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Anti-*Salmonella* Effects of Pyruvic and Succinic Acid in Combination with Oregano Essential Oil

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Objectives

Effective decontamination approaches will aid in improving safety of poultry products and help processors comply with pathogen performance standards. Increasing consumer demand for clean label and more natural ingredients presents a scope to explore alternative decontamination approaches for meat and food contact surfaces. This study aimed to evaluate the antimicrobial efficacy of combinations of pyruvic acid (PA), succinic acid (SA), and oregano essential oil (EO) against *Salmonella* Typhimurium in suspensions, cells inoculated on raw chicken, and cells attached to steel.

Materials and Methods

Minimum bactericidal concentration (MBC) assays were conducted in Mueller-Hinton broth (5 mL). Bacterial cells were added to broth suspensions of antimicrobial agents or their combinations. A contact time not exceeding 10 s was provided. Surviving bacteria were recovered on tryptic soy agar (TSA). Bacterial inactivation was confirmed by enrichment in D/E broth. Experiment involved completely randomized design with each concentration of organic acid and essential oil being considered as one level. Data were analyzed using 1-way ANOVA. Aqueous solutions of PA, SA, EO, and the mixtures of PA+EO and SA+EO were prepared using 0.05% agar to suspend the essential oil. Skin-on raw chicken breast meat pieces (2.5 cu cm) were used as a substrate to inoculate nalidixic acid (NA) adapted *Salmonella* cells. Pieces were treated with antimicrobial agents for 30 s by dipping, and surviving S*almonella* were recovered using D/E broth on XLT-4 agar with 50 ppm NA. Four different experiments with variable acid and essential oil concentrations were performed and data were analyzed using 1-way ANOVA. Each experiment included an inoculated untreated control. Stainless steel coupons (2 × 5 cm) were used as a substrate for *Salmonella* attachment. Cells were allowed to grow and attach on coupons submerged in tryptic soy broth for 24 h. Coupons were rinsed to remove planktonic cells. Attached cells remaining on the coupon were dip treated with antimicrobial agents for 5 min. Surviving cells were recovered on TSA. For antimicrobial treatments leading to no cell recovery, additional experiments were performed. The recovery broth was enriched in tryptic soy broth and streaked on TSA to confirm inactivation. Three different experiments were conducted while including their respective inoculated and untreated controls and analyzed using 1-way ANOVA. All experiments were conducted in three replicates.

Results

MBC for was found to be PA (0.5%), SA(3%), EO (0.04%), PA+EO (0.25 + 0.02%), SA+EO (0.25 + 0.02%), respectively. 1% PA + 0.08% EO combination produced the maximum reduction (1.42 ± 0.11 log CFU/cm^2) followed by 6% SA + 0.08% EO (1.02 ± 0.08 log CFU/cm^2) in *Salmonella* populations on raw chicken. More than 6 log CFU/coupon of attached *Salmonella* were inactivated by mixtures of 0.25% PA + 0.02% EO and 1.5% SA + 0.02% EO.

Conclusion

The combinations of PA+EO and SA+EO both exhibited strong anti-*Salmonella* activity in cell suspensions, on cells attached to stainless steel, and were effective in reducing *Salmonella* populations on raw chicken. Therefore, these antimicrobial combinations merit further research for raw poultry, meat, and other sanitation applications.