RESEARCH ABSTRACT

PORK SAFETY

Title: Post-Harvest Hurdle Interventions to Reduce *Salmonella* in Pork Trimming – **NPB #18-100**

Investigator: Thu Dinh

Institution: Mississippi State University

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Scientific Abstract

Pork loin and pork trimming were purchased from a commercial purveyor to produced 2.5 cm (L) × 2.5 cm (W) × 1.3 cm (H) cubes and 2.3-kg chubs, respectively. The meat chubs were vacuum-packaged and stored similarly. Additional pork loins were prepared similarly and cut into 14 1.3-cm thick chops. These chops were further cut laterally into 28 halves per loins to be used in meat quality experiments. On the day of the experiments, pork was thawed at 2°C for 24 h and pork cubes were inoculated 5 log of nalidixic acid-resistant *Salmonella enterica* serovar Typhimurium or a cocktail of *Salmonella enterica* serovar Typhimurium and *Salmonella enterica* serovar Enteritidis inoculum or 8 log of lux-modified *Salmonella enterica* serovar Typhimurium. For the chub, an inoculated cube was placed at the geometrical center of the chub mimic bulks of trimming bucket in the industry. Three experiments were conducted to determine the effects of temperature (21 or ACC and 50°C or ACH) on efficacy of 3% acetic acid in reducing *Salmonella* in 15-s dipping, the effects of heat shock (cold-to-hot or HSC and hot-to-cold or HSH) in reducing *Salmonella*, and the effects of temperature (21 and 50°C) and dipping time (15, 45, and 75 s) on efficacy of 3% acetic acid in reducing *Salmonella*. Inoculated pork cubes were dipped in 3% acetic acid or ice-cold/50°C water according to the designated treatments. A combination of 50°C and 75-s dipping without or with shaking was used in the last experiment with pork chubs. A meat quality experiment was also conducted at both temperatures and 3 dipping times. In addition to XLD-agar plating and bioluminescent imaging, scanning electron microscopy and transmission electron microscopy were also employed to analyze the cellular structure.

At 15-s dipping, there was 0.2-log reduction in *Salmonella* count with ACC treatment ($P = 0.026$) and 0.3-log reduction with ACH treatment ($P = 0.003$) when using plating method; but IVIS imaging 1.3-log reduction ($P = 0.001$) for both ACC and ACH. No heat shock effect on pork cubes ($P \geq 0.20$), although there was a heat-shock reduction of 0.4 log *in vitro* ($P \leq 0.030$). When studying the effects of temperature and dipping time, there was a 2-way treatment × time interaction ($P = 0.03$). ACH reduced *Salmonella* 0.5, 0.7, and 1.4 log greater than ACC at 15, 45, and 75 s, respectively ($P < 0.001$). Treatments had an overall effect on lightness (L*; $P < 0.001$) slightly greater L* value than negative control ($P \leq 0.008$); but there was no difference at cross-sectional surface. The surface before treatment and cross-section surface had similar L* values (60.1 to 60.6; $P = 0.120$). After treatment, all treatment cubes had 2.2- to 2.9-unit less redness than the NEG cubes ($P \leq 0.037$). At the cross-sections after treatment, most treatment cubes had similar redness to that of the NEG cubes ($P \geq 0.154$), except for ACC15 cubes having 2.2 units more ($P < 0.001$). After treatment, the OMb and DMb values of the NEG cubes remained at 66.6% (3 to 5% less; $P \leq 0.037$) and 7.3% (2.0 to 3.8% more; $P \leq 0.051$), respectively, compared with other treatment cubes. Compared with NEG, no treatment dif

ference in OMb was found at cross-sectional surfaces ($P \geq 0.244$). The NEG was 0.1 mmol/kg trolox equivalence more than ACH45 ($P = 0.018$) but 0.06 to 0.15 mmol/kg more than ACC15, 45 ($P \leq 0.040$). The NEG cubes had similar TEAC value to that of ACH15 and 75 ($P \geq 0.385$). No treatment difference was found for TBARS value (0.53 to 0.63 mg MDA/kg meat; $P = 0.644$), protein solubility (30.92 to 33.72 mg/g of meat; $P = 0.187$), and WHC as expressible moisture percentage (1.24 to 1.68%; $P = 0.076$). The ACH treatment reduced *Salmonella* in the geometrically centered cubes by 0.2 log ($P = 0.04$). The ACHS treatment similarly ($P = 0.198$) reduced *Salmonella* 0.3 log ($P = 0.01$). All surrounding pork pieces, including those of the POS chubs, mostly had no *Salmonella* counts; only a few pieces had 1 to 3 CFU.

The SEM and TEM images indicated damages in the cell membrane of the *Salmonella* cells treated with 3% acetic acid at 50°C for 45 and 75 s. The SEM images showed a less rigid surface of treated cells than the POS cells, especially for 75-s treatment. The treated cells had a smoother surface with less rigid structural grooves. Moreover, the TEM images clearly revealed structural damages inside the treated *Salmonella* cells and the disappearance of the cell membrane of the treated cells, especially for 75-s dipping. Some *Salmonella* cells treated for 75 s appeared to be dead and had no cell membrane.

Acetic acid at 3% and 50°C provided a meaningful reduction of *Salmonella* by 1.4-log at 75 s, which is recommended for industry application. However, the processors need to find ways to allow acetic acid to contact all meat pieces such as spreading trimming on conveyor for a dipping or spraying application or loosening the trimming bulks to allow for adequate penetration by acetic acid.