REDUCTION OF MICROBIAL LOADS ON BEEF TRIMMINGS USING A SUBMERSION INTERVENTION TREATMENT IN A COMMERCIAL FABRICATION FACILITY IN THE UNITED STATES

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I. INTRODUCTION

Lactic acid is listed in the Food Safety Inspection Services directive as a safe and suitable processing aid for beef to reduce food-borne pathogens [1]. It is commonly used on beef carcasses as an anti-microbial intervention [2]. While extensive data exist on the use of lactic acid on intact carcasses as an intervention, little information is available on trim products that are raw ground beef components such as chuck, heel, and shanks in actual processing situations. Additionally, interventions applied as a submersion are even more rare in the beef industry in the United States. Therefore, the objective of this study was to evaluate the efficacy of lactic acid immersion dip as an antimicrobial intervention on various trim products in a commercial beef facility in the United States from 2016 to 2018.

II. MATERIALS AND METHODS

During the course of 3 years, sampling replications were conducted over 3 separate production days in a commercial beef fabrication facility in the United States. Chuck, heel, and shank trim meat samples were randomly collected, pre- and post-lactic acid immersion treatment (2016: N=150; 2017: N=260; 2018: N=40). Lactic acid immersion parameters included a concentration between 2 to 5%, temperature between 43 to 54°C. After the immersion, the facility had a conveyor belt system to allow for the drip loss to ensure that US standards were not exceeded for added water/adulteration. The selected trim products were sampled in a 100 cm^2 areas utilizing sterile, pre-hydrated (25 mL Buffered Peptone Water) sponges. Sponges were immediately placed in coolers with ice packs and shipped overnight to the Texas Tech University Food Microbiology laboratory for microbiological analyses. Sponges were stomached at 230 rpm for 30 seconds, serially diluted, and plated to determine total aerobic plate counts (APC), total coliform counts, and generic *Escherichia coli* (*E. coli*) counts using 3M APC Petrifilm and 3M *E. coli*/Coliforms Petrifilm, according to the manufacturer's instructions. All counts were determined, converted to Log CFU/swab, and statistically analyzed as a randomized complete block design and fixed effects being meat (chuck, heel, and shank), treatment (pre – and post-lactic acid immersion), and meat × treatment interaction and the random effect as year, using the MIXED procedure of SAS version 9.4, with significant differences at $P \leq 0.10$.

III. RESULTS AND DISCUSSION

There was a meat × treatment interaction for aerobic bacteria and coliform counts (P = 0.030 and 0.009, respectively, Figure 1). Furthermore, both aerobic bacteria (P < 0.001) and coliforms (P < 0.001), for all meat types, were significantly reduced post-lactic acid treatment. However, there was no interaction effect on *E. coli* counts (P = 0.333). Moreover, there were differences in the fixed effects, meat type (Figure 2) and treatment effect on aerobic bacteria, coliforms, and *E. coli* counts. Comparing meat types, chuck had more aerobic bacteria (P < 0.001), coliforms (P < 0.001), and *E. coli* (P < 0.001) counts compared to heel and shanks. Heel and shanks were also significantly different from each other for aerobic bacteria (P < 0.001), coliforms (P < 0.001), and *E. coli* (P = 0.007) counts. Moreover, heel bacteria counts were less compared to shanks with reductions ranging from 0.16 to 0.50 Log CFU/swab. Overall, lactic acid immersion treatments significantly reduced all bacteria (P < 0.001) as demonstrated through multiple studies over time. Aerobic bacteria, coliforms, and *E. coli* counts reduced by 0.99, 1.12, and 0.35 logs post-lactic acid. Total indicator bacteria on all meat types were significantly different pre- and post-lactic acid treatment (P < 0.001), except for

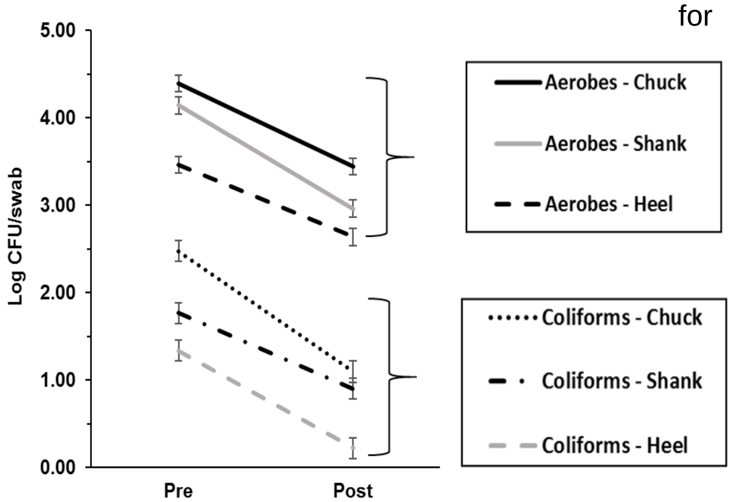

Figure 1. Meat × treatment interaction between pre- and post-lactic acid immersion treatment for aerobic bacteria (P = 0.030) and coliform (P = 0.009) Log CFU/swab. Error bars represent standard error of mean.

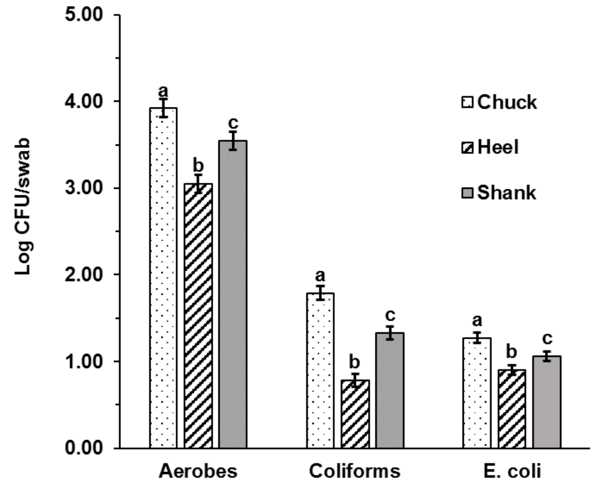

Figure 2. Aerobic bacteria, coliforms, and *Escherichia coli* (*E. coli*) Log CFU/swab enumeration between meat types. Error bars represent standard error of mean. [ab]within bacteria, means without common letters differ.

coliform counts of chuck (1.10 Log CFU/swab) and shank (0.90 Log CFU/swab) post-lactic acid treatment (P = 0.129)

IV. CONCLUSION

This experiment validates the efficacy of lactic acid immersion as an antimicrobial intervention for beef trim production and the consistent reduction in the indicator bacteria over time. The selection of meat types from locations that can easily be cross-contaminated after hide removal can be observed to still contain detectable levels of aerobic bacteria, coliforms, and *E. coli.* Carcasses are submitted to a lactic acid wash, however, there is an evident need for the additional lactic acid wash prior to final subprimal trim packaging. The Log CFU/swab observed in heel and shank products was less compared to chuck, which could be attributed to the additional on-line interventions such as steam washing on the hind legs prior to disassembly into subprimals. Moreover, previous research as shown that lactic acid immersion is more effective at reducing bacteria, specifically *E. coli* O157:H7, non-O157 STEC, and *Salmonella,* compared to lactic acid spray, water spray, and water immersion on beef trim [3]. Furthermore, using validated in-plant lactic acid immersion parameters and a continuous delivery system, the immersion procedure effectively reduces aerobic bacteria, total coliforms, and generic *E. coli*. Thus, validating antimicrobial interventions, such as lactic acid immersion, in actual processing situations provides additional knowledge and understanding of how processing aids can be influenced by unforeseen variables in commercial facilities. One important consideration when using an immersion treatment, is that care is taken not to result in product adulteration. Lastly, conducting multi-year evaluations can provide commercial facilities with a powerful baseline enumeration of common foodborne indicators and pathogens pre- and post-antimicrobial treatments in various locations and stages of beef productions.

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