DECONTAMINATION TREATMENT FOR CONTROLLING BACTERIAL PATHOGENS ON CHICKEN CARCASSES SKIN

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Abstract

A comparative study on the effect of different decontamination treatments to reduce inoculated bacterial pathogens and spoilage micro flora in chicken wings skin was conducted. Uninoculated and inoculated raw chicken wings with *L. monocytogenes*, *S. Typhimurium* and *S. aureus* were dipped in tap water (control), 8 % (pH 12.59), 10 % (pH 12.68), 12 % (pH 12.75) w/v. Trisodium phosphate (TSP) solution, 1 % (pH 1.8) v/v lactic acid, 2 % (pH 1.8 – 2) v/v acetic acid and combination of the decontamination treatment and hot water 70°C were assessed. Surface pH value and bacterial count of chicken wings were determined immediately after treatment (day 0) and after 1, 3 and 5 days of refrigerated storage at 4°C. Compared with water dipping ,all the decontamination treatments significantly ($P < 0.05$) reduced inoculated bacterial pathogens. The concentration of TSP was a significant factor in reducing bacterial populations. The TSP and lactic (or acetic) acid treatment resulted in relatively high ($8.3 \pm 0.15 - 9.07 \pm 0.04$) and low ($6.4 \pm 0.07 - 6.32 \pm 0.07$) surface pH, respectively, initially and throughout storage. The decontamination treatment retarded the growth of spoilage micro flora on uninoculated chicken wings, and thus, potentially extending the shelf life. The interaction between decontamination treatment and hot water 70°C was more effective in reducing count for spoilage micro flora than for inoculated bacteria. It is concluded that decontamination treatment (especially 12 % TSP and 1 % lactic acid) combined with hot water 70°C, markedly improved the bacterial safety and increased the refrigerated shelf life of chicken carcasses.

INTRODUCTION

Chickens naturally carry a wide variety of bacteria into the processing plant, and this micro flora can be transferred onto the surface of carcasses during processing. Although most of these bacterial species are non-pathogenic, they may adversely affect the shelf life of raw poultry (Capita *et al.*, 2002).

Food borne illness cases caused by the consumption of contaminated poultry meat are due to improper cooking or handling (Ryser, 1999). In addition, raw poultry products are refrigerated or frozen prior to cooking; the growth of psychrotrophic pathogens in refrigerated poultry product is of food safety concern.

Experiments with Gram positive and Gram negative flagellated and non-flagellated bacterial species showed that all attach to chicken skin; there was generally

a linear increase in rate of attachment from 0.25 to 60 min. during exposure to microorganisms (Lillard, 1985).

Since microbial contamination is primarily on the surface of carcasses, several studies were directed to eliminate or substantially decrease bacterial population on poultry carcasses. A number of antimicrobial treatments for chicken carcasses had been studied. Recently, Del Rio *et al.* (2006) found that *Pseudomonas fluorescence* (a spoilage organism) was more susceptible to TSP treatment than *L. monocytogenes* when inoculated at $10^{(6)}$ cfu ^{per} (g^{-1}) on chicken legs.

So, the present study was undertaken with two aims, first, to explore the efficacy of certain chemicals dipping and/or hot water in reducing spoilage and microbial populations of refrigeration storage 4°C poultry wings inoculated with *L. monocytogenes*, *S. Typhimurium* and *S. aureus*, Second, to assess the mechanism by which decontamination treatment kills surface bacteria on poultry.

MATERIALS AND METHODS

Preparation of bacterial inoculums

L. monocytogenes, *S. Typhimurium* and *S. aureus* were obtained from Animal Health Research Institute, Serology Unit. All had been originally isolated from chicken carcasses. Each strain was loop-transferred from a24 h culture to 10 ml triptych soya broth pH 7.3 (Difco) and incubated at 30°C for 24 h to achieve populations of approximately 10^9 CFU/ml. Inocula of *L. monocytogenes*, *S. Typhimurium* and *S. aureus* were prepared separately by diluting 10 ml of the suspension with 90 ml of sterile 0.1 % w/v peptone water (Oxoid) to yield 10^8 CFU/ml.

Sample inoculation

Chicken wings were collected from same poultry processing plant immediately after evisceration, and transported in an ice bag to the laboratory. Four main groups of chicken wings were used. Three equal main groups were immersed for 5 min in suspension of 10^8 CFU/ml of *L. monocytogenes*, *S. Typhimurium* and *S. aureus*, respectively. After inoculation, chicken wings were kept for 30 min at room temperature to allow the bacteria to attach the skin. Populations of each bacterial species on chicken wings were determined. The remaining main groups were kept as uninoculated wings, and population of spoilage bacteria was determined (Rodriguez de Ledesma *et al.*, 1996).

Decontamination treatment

According to Rodriguez de Ledesma *et al.* (1996), each main group of chicken wings was randomly divided into 12 subgroups. For each main group, samples in one subgroup were dipped into sterile tap water (control) for 15 min. Samples in three

subgroups were dipped into 8 % (pH 12.59), 10 % (pH 12.68) or 12 % (pH 12.75) w/v Trisodium phosphate (TSP) (Merck) solution for 15 sec, respectively. Samples in other two subgroups were dipped into 1 % (pH 1.8) v/v lactic acid (EA Chemicals) and 2 % (pH 1.8 – 2) v/v acetic acid (Adwic) for 15 sec, respectively. The concentration of acetic acid was selected because the pH value was similar to that of the lactic acid solution used. Samples in the five subgroups were dipped in TSP (8 %, 10 % and 12 %), lactic acid (1 %) and acetic acid (2 %), respectively, as described above, followed by dipping in hot water 70°C for 5 sec. Samples in the remaining last subgroup were dipped in hot water 70°C for 15 sec. After treatment, chicken wings were drained for 15 min. at room temperature. The samples were placed in sterile bags and stored at 4°C. All samples were evaluated for bacteriological examination, and the first six subgroups for pH values after 0, 1, 3 and 5 days of storage. On day 0, samples were tested immediately after the inoculation and dipping treatment had been completed.

Bacteriological examination and pH determination

For each decontamination treatment, half of the chicken wings was used for bacteriological examination, and the other half for pH determination. For bacterial count, each sample was prepared by excising 5 g of skin with a sterile knife blade. The samples were placed in a sterile blender containing 45 ml of sterile 0.1 % w/v buffered peptone water and macerated in a blender for 2 min. Serial dilutions in sterile 0.1 % w/v peptone water were prepared from this homogenate, 0.1 ml on plating medium listeria agar (Difco) for *L. monocytogenes*, brilliant green novobiocin agar (Difco) for *S. Typhimurium* and mannitol salt agar (Difco) for *S. aureus*. The plates were incubated at 37°C overnight before colonies were counted, calculated and expressed as $\log_{10}$ cfu g^{-1} skin.

Plating from non- inoculated wings to determine shelf life was done on nutrient agar (Difco) at 20°C after 0, 1, 3 and 5 days of storage at 4°C. The nutrient agar plates were incubated for 72 h.

For pH determination, 5 g of skin wings were placed in a blender with 15 ml of sterile distilled deionized water and blended for 2 min in a blender. The pH was measured using pH meter.

Statistical method

Statistical tests were performed on obtained data using SPSS 11 (2002) computer program. All results with $P < 0.05$ were considered statistically significant.

RESULTS AND DISCUSSION

Bacterial contamination of poultry during commercial processing is undesirable, though unavoidable. Not only does contamination of poultry by pathogenic microorganisms pose a health hazard to human, but, spoilage of poultry meat is one of the major causes of economic loss to both consumer as well as producer.

In this study, the decontamination of inoculated chicken wings with three common pathogenic bacteria gave significantly different results (Table 1). Populations of *L. monocytogenes*, *S. Typhimurium* and *S. aureus* recovered from chicken wings immediately after inoculation were 7.6, 6.7 and 6.4 $\log_{10}$ cfu g^{-1} skin, respectively. Table 1 shows the microbial counts on 0, 1, 3 and 5 days of *L. monocytogenes*, *S. Typhimurium* and *S. aureus* recovered from inoculated chicken wings which were treated in tap water, TSP, lactic acid and acetic acid prior to refrigerated storage at 4°C. All the decontamination treatments reduced inoculated bacterial pathogens.

Both 12 % TSP and 1 % lactic acid were very effective in inactivating *L. monocytogenes* since significant reductions in the bacterial populations were observed on day 0, 1, 3 and 5 day of refrigeration storage when compared to tap water dipping. As can be seen from Table 1, *L. monocytogenes* reduction in treated samples with 8, 10, 12 % TSP and 1% lactic acid were 5.7 $\pm$ 0.36, 5.9 $\pm$ 0.13, 4.91 $\pm$ 0.02 and 4.4 $\pm$ 0.19 respectively, after 5 days of refrigerated storage at 4°C.

When comparing the present results with those of other authors (Mu *et al.*, 1997) they did not find any significant reduction in *L. monocytogenes* population either in artificially contaminated fresh headed shrimp or rainbow trout fillets which had been dipped in 10 and 20 % TSP solution for 10 min. This could be explained by Capita *et al.* (2002) who suggested that decontamination depends on the difference in treatment time, TSP concentration and that the type of tissue studied must be taken into account. Hwang and Beuchat (1995) dipped fragments of chicken skin artificially contaminated with *L. monocytogenes* in 1 % TSP solutions for 30 min. and found reductions of 1.3 $\log_{10}$ cycles after treatment.

Concerning the decontamination effect of lactic acid, the results of this study agree with the study of Greer and Dilts (1995), who reported that *L. monocytogenes* and other psychrotrophic meat pathogens were more sensitive to organic acid than mesophilic pathogens.

From Table 1, it is clear that the antimicrobial effects of 8, 10 & 12% TSP and 1 % lactic acid against *S. Typhimurium* 3.81 $\pm$ 0.08, 3.69 $\pm$ 0.075, 3.26 $\pm$ 0.36 and 2.28 $\pm$ 0.11 $\log_{10}$ cfu g^{-1} skin are more effective than their effect against *S. aureus* 4.1 $\pm$ 0.15, 3.79 $\pm$ 0.07, 3.30 $\pm$ 0.08 and 3.14 $\pm$ 0.20 $\log_{10}$ cfu g^{-1} skin, respectively, after 5 days of storage. These results agree with the study of Hwang and Beuchat (1995)

who suggested that 1 % TSP, 1% lactic acid and 0.05 % NaOH were all effective in reducing the number of viable *Salmonella* spp. cells on chicken skin. Also, Surve *et al.* (1991) suggested that the antibacterial effects of lactic acid and acid mixtures (acetic acid and propionic acid) against Gram negative organisms are generally more extensive than their effects against Gram positive organisms.

The concentration of the TSP solution was a significant factor in reducing bacterial population (Table 1). This result agrees with Capita *et al.* (2002) who suggested that the concentration of TSP solution was a significant factor in reducing the populations of *L. monocytogenes*. On the contrary, Dickson *et al.* (1994), found no significant differences in bacterial reductions when different TSP concentrations were used. However, differences were observed when other tissue types were investigated with reduction on adipose greater than those on lean tissue.

From Table 1, it is clear that all pathogens were inactivated faster in 1 % lactic acid than in 2 % acetic acid at the same pH (1.8 – 2). Populations of *L. monocytogenes*, *S. Typhimurium* and *S. aureus* recovered from acetic acid treated chicken wings were 5.91 $\pm$ 0.08, 3.56 $\pm$ 0.27 and 3.83 $\pm$ 0.19 $\log_{10}$ cfu g^{-1} skin, respectively, after 5 days of refrigerated storage. This result suggested that there are other important factors in addition to pH which influence the antimicrobial effect of lactic acid and acetic acid. In this concern, Samelis *et al.* (2001) suggested that the lower effectiveness of acetic acid might be due to potentially faster dissipated rate of acetic acid during storage. Sinhamahapatra *et al.* (2004) explained the mode of action of lactic acid which in dissociated form passes across the cell membrane, dissociates within the cell, acidifies cell interiors and causes retardation of microbial growth.

In this study, it was noticed that the benefit of using either TSP, lactic or acetic acid as decontaminant was apparent after several days of storage, as *L. monocytogenes* is a psychrotrophic microorganism. Populations in control samples increased from the first day of refrigerated storage approximately 6.95 $\pm$ 0.09 $\log_{10}$ cfu g^{-1} skin and counts on day 3 and 5 were significantly higher (8.3 $\pm$ 0.06 and 8.33 $\pm$ 0.06) than counts on day 0 and 1 (7.20 $\pm$ 0.16 and 6.95 $\pm$ 0.09), respectively. Populations in treated samples with 8, 10, 12 % TSP, 1 % lactic acid and 2 % acetic acid were 5.92 $\pm$ 0.1, 5.81 $\pm$ 0.07, 5.4 $\pm$ 0.41, 4.95 $\pm$ 0.08 and 5.78 $\pm$ 0.13 $\log_{10}$ cfu g^{-1} skin after 3 days of storage. Similar results were obtained by Colin and Salvat (1996) who suggested an increase in TSP efficiency after several days of refrigerated storage. Also, Capita *et al.* (2002) indicated that the antimicrobial effect of TSP on *L. monocytogenes* population was maintained throughout the refrigerated storage, thereby, impede their multiplication on the poultry products.

On the other hand, *S. Typhimurium* and *S. aureus* counts on TSP, lactic acid and acetic acid treatment did not significantly change over the storage period (Table

1), possibly as a result of the inhibitory effect of the residue of decontamination on the chicken wings skin, and they are not psychrotrophic microorganisms.

The results of skin pH on 0, 1 , 3 and 5 days of bacterial inoculated chicken wings were observed in Table 2. It is clear that dipping of chicken wings in TSP solution resulted relatively in high surface pH value between 8.3 $\pm$ 0.15 and 9.07 $\pm$ 0.04 initially to the range between 8.12 $\pm$ 0.07 and 8.15 $\pm$ 0.04 within 3 days of storage at 4°C compared to surface pH value of samples dipped in tap water (6.64 $\pm$ 0.11) (Table 2). This result could be explained by Mu *et al.* (1997) who suggested that the natural buffering capacity of food systems, as well as acid production due to microbial growth probably both contributed to the drop of pH value. The concentration of TSP did not significantly affect the pH of chicken skin on day 1, 3 and 5 of storage (Table 2).

On the other hand, the pH values of the chicken wings remained constant until day 3 in the 1 % lactic and 2 % acetic acid dipped samples 6.58 $\pm$ 0.07 and 6.45 $\pm$ 0.11, respectively, and increased slightly between 3 and 5 days of refrigerated storage (Table 2). This pH maintenance was explained by Gibson (1988) who suggested that meat and meat products have a marked buffering capacity which can limit changes in pH induced by microbial metabolites. Also, Sinhamahapatra *et al.* (2004) explained that lactic acid penetrates the muscle during treatment, that is why the pH at 0 hours of the lactic acid treated carcass was lower than the untreated control one. The strength of the lactic acid solution was not so high that it prevents the raise of pH following storage, but, due to its better penetrating capacity, it was able to control the rise in pH at 24 and 48 h.

Generally speaking, the mechanism by which TSP, lactic acid and acetic acid kill surface bacteria on poultry meat may be a result of combination of pH factor and a specific antimicrobial effect, however, it appears that *L. monocytogenes* is more resistant to alkaline pH than to acidic pH.

To evaluate the effect of decontamination treatment on the natural spoilage micro flora, and thus, on the shelf-life of the product is shown in Table 3. On day 1, there was a higher number of spoilage organism on the surface of chicken wings in the untreated group 5.41 $\pm$ 0.07 compared to the 8, 10 & 12 % TSP, 1 % lactic and 2% acetic acid treated groups which were 2.74 $\pm$ 0.1, 2.42 $\pm$ 0.07, 1.01 $\pm$ 0.09, 1.21 $\pm$ 0.36 and 1.95 $\pm$ 0.29 $\log_{10}$ cfu g^{-1} skin, respectively. The apparent slower growth of bacteria on the control during storage may be due to the high initial numbers of organisms. However, on 5 days of storage, the numbers on the controls were 7.65 $\pm$ 0.11 $\log_{10}$ cfu g^{-1} skin compared to 8, 10 & 12 % TSP, 1 % lactic and 2 % acetic acid treated groups which were 2.2 $\pm$ 0.15, 2.03 $\pm$ 0.04, 0.93 $\pm$ 0.06, 0.92 $\pm$ 0.06 and 1.69 $\pm$ 0.55 $\log_{10}$ cfu g^{-1} skin, respectively.

It appears that, 12 % TSP and 1 % lactic acid solutions were most effective, and significantly reduced population of spoilage bacteria on chicken wings when compared to 8, 10 % TSP and 2 % acetic acid (Table 3).

From this result, it is concluded that decontamination treatment specially 12 % TSP and 1 % lactic acid retarded the growth of spoilage bacteria on chicken wings, thus, potentially may extend the shelf-life.

The interaction between decontamination treatment and hot water 70°C had an additive effect on inoculated bacterial pathogens (Table 4). Comparing the result obtained in Table 1 with the result in Table 4, it was concluded that, none of the individual treatments achieved a high degree of pathogen reduction, but, when the treatment was combined, the effect was more notable. The reductions were 3.88 $\pm$ 0.40, 3.32 $\pm$ 0.31 and 4.7 $\pm$ 0.15 for *L. monocytogenes*, 2.34 $\pm$ 0.30, 1.84 $\pm$ 0.15 and 2.34 $\pm$ 0.27 for *S. Typhimurium* and 3.14 $\pm$ 0.28, 3.0 $\pm$ 0.35 and 3.62 $\pm$ 0.19 for *S. aureus* after combined treatment 12 % TSP or 1 % lactic or 2 % acetic acid with hot water, respectively, after 5 days of storage. This effect is reasonable since the two treatments have different mechanisms of action. In this aspect, Rodriguez de Ledesma *et al.* (1996) suggested that TSP probably has a detergent effect making clumps of the cells split and loose from the skin while, hot water results in direct heat kill of bacteria.

It was noticed that the effect of combined treatment on spoilage bacteria was higher than the effect on inoculated pathogenic bacteria (Table 4). The reduction was 2.20 $\pm$ 0.15, 1.80 $\pm$ 0.15, 0.62 $\pm$ 0.11, 0.61 $\pm$ 0.09 and 0.97 $\pm$ 0.13 after combined treatment 8, 10, 12 % TSP, 1 % lactic acid and 2 % acetic acid with hot water, respectively, after 5 days of storage.

TSP, lactic acid and acetic acid are more effective than hot water against *S. Typhimurium*, *S. aureus* and spoilage micro flora, while, there is no clear difference for *L. monocytogenes* except after 3 days of storage at 4°C (Table 4).

The antimicrobial effect of decontamination treatment followed by dipping in hot water 70°C could maintain throughout the refrigerated storage for inoculated bacteria and spoilage micro flora (Table 4).

It is concluded that all the decontaminants were effective in reducing inoculated bacterial pathogens and spoilage micro flora, but, 12 % TSP and 1% lactic acid were more effective. We advice to extend the use of combined decontamination treatment and hot water at 70°C to poultry industry as an effective means to reduce bacterial population and extension of shelf-life of chilled poultry.

Table 1. Number of bacteria $\log_{10}$ cfu g^{-1} skin recovered from chicken wings on 0, 1, 3 and 5 days of bacterial inoculated chicken followed by decontamination treatment.

Treatment	$\log_{10}$ cfu g^{-1} skin											
	L. monocytogenes				*S.* Typhimurium				*S. aureus*			
	0	1	3	5	0	1	3	5	0	1	3	5
Tap water (control)	$7.20 \pm 0.16^{a}_{a}$	$6.95 \pm 0.09^{a}_{a}$	$8.32 \pm 0.06^{b}_{a}$	$8.33 \pm 0.06^{b}_{a}$	$6.43 \pm 0.45^{a}_{a}$	$6.77 \pm 0.09^{a}_{a}$	$6.40 \pm 0.08^{a}_{a}$	$6.58 \pm 0.11^{a}_{a}$	$5.93 \pm 0.11^{a}_{a}$	$6.20 \pm 0.07^{a}_{a}$	$6.70 \pm 0.55^{a}_{a}$	$6.15 \pm 0.10^{a}_{a}$
8 % TSP	$5.72 \pm 0.17^{a}_{b}$	$5.74 \pm 0.09^{a}_{b}$	$5.92 \pm 0.01^{a}_{b}$	$5.7 \pm 0.36^{a}_{b}$	$4.68 \pm 0.19^{a}_{b}$	$4.53 \pm 0.26^{a}_{b}$	$4.28 \pm 0.40^{a}_{b}$	$3.81 \pm 0.08^{a}_{b}$	$4.59 \pm 0.23^{a}_{b}$	$4.26 \pm 0.25^{a}_{b}$	$4.20 \pm 0.18^{a}_{b}$	$4.10 \pm 0.15^{a}_{b}$
10 % TSP	$5.43 \pm 0.02^{a}_{c}$	$5.54 \pm 0.02^{a}_{c}$	$5.81 \pm 0.07^{a}_{c}$	$5.9 \pm 0.13^{a}_{c}$	$4.42 \pm 0.09^{a}_{c}$	$4.19 \pm 0.37^{a}_{c}$	$3.82 \pm 0.15^{a}_{c}$	$3.69 \pm 0.08^{a}_{c}$	$4.34 \pm 0.23^{a}_{c}$	$4.01 \pm 0.01^{a}_{c}$	$3.89 \pm 0.10^{a}_{c}$	$3.79 \pm 0.07^{a}_{c}$
12 % TSP	$5.05 \pm 0.04^{a}_{d}$	$5.1 \pm 0.09^{a}_{d}$	$5.4 \pm 0.41^{a}_{d}$	$4.91 \pm 0.02^{a}_{d}$	$4.01 \pm 0.07^{a}_{d}$	$3.20 \pm 0.19^{a}_{d}$	$3.14 \pm 0.04^{a}_{d}$	$3.26 \pm 0.36^{a}_{d}$	$4.13 \pm 0.08^{a}_{d}$	$3.84 \pm 0.04^{a}_{d}$	$3.30 \pm 0.15^{a}_{d}$	$3.30 \pm 0.08^{a}_{d}$
1 % Lactic acid	$4.88 \pm 0.04^{a}_{e}$	$4.9 \pm 0.11^{a}_{e}$	$4.95 \pm 0.08^{a}_{e}$	$4.4 \pm 0.19^{a}_{e}$	$3.14 \pm 0.53^{a}_{e}$	$2.34 \pm 0.04^{a}_{e}$	$2.37 \pm 0.47^{a}_{e}$	$2.28 \pm 0.11^{a}_{e}$	$4.26 \pm 0.36^{a}_{dc}$	$3.71 \pm 0.15^{a}_{d}$	$3.20 \pm 0.20^{a}_{d}$	$3.14 \pm 0.20^{a}_{d}$
2 % acetic acid	$5.72 \pm 0.13^{a}_{b}$	$5.6 \pm 0.11^{a}_{bc}$	$5.78 \pm 0.13^{a}_{c}$	$5.91 \pm 0.08^{a}_{c}$	$4.22 \pm 0.13^{a}_{c}$	$3.77 \pm 0.26^{a}_{dc}$	$3.09 \pm 0.09^{a}_{d}$	$3.56 \pm 0.27^{a}_{dc}$	$4.44 \pm 0.50^{a}_{bc}$	$4.44 \pm 0.39^{a}_{b}$	$3.79 \pm 0.19^{a}_{c}$	$3.83 \pm 0.19^{a}_{c}$

Results are reported as means $\pm$ s.d. (n = 5). Means in the same row with no superscripts in common are significantly different ($P < 0.05$) within the same microorganism. Means in the same column with no subscripts in common are significantly different ($P < 0.05$) within the same microorganism.

Table 2. Skin pH value on 0, 1, 3 and 5 days of bacterial inoculated chicken wings followed by decontamination treatment.

Treatment	Bacterial inoculation											
	L. monocytogenes				*S.* Typhimurium				*S. aureus*			
	0	1	3	5	0	1	3	5	0	1	3	5
Tap water (control)	$6.58 \pm 0.2^{a}_{a}$	$6.6 \pm 0.15^{a}_{a}$	$6.64 \pm 0.11^{a}_{a}$	$6.68 \pm 0.07^{a}_{a}$	$6.7 \pm 0.15^{a}_{a}$	$6.73 \pm 0.17^{a}_{a}$	$6.88 \pm 0.07^{a}_{a}$	$6.9 \pm 0.07^{a}_{a}$	$6.49 \pm 0.08^{a}_{a}$	$6.7 \pm 0.07^{a}_{a}$	$6.9 \pm 0.07^{a}_{a}$	$6.85 \pm 0.11^{a}_{a}$
8 % TSP	$8.3 \pm 0.15^{a}_{b}$	$7.85 \pm 0.10^{a}_{b}$	$8.12 \pm 0.07^{a}_{b}$	$8.11 \pm 0.07^{a}_{b}$	$8.3 \pm 0.15^{a}_{b}$	$8.47 \pm 0.12^{a}_{b}$	$8.1 \pm 0.05^{a}_{b}$	$8.14 \pm 0.04^{a}_{b}$	$8.31 \pm 0.16^{a}_{b}$	$8.23 \pm 0.12^{a}_{b}$	$8.15 \pm 0.11^{a}_{b}$	$8.15 \pm 0.11^{a}_{b}$
10 % TSP	$9.07 \pm 0.07^{a}_{c}$	$8.17 \pm 0.08^{b}_{b}$	$8.13 \pm 0.03^{b}_{b}$	$8.16 \pm 0.07^{b}_{b}$	$9.07 \pm 0.07^{a}_{c}$	$8.14 \pm 0.04^{b}_{b}$	$8.18 \pm 0.06^{b}_{b}$	$8.19 \pm 0.08^{b}_{b}$	$9.05 \pm 0.03^{a}_{c}$	$8.12 \pm 0.01^{b}_{b}$	$8.23 \pm 0.12^{b}_{b}$	$8.2 \pm 0.07^{b}_{b}$
12 % TSP	$9.07 \pm 0.04^{a}_{c}$	$8.13 \pm 0.04^{b}_{b}$	$8.15 \pm 0.04^{b}_{b}$	$8.15 \pm 0.04^{b}_{b}$	$9.10 \pm 0.07^{a}_{c}$	$8.12 \pm 0.07^{b}_{b}$	$8.15 \pm 0.03^{b}_{b}$	$8.15 \pm 0.03^{b}_{b}$	$9.06 \pm 0.08^{a}_{c}$	$8.11 \pm 0.07^{b}_{b}$	$8.2 \pm 0.15^{b}_{b}$	$8.14 \pm 0.11^{b}_{b}$
1 % Lactic acid	$6.4 \pm 0.07^{a}_{d}$	$6.4 \pm 0.12^{a}_{d}$	$6.5 \pm 0.08^{a}_{d}$	$6.56 \pm 0.15^{a}_{d}$	$6.32 \pm 0.07^{a}_{d}$	$6.40 \pm 0.07^{a}_{d}$	$6.58 \pm 0.07^{a}_{d}$	$6.63 \pm 0.17^{a}_{d}$	$6.35 \pm 0.11^{a}_{d}$	$6.41 \pm 0.07^{a}_{d}$	$6.48 \pm 0.07^{a}_{d}$	$6.7 \pm 0.07^{a}_{d}$
2 % acetic acid	$6.44 \pm 0.11^{a}_{d}$	$6.45 \pm 0.04^{a}_{d}$	$6.49 \pm 0.07^{a}_{d}$	$6.7 \pm 0.08^{a}_{d}$	$6.42 \pm 0.07^{a}_{d}$	$6.48 \pm 0.07^{a}_{d}$	$6.45 \pm 0.11^{a}_{d}$	$6.71 \pm 0.14^{a}_{d}$	$6.45 \pm 0.11^{a}_{d}$	$6.45 \pm 0.11^{a}_{d}$	$6.55 \pm 0.11^{a}_{d}$	$6.60 \pm 0.07^{a}_{d}$

Results are reported as means $\pm$ s.d. (n = 5). Means in the same row with no superscripts in common are significantly different ($P < 0.05$) within the same microorganism. Means in the same column with no subscripts in common are significantly different ($P < 0.05$) within the same microorganism.

Table 3. Log_{10} cfu g^{-1} skin of spoilage bacteria on the chicken wings storage at 4°C for 0, 1, 3 and 5 days after decontamination treatment.

Treatment	Storage at 4°C			
	0	1	3	5
Tap water (control)	$5.06 \pm 0.084^{a}_{a}$	$5.41 \pm 0.07^{a}_{a}$	$6.05 \pm 0.12^{b}_{a}$	$7.65 \pm 0.11^{c}_{a}$
8 % TSP	$2.61 \pm 0.07^{a}_{b}$	$2.74 \pm 0.10^{a}_{b}$	$2.40 \pm 0.07^{a}_{b}$	$2.20 \pm 0.15^{a}_{b}$
10 % TSP	$2.06 \pm 0.05^{a}_{c}$	$2.42 \pm 0.07^{a}_{c}$	$2.12 \pm 0.07^{a}_{c}$	$2.03 \pm 0.04^{a}_{c}$
12 % TSP	$0.95 \pm 0.12^{a}_{d}$	$1.01 \pm 0.09^{a}_{d}$	$0.88 \pm 0.04^{a}_{d}$	$0.93 \pm 0.06^{a}_{d}$
1 % Lactic acid	$1.29 \pm 0.30^{a}_{d}$	$1.21 \pm 0.36^{a}_{d}$	$1.04 \pm 0.17^{a}_{d}$	$0.92 \pm 0.06^{a}_{d}$
2 % acetic acid	$1.93 \pm 0.21^{a}_{c}$	$1.95 \pm 0.298^{a}_{e}$	$1.68 \pm 0.29^{a}_{e}$	$1.69 \pm 0.055^{a}_{e}$

Results are reported as means $\pm$ s.d. (n = 5). Means in the same row with no superscripts in common are significantly different ($P < 0.05$) within the same microorganism. Means in the same column with no subscripts in common are significantly different ($P < 0.05$) within the same microorganism.

Table 4. Effects of combined treatment (dipping in decontamination treatments 15 sec. and in hot water 70°C for 5 sec.) followed by storage at 4°C log_{10} cfu g^{-1} skin bacterial counts for inoculated pathogenic bacteria and spoilage micro flora on the surface of chicken wings.

Treatment	log_{10} cfu g^{-1} skin												Spoilage microflora			
	L. monocytogenes				*S.* Typhimurium				*S. aureus*							
	0	1	3	5	0	1	3	5	0	1	3	5	0	1	3	5
Tap water (control)	$7.19 \pm 0.15^{a}_{a}$	$6.96 \pm 0.10^{a}_{a}$	$8.32 \pm 0.07^{b}_{a}$	$8.32 \pm 0.06^{b}_{a}$	$6.42 \pm 0.11^{a}_{a}$	$6.82 \pm 0.30^{a}_{a}$	$6.42 \pm 0.06^{a}_{a}$	$6.56 \pm 0.12^{a}_{a}$	$5.84 \pm 0.18^{a}_{a}$	$6.20 \pm 0.07^{a}_{a}$	$6.25 \pm 0.11^{a}_{a}$	$6.19 \pm 0.13^{a}_{a}$	$5.06 \pm 0.06^{a}_{a}$	$5.41 \pm 0.07^{a}_{a}$	$6.05 \pm 0.12^{b}_{a}$	$7.65 \pm 0.11^{c}_{a}$
Hot water 70°C	$5.06 \pm 0.2^{a}_{b}$	$5.02 \pm 0.16^{a}_{b}$	$5.38 \pm 0.2^{a}_{b}$	$5.8 \pm 0.36^{b}_{b}$	$4.72 \pm 0.19^{a}_{b}$	$4.42 \pm 0.16^{a}_{b}$	$4.76 \pm 0.27^{a}_{b}$	$4.82 \pm 0.27^{a}_{b}$	$4.5 \pm 0.15^{a}_{b}$	$4.4 \pm 0.23^{a}_{b}$	$4.91 \pm 0.15^{a}_{b}$	$5.24 \pm 0.36^{a}_{b}$	$4.24 \pm 0.28^{a}_{b}$	$3.96 \pm 0.11^{a}_{b}$	$4.26 \pm 0.20^{a}_{b}$	$4.48 \pm 0.22^{a}_{b}$
8 % TSP + hot water	$5.09 \pm 0.17^{a}_{b}$	$4.91 \pm 0.15^{a}_{b}$	$4.87 \pm 0.18^{a}_{bc}$	$4.78 \pm 0.13^{a}_{bc}$	$4.63 \pm 0.23^{a}_{b}$	$4.29 \pm 0.46^{a}_{b}$	$3.68 \pm 0.43^{b}_{bc}$	$3.38 \pm 0.39^{b}_{bc}$	$4.13 \pm 0.26^{a}_{bc}$	$3.96 \pm 0.34^{a}_{bc}$	$3.92 \pm 0.20^{a}_{bc}$	$3.70 \pm 0.23^{a}_{c}$	$2.4 \pm 0.15^{a}_{c}$	$2.38 \pm 0.19^{a}_{c}$	$2.24 \pm 0.26^{a}_{c}$	$2.20 \pm 0.15^{a}_{c}$
10 % TSP + hot water	$4.57 \pm 0.54^{a}_{c}$	$4.73 \pm 0.42^{a}_{c}$	$4.52 \pm 0.36^{a}_{c}$	$4.06 \pm 0.37^{a}_{c}$	$4.08 \pm 0.74^{a}_{c}$	$3.46 \pm 0.67^{b}_{c}$	$3.02 \pm 0.69^{b}_{c}$	$2.92 \pm 0.58^{b}_{c}$	$3.95 \pm 0.08^{a}_{c}$	$3.80 \pm 0.23^{a}_{c}$	$3.6 \pm 0.40^{a}_{c}$	$3.16 \pm 0.37^{a}_{d}$	$1.83 \pm 0.11^{a}_{d}$	$2.0 \pm 0.15^{a}_{d}$	$1.80 \pm 0.19^{a}_{d}$	$1.80 \pm 0.16^{a}_{d}$
12 % TSP + hot water	$4.01 \pm 0.16^{a}_{d}$	$4.41 \pm 0.40^{a}_{d}$	$4.28 \pm 0.30^{a}_{d}$	$3.88 \pm 0.40^{a}_{d}$	$3.34 \pm 0.21^{a}_{d}$	$2.6 \pm 0.43^{a}_{d}$	$2.36 \pm 0.35^{b}_{d}$	$2.34 \pm 0.30^{b}_{d}$	$3.88 \pm 0.13^{a}_{d}$	$3.66 \pm 0.20^{a}_{d}$	$3.12 \pm 0.44^{a}_{d}$	$3.14 \pm 0.28^{a}_{d}$	$0.73 \pm 0.09^{a}_{e}$	$0.78 \pm 0.11^{a}_{e}$	$0.62 \pm 0.11^{a}_{e}$	$0.62 \pm 0.11^{a}_{e}$
1 % Lactic acid + hot water	$3.71 \pm 0.16^{a}_{e}$	$3.70 \pm 0.15^{a}_{e}$	$3.54 \pm 0.20^{a}_{e}$	$3.32 \pm 0.31^{a}_{e}$	$2.62 \pm 0.46^{a}_{e}$	$2.10 \pm 0.07^{a}_{e}$	$1.84 \pm 0.11^{b}_{e}$	$1.84 \pm 0.15^{b}_{e}$	$3.88 \pm 0.13^{a}_{d}$	$3.46 \pm 0.11^{a}_{d}$	$3.02 \pm 0.17^{a}_{d}$	$3.0 \pm 0.35^{a}_{d}$	$0.86 \pm 0.07^{a}_{e}$	$0.81 \pm 0.13^{a}_{e}$	$0.64 \pm 0.13^{a}_{e}$	$0.61 \pm 0.09^{a}_{e}$
2 % acetic acid + hot water	$5.26 \pm 0.27^{a}_{b}$	$4.88 \pm 0.17^{a}_{b}$	$4.70 \pm 0.15^{a}_{b}$	$4.7 \pm 0.15^{a}_{c}$	$3.58 \pm 0.29^{a}_{dc}$	$2.46 \pm 0.30^{b}_{d}$	$2.14 \pm 0.19^{b}_{d}$	$2.34 \pm 0.27^{b}_{d}$	$4.28 \pm 0.19^{a}_{bc}$	$3.96 \pm 0.23^{a}_{bc}$	$3.54 \pm 0.46^{a}_{c}$	$3.52 \pm 0.19^{a}_{c}$	$1.60 \pm 0.13^{a}_{d}$	$1.14 \pm 0.38^{a}_{de}$	$0.97 \pm 0.12^{a}_{de}$	$0.97 \pm 0.13^{a}_{de}$

Results are reported as means $\pm$ s.d. (n = 5). Means in the same row with no superscripts in common are significantly different ($P < 0.05$) within the same microorganism. Means in the same column with no subscripts in common are significantly different ($P < 0.05$) within the same microorganism.

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إستخدام مضادات التلوث فى السيطرة علي البكتريا الموجودة في جلد الدواجن

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هذه دراسة مقارنة عن تأثير إستخدام مضادات التلوث المختلفة لتقليل التواجد البكتيري الناتج من ميكروفلورا طبيعية أو بعض ميكروبات التسمم الغذائي المحقونة في أجنحة الدواجن.

تم إستخدام مجموعتين من أجنحة الدواجن ، المجموعة الأولي تم تقسيمها وحقنها بكل من ميكروب اللستيريا مونوسيتوجين ، سالمونيلا تيفيميوريم والميكروب العنقودي الذهبي كل علي حدة. و المجموعة الثانية لم يتم حقنها و التي تمثل التواجد الطبيعي للميكروفلورا.

تم معالجة المجموعتين بمضادات التلوث كل علي حدة : ٨% تراي صوديوم فوسفات (الأس الهيدروجيني ١٢,٥٩) ، ١٠% تراي صوديوم فوسفات (الأس الهيدروجيني ١٢,٦٨) ،١٢% تراي صوديوم فوسفات (الأس الهيدروجيني ١٢،٧٥) ، ١% حمض اللاكتيك (الأس الهيدروجيني ١,٨) و ٢% حمض الخليك (الأس الهيدروجيني ١,٨– ٢) مع وجود مجموعة ضابطة معالجة بالماء العادي .

وتم دراسة المعالجة المزدوجة وذلك باستخدام مضادات التلوث السابقة كل علي حدة يليها إستخدام الماء الساخن ٧٠ درجة مئوية .

وتم التقييم بعمل العد البكتيري وقياس الأس الهيدروجيني بعد المعالجة مباشرة وبعد ١،٣،٥ أيام . وبالمقارنة بتأثير الماء العادي وجد أن كل مضادات التلوث المستخدمة تقلل من العد البكتيري تقليلا معنويا باحتمالية أقل من ٠,٠٥ بالأضافة إلى أن زيادة تركيز التراي صوديوم فوسفات عامل معنوي هام لتقليل التواجد البكتيري. وبقياس الأس الهيدروجيني وجد أن المعالجة بالتراي صوديوم فوسفات و حمض اللأكتيك (أو الخليك) ينتج عنه إرتفاع في درجة الأس الهيدروجيني (٩,٠٧ ± ٠,٠٤ – ٨,٣ ± ٠,١٥) أو إنخفاض (٦,٤ ±٠,٠٧ – ٦,٣٢ ±٠,٠٧) علي التوالي من بداية المعالجة وحتي اليوم الخامس.

إن مضادات التلوث المختلفة تقلل من نمو الميكروفلورا الطبيعية وذلك قد يزيد من مدي صلاحية الدواجن المحفوظة عند ٤ درجة مئوية. التأثير المزدوج لمضادات التلوث و الماء الساخن يقلل من العد البكتيري للميكروفلورا الطبيعية أكثر من تأثيرها علي ميكروبات التسمم الغذائي المحقونة.

وتوصي هذه الدراسة بأن المعالجة المزدوجة بأستخدام مضادات التلوث خاصة ١٢% تراي صوديوم فوسفات و ١% حامض اللاكتيك يليه المعالجة بالماء الساخن ٧٠درجة مئوية يقلل من التواجد البكتيري للميكروفلورا الطبيعية و ميكروبات التسمم الغذائي و بالتالي قد يزيد من مدي صلاحية الدواجن ويقلل من حدوث حالات التسمم الغذائي.