

Abstract

The use of multiple antimicrobials or hurdle technology might provide better assurance for the safety enhancement in beef products. Therefore, the effectiveness of multiple antimicrobial interventions applied through electrostatic spray on *Longissimus lumborum* at both sub-primal and steak levels on microbial quality and instrumental color of beef steaks during display was evaluated. *Longissimus lumborum* muscles (n=7) were cut into 3 subsections (n=21) and inoculated with *Escherichia coli* (EC; ATCC #11775) and *Salmonella Typhimurium* (ST; ATCC #1769NR) at 107 CFU/mL. The inoculated subsections were then spray treated with: (1) water, (2) 10% trisodium phosphate (TSP), (3) 3% potassium lactate (KL), (4) 0.4% cetylpyridinium chloride (CPC), (5) 20% hydrochloric/citric acid mixture, or kept as (6) untreated inoculated control; or (7) uninoculated control before being cut into 2.5cm thickness steaks. The steaks (n=63) were then spray treated with the same treatments allotted at the sub-primal level to allow for multiple intervention technique (n=9 steaks/treatment). The steaks were then placed on foam trays with absorbent pads and overwrapped with polyvinyl chloride film. Steaks were removed from display for bacterial enumeration of EC, ST, coliform (CO), aerobic plate count (APC) and instrumental color properties on days 1, 3, and 7. The hydrochloric/citric acid mixture achieved greater EC, CO and APC reductions (P>0.05) compared to CPC, KL, TSP, and water treatments. All the treated steaks maintained a similar (P>0.05) redness (a*), lightness (L*), and hue angle compared to the inoculated untreated control steaks. The results suggest that electrostatic spray application of CIT treatment may enhance steak microbial properties while retaining the product color characteristics. Further studies under un-inoculated conditions are recommended to evaluate these treatment effects on product quality attributes.

Introduction

- Throughout processing, meat provides a rich source of nutrients for microbial growth.

- With the need to control pathogens and improve beef safety, and persuade consumer perception to the positive, interventions involving chemicals have been used.

- Beef carcass decontamination has been reported to be more effective by using hurdle technology, rather than single interventions.

Objective

The purpose of this study was to evaluate the effectiveness of the electrostatic spray application of CPC, TSP, KL, citric/ hydrochloric acid mixture, or water as multiple antimicrobial interventions on reducing *Escherichia coli* and *Salmonella Typhimurium* populations in pre-inoculated beef steaks.

Conclusion

The CIT treatment reduced EC, CO, and APC counts significantly. The beef steaks from sequential treatment applications of CIT at the sub-primal and steak levels showed improvement on microbial quality compared to other treatments.

Materials and Methods

1. Bacterial preparation and inoculation

Escherichia coli (ATCC # 11775; EC) 0.1 mL

Salmonella Typhimurium (ATCC # 1769NR; ST) 0.1 mL
Incubated in Brain Heart Infusion Agar (40 mL) at 37° C for 18 hours.

The inoculum was centrifuged 3500 x g for 20 min at 37°C.
Re-suspended in 40 mL 0.1% Buffered Peptone.

The bacterial cocktail (EC and ST log 10⁷ CFU, 3600 mL) stored at 4°C.

Beef *Longissimus lumborum* (n=11) were inoculated by dipping into the bacterial cocktail and placed in a 4°C cooler for 12 to 14 hours to allow for further attachment.

2. Antimicrobial Treatment

Longissimus lumborum subsections (n=3/treatment) were sprayed with an electrostatic spraying system (3ml/sec/60psi). Then steaks were sprayed again with the corresponding treatments

Steaks were overwrapped with polyvinyl chloride film
O₂ transmission rate =14,000 cc/mm²/24h/1atm

Stored in simulated retail display at 4°C .
1630 lux of deluxe warm white fluorescent lighting.

3. Sample Analysis

- Instrumental color characteristics were measured by Hunter Miniscan XE, with the Illuminant A and 10 observer
- Properties for L*, a*, b*, hue angle and saturation index were evaluated on days 1, 3, and 7.
- Least squares means were generated for all variables and separated using the PDIFF option of SAS.

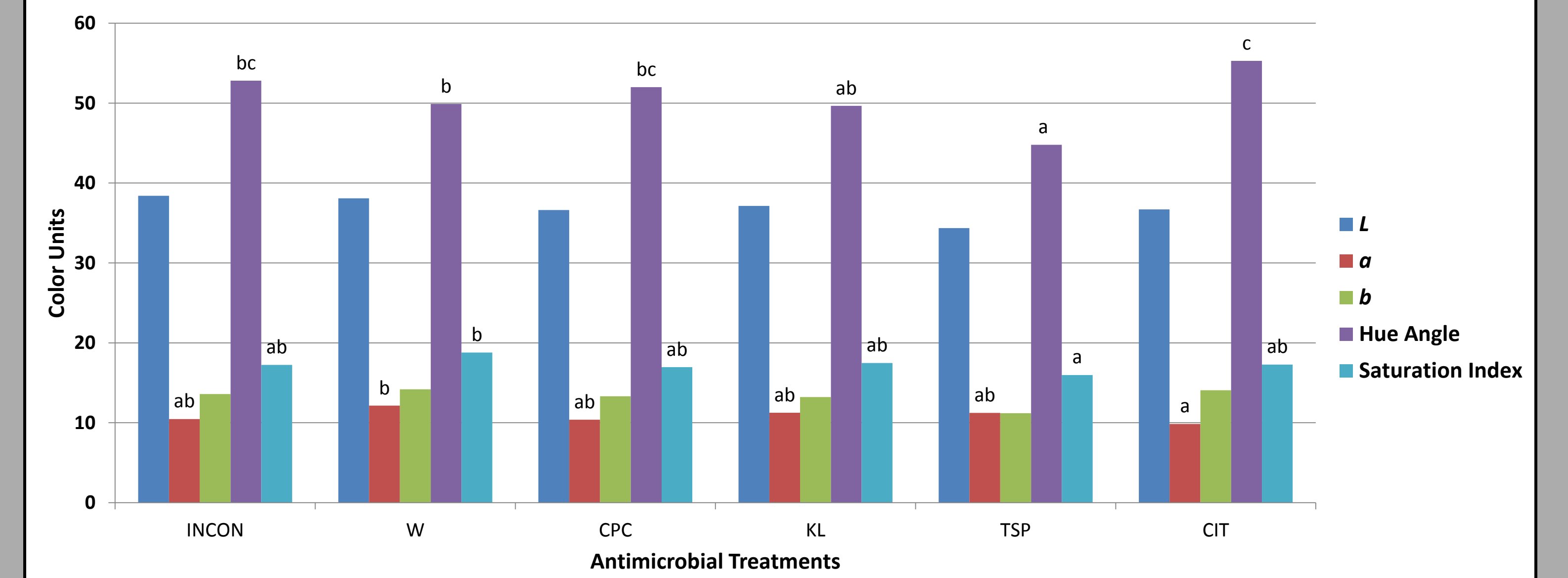
- Sampled on day 1, 3, and 7 as described by Pohlman et al., 2009.
- Spread plating in duplicates: Aerobic plate count (APC), *E. coli* (EC) / coliform (CO) counts on Petrifilm ©.
- ST plating was performed on Difco *Salmonella* Agar.
- Bacterial values were transformed to log values and least squares means were generated for all variables and separated using the PDIFF option of SAS.

Treatments

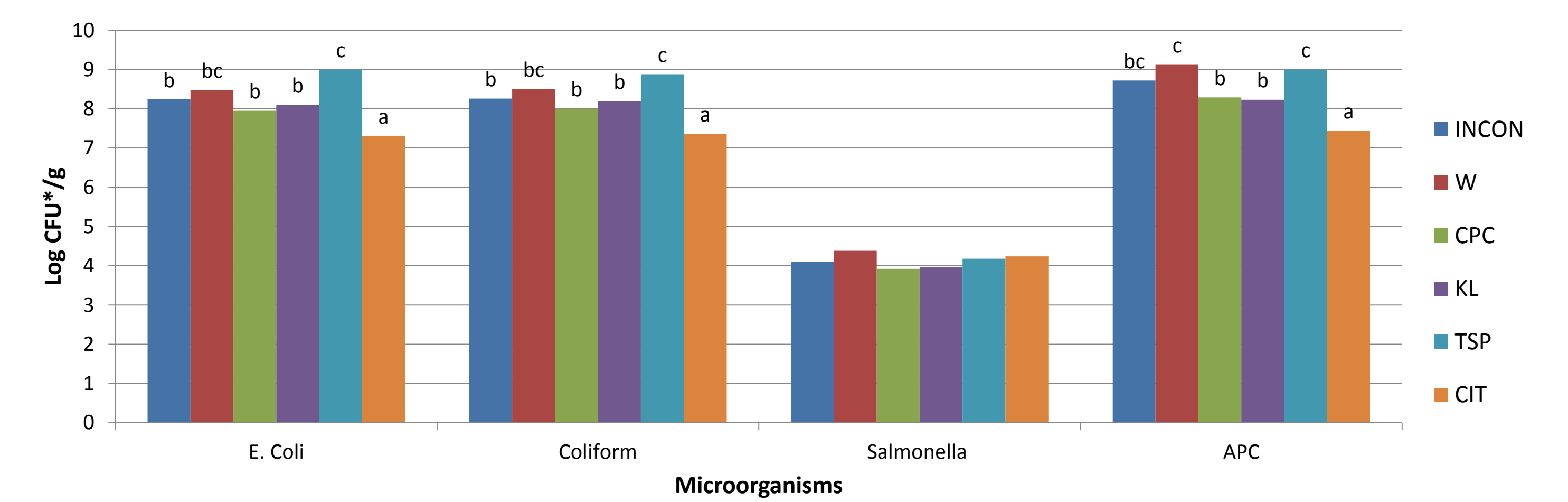
- INCON = untreated inoculated control
- CONTROL = untreated uninoculated control
- W = water
- TSP = 10% trisodium phosphate
- CPC = 0.4% cetylpyridinium chloride
- KL = 3% potassium lactate
- CIT = 20% hydrochloric / citric acid mixture

Results

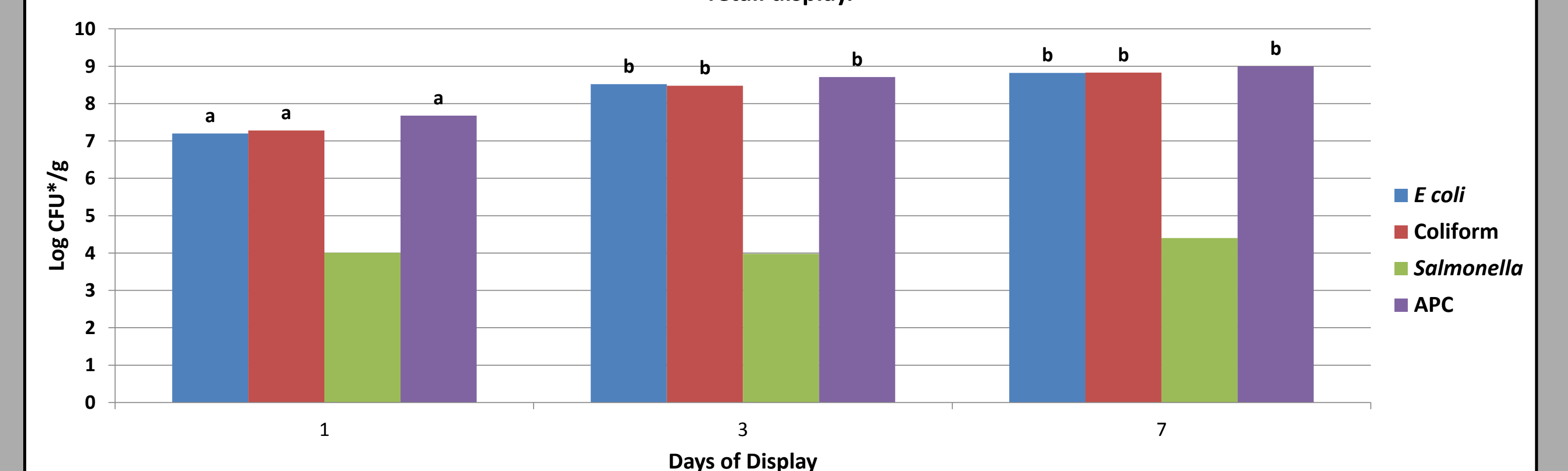
Effect of antimicrobial treatments on L*,a*,b* hue angle, and saturation index values of beef steaks through simulated retail display.



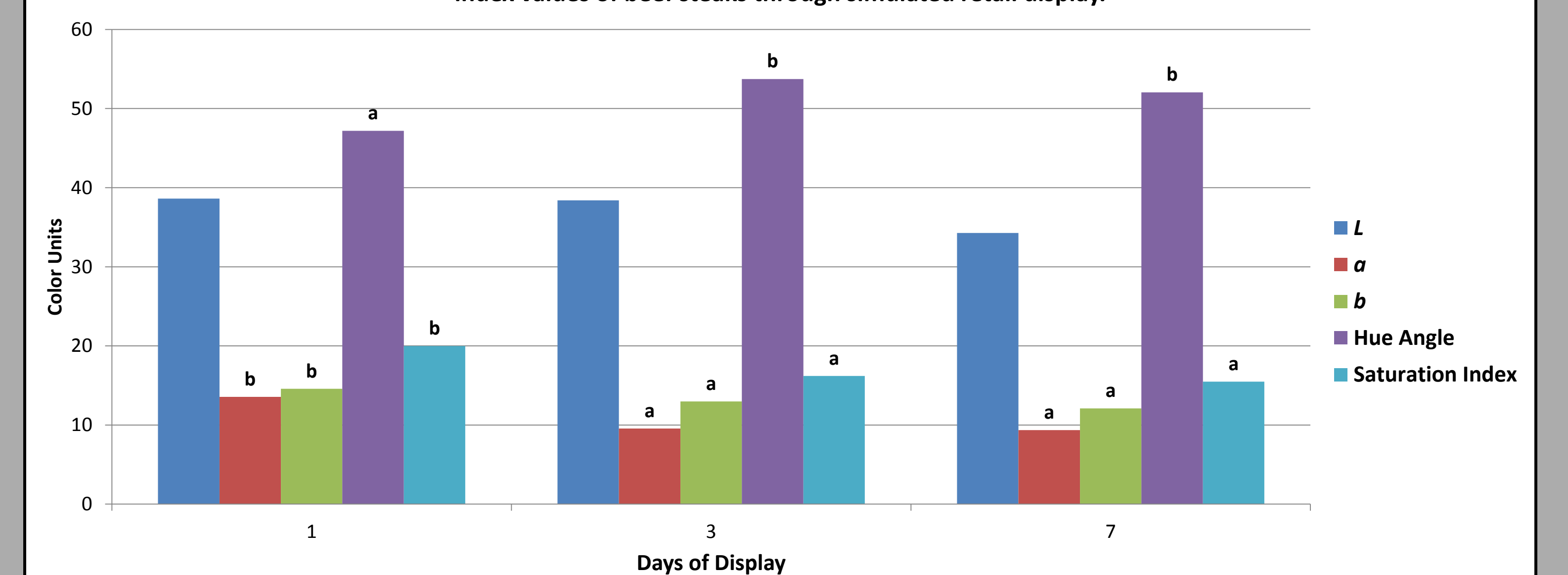
Effect of antimicrobial treatment on least squares mean log CFU*/g Coliform *Escherichia coli*, *Salmonella Typhimurium*, and Aerobic plate count on beef steaks through simulated retail display.



Effect of duration of display, pooled across antimicrobial treatments on least squares mean log CFU*/g *Escherichia coli*, coliform, *Salmonella Typhimurium*, and Aerobic Plate count on beef steaks through simulated retail display.



Effect of duration of display, pooled across antimicrobial treatments, on L*,a*,b*, hue angle and saturation index values of beef steaks through simulated retail display.



*CFU- colony forming units
abc Least squares means with different superscripts differ (P < 0.05)