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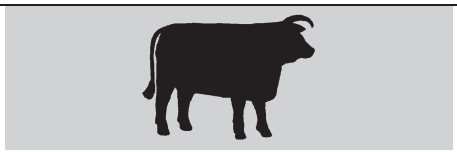

The influence of trisodium phosphate, potassium lactate, sodium metasilicate, cetylpyridinium chloride, or water as antimicrobial intervention systems on microbiological and instrumental color characteristics of beef biceps femoris muscles

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ABSTRACT

Biceps femoris muscle subsections (n = 35) were inoculated with Escherichia coli (EC) and Salmonella Typhimurium (107 cfu/mL). Subsections were spray treated with (1) water; (2) 3% potassium lactate; (3) 4% sodium metasilicate; (4) 0.5% cetylpyridinium chloride (CPC); and (5) 10% trisodium phosphate and compared with (6) an inoculated, untreated control or (7) an uninoculated, untreated control. Steaks from subsections (n = 105) were placed on Styrofoam trays with absorbent pads, overwrapped with polyvinyl chloride film, displayed at 2°C in a simulated retail display, and sampled on d 0, 1, 2, 3, 5, and 7 of display for EC, Salmonella Typhimurium, coliforms (CO), aerobic plate count, and instrumental color characteristics. All treatments were similar (P > 0.05) in redness (a) to the uninoculated, untreated control through display. The potassium lactate treatment reduced (P < 0.05) CO, EC, and aerobic plate count, and CPC and water reduced (P < 0.05) CO and EC counts on d 0 compared with the inoculated, untreated control. The CPC and sodium metasilicate treatments outperformed (P < 0.05) other treatments in reducing CO, EC, and aerobic plate count counts on d 3 of display. Therefore, potassium lactate, CPC, and sodium metasilicate might provide additional safety for regulatory considerations and beef processors at the subprimal or intact muscle level.*

Key words: cetylpyridinium chloride, trisodium phosphate, potassium lactate, *Escherichia coli*, *Salmonella* Typhimurium

INTRODUCTION

New and emerging pathogens continue to provide an obstacle for producers and consumers with regard to meat safety. In the United States there are an estimated 48 million

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cases of food-borne illnesses each year (CDC, 2014). Adam and Brulisauer (2010) stated that the production of safe red meat depends on effective control of pathogenic microorganisms from farm to fork. The most serious meat-safety issues affecting consumer health involve microbial pathogens (Sofos, 2008).

Meat decontamination techniques provide benefit for reducing or eliminating bacteria that may be pathogenic to humans and those that may cause meat spoilage (Huffman, 2002). Castillo et al. (1999), Shelef (1994), and Siragusa (1995) investigated and reviewed various antimicrobials in an attempt to reduce microorganisms on carcass surfaces. Although antimicrobials may be effective for reducing microorganisms, they can sometime be detrimental to quality (Reagan et al., 1996; Dorsa et al., 1997).

When beef carcasses are fabricated into retail cuts, any microbial contamination present on carcasses will be introduced to newly exposed surfaces (Emswiler et al., 1976). Therefore, it is important to provide interventions that reduce or eliminate potential pathogens on newly inoculated surfaces. Because of the importance, the USDA-Food Safety and Inspection Service addressed the need for applying antimicrobials at the subprimal level (FSIS, 2007). Postfabrication interventions provide an opportunity to enhance beef safety, but little is known regarding the effect on beef color.

The strength of attachment of bacteria plays a significant role in the effectiveness of antimicrobial interventions (Pohlman et al., 2002). Trisodium phosphate (**TSP**) and cetylpyridinium chloride (**CPC**) are 2 very effective treatments that have been used for microbial decontamination of beef and poultry tissues (Dickson et al., 1994; Kim and Slavik, 1994). Pohlman et al. (2009) found that potassium lactate (**KL**) and sodium metasilicate (**NMS**) treatments maintained oxymyoglobin content and redness of beef color through simulated retail display, indicating that antimicrobials applied after fabrication may have the potential to improve safety and maintain color.

Therefore, the objectives of this study were to evaluate the effectiveness of antimicrobial interventions on reducing *Escherichia coli* and *Salmonella* Typhimurium of preinoculated beef biceps femoris muscles on resulting steaks and to determine the effect on instrumental color characteristics through display.

MATERIALS AND METHODS

Bacterial Preparation and Inoculation

Escherichia coli (ATCC #11775) and a nalidixic acid–resistant strain of *Salmonella* Typhimurium (ATCC #1769NR) inocula were prepared from frozen (−80°C) stock cultures. *Escherichia coli* was maintained in brain heart infusion (**BHI**; Becton Dickinson and Company, Sparks, MD) broth with 20% glycerol, and *Salmonella* Typhimurium was maintained in BHI broth containing nalidixic acid (Fisher Scientific, Fair Lawn, NJ) with 20% glycerol. Frozen cultures of *E. coli* and *Salmonella* Typhimurium were thawed. Then, 0.1 mL of *E. coli* suspension was inoculated into 40 separate 40-mL aliquots of BHI, and 0.1 mL of *Salmonella* Typhimurium suspension was inoculated into 40 separate 40-mL aliquots of BHI with nalidixic acid. Following 18 h of incubation at 37°C, bacteria were then harvested by centrifugation (3,500 × *g* for 20 min at 37°C) (Beckman GS-6 series, Fullerton, CA), and resuspended with 40 mL of 0.1% buffered peptone water (Difco Laboratories, Becton Dickinson and Company) and pooled together (1,600 mL of *E. coli* and 1,600 mL of *Salmonella* Typhimurium) to make a bacterial cocktail. The bacterial cocktail (3,200 mL; 107 cfu/mL *E. coli* and 107 cfu/mL *Salmonella* Typhimurium) was cooled to 4°C and then combined (Pohlman, et al., 2002; Stivarius et al., 2002a,b). Beef biceps femoris muscles (n = 12; 4 d postmortem) were cut into 3 subsections (n = 36 subsections; 10.2 cm × 27.9 cm) and brush inoculated as described by Dorsa et al. (1996) and Cutter et al. (1997, 2000) with the bacterial cocktail, placed in a sterile bag (n = 5 subsections per sterile bag), and stored in a 4°C cooler for 12 to 14 h to allow for further microbial attachment.

Antimicrobial Treatment Application and Sample Processing

Municipal purified water (EPA, 2002) was used for the water treatment. The antimicrobial treatments of 3% (wt/vol) KL (UltraLac KL—60, Hawkins Inc., Minneapolis, MN), 4% (wt/vol) NMS (Metso Pentabead 20, PQ Corporation, Valley Forge, PA), 0.5% (wt/vol) CPC (Cecure, Safe Foods Cooperation, Little Rock, AR), and 10% (wt/vol) TSP [trisodium phosphate anhydrous (FG), ICL Performance Products, St. Louis, MO] were prepared by mixing appropriate amounts with municipal purified water. Inoculated, untreated samples (**IN**) and uninoculated, untreated samples (**CON**) were used as control treatments of the experiment. The CON treatment was not used for microbial analysis but was used for instrumental color characteristics. Inoculated subsections (n = 5 subsections per treatment; approximately 10.2 cm × 27.9 cm) were spray treated (SureSpray Sprayer Deluxe, Chapin International Inc., Batavia, NY, applied 50 mL on a 284-cm^2 area in 10 s) with (1) municipal purified water (**W**), (2) 3% KL, (3) 4% NMS, (4) 0.5% CPC, (5) 10% TSP, (6) IN, or (7) CON. Each subsection was cut into 3 individual steaks (n = 105) allowing 15 steaks per treatment per display day. Steaks were placed on Styrofoam trays (Cryovac Food Packaging and Food Solutions, Duncan, SC) with absorbent pads (1 steak per package) and overwrapped with polyvinyl chloride film (O^2 transmission rate = 14,000 mL/mm^2 per 24 h per 1.0 × 10^5 Pa; Koch Supplies Inc., Kansas City, MO). The oxygen-permeable film was place in direct contact with packaged meat surfaces (no headspace), heat sealed with a heat