect of carcass washing in reducing bacterial contamination, although smaller in magnitude, is still better than no wash. In addition, since the bacterial reduction caused by TW treatment was greater than that achieved by NTW, use of trimming in combination with washing seems more practical and desirable than washing alone.

Figure 3. *Effect of trimming and/or washing treatment on total aerobic bacterial populations (mean $\log_{10}$ CFU/cm^2) of beef carcasses sampled immediately before being moved to the cooler. Individual means in each treatment are based on 48 surface samples from 3 replicates of 16 carcass sides each. Means with different letters (a,b,c,d) differ significantly (P<0.05).*



Enumeration data of *E. coli* and coliform populations showed that, although the number of these organisms was very low in all treatments, the mean *E. coli* and coliform counts ($\log_{10}$ CFU/cm^2) were significantly higher ($P < 0.05$) in treatment NTNW than in the rest of the treatments. The range of counts between treatments was log 0.04 to 0.2 CFU/cm^2 (*E. coli*) and log 0.03 to 0.4 CFU/cm^2 (coliform). The ranking of these counts among treatments was the same as observed for APCs (Fig. 3).

This study was designed to remove as much experimental error as possible from the microbiological analyses by taking all four carcass treatments from the same general area of the same carcass. The result of this study showed that TNW samples had the lowest microbial counts. This is probably because TNW samples were taken from the location that was completely trimmed by making one cut using a sterile knife. In this study, the controlled trimming procedure was done with the objective of comparing the actual effect of trimming alone on the microbiological quality of carcasses and of determining the extent of spreading microbial contamination during subsequent washing of trimmed carcasses. The effectiveness of the trimming process is mainly dependent upon the skills and training of the employee involved and the sanitary condition of the knife used between trimming sites. The trimming procedure that is practiced on the actual commercial trimming line consists of removing only areas showing visible fecal and/or physical contamination. Since the knife used in the trimming process is not always sanitized between trimming sites within a carcass, the possible spread of contamina-

tion from one area to another is a potential concern. In such a situation, the bacterial counts following conventional trimming of a carcass would likely be higher than counts after the controlled trimming procedure followed in this study.

In conclusion, the effectiveness of trimming and/or washing in reducing bacterial contamination is not disputed. However, trimming of the entire carcass surface using sterile instruments is not practical in a commercial process and washing will likely be a part of all protocols. Therefore, trimming of visible carcass contamination followed by washing seems to be the most practical and effective method for reducing microbial contamination in the commercial beef processing setting. Frequent sanitization of knives and any other tools to be used in the trimming process would reduce or minimize the spread of bacterial contamination.

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