Effects of Applying Safe$_2$O Poultry Wash to Broiler Wings on Shelf Life, Listeria monocytogenes, Pseudomonads, Staphylococcus Species, and Psychrotrophic Bacteria Levels After Three, Seven, and Ten Days of Storage

J. A. Dickens, K. D. Ingram, and A. Hinton Jr.

USDA, ARS, SAA, Russell Research Center, Athens, Georgia 30604

ABSTRACT Bacterial contamination of raw processed poultry continues to be of concern to consumers as well as regulatory and health officials. For many years wings were considered a low-value product; therefore, shelf life of wings was not a major concern. Due to changes in consumer attitudes and increases in the fast-food market, wings are now a valuable commodity. Because wings have a shorter shelf life than most other raw poultry products, acceptable intervention to decrease the population of associated spoilage organisms and human enteropathogens are needed. Safe$_2$O Poultry Wash was evaluated as a postchill treatment to reduce microbial contamination and increase shelf life. Ninety-six carcasses were obtained from a local processor prior to final wash. On arrival at the research facility all carcasses were inoculated with 1 mL of a culture with $10^3$ cfu/mL Listeria monocytogenes. After a 30-min attachment time, carcasses were subjected to a 4-s in-out final wash, hung for 3 min, and chilled in ice-water for 45 min. After the chilling, wings were removed by hand with a knife, pooled together, and subjected to a hand spray (4 mL/wing) with deionized water or Safe$_2$O Poultry Wash. Two wings were then placed in each of 96 ziplock type storage bags, and wings were held at $5 \pm 1 ^\circ C$ for 3, 7, 10, and 14 d. On the day of sample, weep was decanted, and 100 mL of Butterfield’s phosphate buffer was added to each bag. Three sets of wings were shaken by hand for 1 min, and total aerobes, Pseudomonads, Staphylococcus sp., psychrotrophic bacteria, and L. monocytogenes in the rinsates were enumerated. By using $7 \log_{10}$ recovery of total aerobes from rinsates as a spoilage baseline, all wings were spoiled by d 10, but the wings treated with water were approaching spoilage counts on d 7, ($\log_{10}$ 6.8), whereas only $\log_{10}$ 5.5 bacteria were recovered from the wings sprayed with Safe$_2$O Poultry Wash. Fewer Pseudomonads, Staphylococcus sp., L. monocytogenes, and psychrotrophic bacteria were recovered from wings treated with Safe$_2$O Poultry Wash and stored for 10 d. $\log_{10}$ counts for the organisms were Pseudomonas sp., 8.2 and 6.9; Staphylococcus sp., 5.5 and 4.9; L. monocytogenes, 5.2 and 4.6; and psychrotrophs, 8.2 and 6.9 for the water and Safe$_2$O Poultry Wash treatments, respectively. Use of the Safe$_2$O Poultry Wash as a postchill treatment on wings could increase the shelf life of wings by up to 3 d.

(Key words: broiler, Listeria monocytogenes, psychrotrophic bacteria, shelf life, wing)

2004 Poultry Science 83:1047–1050

INTRODUCTION Storage quality of fresh chicken and chicken parts is partially dependent on the bacteria present on the carcass prior to slaughter, but other factors such as processing conditions, hygiene of plant personnel, initial plant storage conditions, and refrigerated conditions during transportation can all significantly contribute to the shelf life of poultry. Dainty and Mackey (1992) demonstrated that a total aerobic load of 7 to 8 $\log_{10}$ cfu/mL on broiler carcasses could be considered spoiled. The bacteria found on fresh processed poultry carcasses are primarily mesophilic and grow at temperatures around 35°C, whereas bacteria on spoiled poultry are generally psychrotrophic and flourish at temperatures between 20 and 30°C but also grow at refrigerated temperatures. Russell et al. (1996) found at storage temperatures of 10°C or below Pseudomonads sp. and other psychrotrophic bacteria are the primary organisms that cause the microbial load to increase and therefore should be considered when testing treatments to increase shelf life. Many chemical and physical treatments have been investigated to slow the growth of these bacteria on fresh poultry to increase shelf life (Cosby et al.,
Over the last several years, wings have evolved from a low-cost product with little demand to one of the fastest selling parts of the processed broiler. This change in demand is due primarily to the growth of the fast-food market and changes in consumer trends. Wings tend to have a shorter shelf life than the remainder of the cut-up parts from broilers due in part to the wings being handled more by processing and cut-up personnel during processing and deboning operations and the use by automated equipment as a point of reference and orientation. These same reasons may also be the primary causes of <i>L. monocytogenes</i> contamination.

This project investigated the ability of a new chemical to increase the shelf life of raw wings from freshly processed broilers. The chemical was sprayed on the wings after deboning. Safe2O Poultry Wash3 has been shown to reduce total aerobes and selected enteric pathogens when applied to carcasses prechill and has been tested after chilling (J. A. Dickens, K. D. Ingram, and A. Hinton, Jr., unpublished data). The research projects tested the efficacy of Safe2O Poultry Wash for its ability to kill or slow the growth of <i>Listeria monocytogenes</i> and specific microorganisms directly related to shelf life.

**MATERIALS AND METHODS**

**General**

Before actual experimentation with the treatment solutions, it was necessary to find a suitable rinse buffer for the rinse procedures that would neutralize the Safe2O Poultry Wash. Trials were made with numerous rinse solutions before Butterfield’s phosphate buffer, pH 7.2, (FDA, 1995) was found to have the best neutralizing properties. The pH value for the rinsates from Safe2O Poultry Wash was 6.95 ± 0.2. To confirm the ability of Butterfield’s phosphate buffer to properly neutralize the Safe2O Poultry Wash, carcass rinsates were plated on bacteriological media. All plates inoculated with rinsates were grown at the end of the incubation period, which confirmed the ability of Butterfield’s phosphate buffer as an adequate neutralizing rinse.

Thirty-two broiler carcasses were obtained from a local processor, prior to final wash, on each of 3 trial days. Special care was taken to ensure that all carcasses had both wings intact. Carcasses were placed in an insulated container and transported to the pilot processing facility within 15 min of removal from the line. Immediately after arrival back at the pilot plant, the wings of all carcasses were inoculated with 1 mL of a 3 log<sub>10</sub> solution of <i>L. monocytogenes</i>. The <i>L. monocytogenes</i> used was ATCC strain 49594 and was grown overnight in 100 mL of brain heart infusion broth at 37°C with shaking. The culture was pelleted via centrifugation and resuspended in 0.1% peptone water. After resuspension, it was brought to proper absorbance at 625 nm (A<sub>625</sub>) optical density in 0.1% peptone water. The culture was 24 h old at use. A bent glass rod was used to spread the solution over the wings. After allowing 30 min for attachment, all carcasses were sprayed with water in a prototype inside/outside washer (J. A. Dickens, K. D. Ingram, and A. Hinton, unpublished data) at 25 psi and a flow rate of 22.7 L per min for 4 s. Each carcass was sprayed with 1.5 L of water during the wash and allowed to drip for 3 min before being placed into 1°C agitated ice water baths for 45 min. After the chilling procedure, carcasses were drained, and all wings were removed manually at the joint with a knife and then pooled together. Treatments of the wings consisted of a hand spray (4 mL/wing) with deionized water or a 1:1 solution of deionized water and Safe2O Poultry Wash. Spray bottles were filled with the treatment solutions and weighed before and after spraying to determine the average amount of treatment solution used on each wing. Wings were selected at random, sprayed, placed in resealable bags, 2 wings per bag, and refrigerated at 5 ± 1°C for up to 14 d or until total aerobes exceeded 7 log<sub>10</sub> cfu/mL. Three sets of wings from each treatment were removed from storage at 3, 7, 10, and 14 d. Drip was decanted from the bags, and 100 mL of Butterfield’s buffer was added to each bag. Wings were shaken by hand for 1 min, and then the rinseate was decanted into sterile plastic cups. The resulting rinsates were placed on ice and taken to the laboratory to be enumerated for total aerobes, <i>Pseudomonads</i>, <i>Staphylococcus</i> sp., psychrotrophic bacteria, and <i>L. monocytogenes</i>. This procedure was replicated 3 times with 32 carcasses per treatment of 192 wings.

**Microbiological Procedures**

Duplicate serial dilutions (1 to 4) of the rinsates (100 μL/plate) were spread on the appropriate selective or nonselective agar and incubated for the specific organisms as follows: total aerobes on plate count agar,6 incubated for 48 h at 35°C; <i>L. monocytogenes</i> on <i>Listeria</i> selective agar,6 incubated for 24 to 48 h at 35°C; <i>Pseudomonas</i> sp. on <i>Pseudomonas</i> agar,6 incubated 48 h at 25°C; <i>Staphylococcus</i> sp. on Baird Parker agar,5 incubated for 48 h at 35°C; psychrotrophic bacteria on plate count agar,7 incubated for 10 d at 4°C. After proper incubation times all plates were inspected and colonies enumerated and recorded.

The GLM, least square means, and Tukey’s studentized range test of SAS software (SAS Institute, 1987) were used to analyze all microbiological data with treat-

---

3 Developed by Mionix Corporation, Rocklin, CA.
4 Orion Research, Inc., Beverly, MA.
5 Difco, Detroit, MI.
6 Oxoid, Hampshire, UK.
ment as the main effect and treatment by replication as the error term.

RESULTS AND DISCUSSION

Safe2O Poultry Wash, a low-pH solution of acidic calcium sulfate and other components, is composed of generally recognized as safe (GRAS) food-grade ingredients. Even though the chemical conglomerate has a pH approaching 1, it has very low corrosive properties on plastics, rubber, stainless steel, and human skin. Visual observations of stainless and bronze equipment during the past year of use with Safe2O Poultry Wash have shown no detrimental effects on the metals tested. As noted earlier, 7 to 8 log10 cfu/mL for total aerobes was used to indicate spoilage (Dainty and Mackey, 1992). The water-sprayed wings were approaching this level at 7 d (6.77), whereas the wings treated with Safe2O Poultry Wash averaged 6.95 ± 0.2, and efficacy of the neutralization was confirmed by plating rinsates with the error term.

Due to the low pH of the treatment solution (1.1), neutralization of the acidic properties of the Safe2O Poultry Wash had to be confirmed. The pH of the Butterfield’s Buffer rinsates from wings treated with Safe2O Poultry Wash averaged 6.95 ± 0.2, and efficacy of the neutralization was confirmed by plating rinsates with aliquots from control samples. All plates inoculated with the rinse had bacterial growth at the end of the incubation period, confirming the ability of the Butterfield’s Buffer as a suitable neutralizing rinse.

All carcasses were inoculated with 1 mL of a 3 log10 solution of L. monocytogenes at arrival back at the laboratory before final wash and chill. These carcasses were inoculated with L. monocytogenes [due to the low incidence rates found in the poultry industry prior to scald and chill (Berrang et al., 2000)] to test the effect of Safe2O Poultry Wash on reducing these organisms.

Analyses were performed on the rinsates for total aerobes, Pseudomonads, L. monocytogenes, Staphylococcus sp. and psychrotrophic bacteria. Microbiological analyses of the rinsates from the water control and Safe2O Poultry Wash demonstrated that the Safe2O Poultry Wash had lower counts on all days for all organisms tested. As noted earlier, 7 to 8 log10 cfu/mL for total aerobes was used to indicate spoilage (Dainty and Mackey, 1992). The water-sprayed wings were approaching this level at 7 d (6.77), whereas the wings treated with Safe2O Poultry Wash were just over 7 log10 at 10 d (7.21) (Table 1), clearly indicating an increase in shelf life of at least 3 d. Because all counts approached the 7 to 8 log10 cfu/mL reference for spoilage at 10 d, wings from d 14 were discarded and not included in the data. For the other organisms tested, counts ranged from 0.5 to 1.5 log10 less for the wings treated with Safe2O Poultry Wash (Table 1). Fewer Pseudomonads, Staphylococcus sp., L. monocytogenes, and psychrotrophic bacteria were recovered from wings treated with Safe2O Poultry Wash at d 10. Log10 counts for the organisms were Pseudomonads (8.2 and 6.9), Staphylococcus sp. (5.5 and 4.9), L. monocytogenes (5.2 and 4.6), and psychrotrophic bacteria (8.2 and 6.9) for the water and Safe2O Poultry Wash treatments, respectively. These data demonstrate that Safe2O Poultry Wash, if approved for post-chill application, could significantly increase the shelf life of poultry and poultry products by reducing spoilage bacteria and potential human pathogens.

Safe2O Poultry Wash has been permitted as a food additive by the Food and Drug Administration. Recently the Food Safety Inspection Service of the USDA, the agency with regulation authority for the poultry processing industry, accepted the Food and Drug Administration’s determination of the generally recognized as safe status of Safe2O Poultry Wash and approved it for use on prechill carcasses. Further research into the residual effects of Safe2O Poultry Wash should lead to the approval of postchill treatments that would allow the industry to produce safer products for all consumers.

REFERENCES