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Effect of Chlorinated Water and Sodium Tripolyphosphate Spray Washing on Microbiological Quality of Quail Carcasses

Rocky, V. R.[3], Zawani, C. J.[1], Wan Zunairah, W. I.[1], Nor Afizah, M.[2], Nur Hanani, Z. A.[2], Ismail-Fitry, M. R.[2], Nor-Khaizura, M. A. R.[1*]

[1]Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor
[2]Department of Food Technology, Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor
[3]Department of Molecular Biology, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak UNIMAS, 94300 Kota Samarahan, Sarawak

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Abstract: Quail is considered a high protein product, with such nutrients that are appropriate for the growth of the microorganisms, for example, bacteria, fungal and yeast. This condition can contribute to easy spoil of the product. The comparison between tap water (control), chlorinated water (CL) and sodium tripolyphosphate (STPP) at 30 and 60°C on the total microbial count of quails. Carcasses were sprayed for 60 s with a tap, (CL) or STPP solution, subjected to 30 °C and 60 °C temperature. Treated carcasses were then diluted up to 10-5 for microbiological analyses; total plate count using plate count agar (PCA), yeast, and mould count using potato dextrose agar (PDA) and Salmonella count using hektoen enteric agar (HEA). Results indicated that a higher bacterial population were found on sample treated with control, followed by a CL-treated sample and STPP solution recorded the least for both PCA and PDA agar when in 30°C. However, when being introduced to the high temperature of 60 °C, (CL) showed the best antimicrobial activity, recorded 4.23 log cfu/g bacterial count for PCA. Meanwhile, STPP solution with 4.42 log cfu/g and control with 4.79 log cfu/g. A different pattern was observed in yeast and mould count, whereby it showed sample treated with control and STPP solution does not significantly different in decreasing the yeast and mould count, in turn, CL counted with the highest microbial load of 4.64 log cfu/g. There was also no presence of Salmonella spp found on the quail of all treatments. The pH of the quail after each treatment was ranging from pH 6 to 7. This indicated that STPP had shown a stronger antimicrobial activity as spray washing for quails than CL and control, at 30°C.

Keywords: Quail; Quality; Washing procedure; Spray washing; Chlorine; Sodium Tripolyphosphate; Temperature.

1. Introduction

Quail (‘*burung puyuh’*) product is getting more attention in the market. In Malaysia, quite a number of quail farm is established. The main quail product in the market is fresh and frozen quail either plain or marinating. Quail is considered a high protein product, with such nutrients that are appropriate for the growth of the microorganisms, for example, bacteria, fungal and yeast. This condition can contribute to easy spoil of the product.

The quails slaughtering processes has the possibility to be a major contributor to cross-contamination of food-borne and fecal-borne microorganisms to occur. This will affect the level of pathogens entering the processing area, resulting in poor microbiological quality of raw poultry product in the retail market [1]. The application of high-pressure spray washing is able to control microbial contaminants on the carcasses [2]. In one report, up to 90 % bacterial reduction was revealed after spray washing treatment [3].

Efficient washing of carcasses before proceeding to chilling can reduce *Campylobacter* to 1 log. Meanwhile, in another study, application of spray washing on cage floor reported that spray washing with or without corn starch followed by 2 h of drying time was effective in reducing the transfer of *Campylobacter* to none detected and improving the reduction in *E. coli* and coliform transfer [5]. Therefore, spray-washing treatment could have a significant role in equipment cleaning and carcasses sanitizing to decrease the spoilage microorganisms.

Incorporating antimicrobial agent such as phosphate, chlorine, organic acid and electrolyzed water into the spray washing

*Corresponding author: norkhaizura@upm.edu.my

treatment will greatly enhance the effectiveness this treatment. This has been proved by a research, which stated that chemical spraying had shown an important reduction in both total aerobes and *Salmonella* contamination compared to the water spray [6]. Furthermore, the addition of bactericidal chemicals or utilizing high-temperature water has been proved to increase the effectiveness of spray washing treatment in eliminating bacterial contamination of broiler carcasses [7].

Even though most of the references used in this research were taken mainly focusing on the chemical-pathogenic bacteria effect, instead of the spoilage bacteria itself, the differences can be neglected as had been described that spoilage organism was more susceptible to anti-bacteria treatment [8].

Therefore, the objective of this study is to determine the effectiveness of chlorinated water and sodium tripolyphosphate spray washing on the microbiological quality of quail carcasses.

2. Methodologies

Quail Samples. Quail carcasses were obtained from a farm and brought to the laboratory in the icebox. The treatments were carried out immediately once reach to the laboratory.

Spray Washing Treatments. Three chemicals were evaluated in the spraying treatments, including tap water as a control, chlorine solution, and sodium tripolyphosphate solution:

a) Tap water (control); total chlorine concentration for tap water was 0.75 mg/L [9], and initial pH was recorded as 7.26

b) Chlorinated solution: 50 mg/L of chlorinated water (pH 7.29) was prepared by mixing approximately 2 mL of 6.15 % commercial bleach in 2 L of tap water.

c) STPP solution: 10 % STPP solution with a pH of 9.14 was prepared by adding 37 g of STPP powder into 1 L distilled water. The initial pH of tap, chlorine, and STPP water was measured using a handheld pH- meter before spraying.

Spraying Washing Procedure. During the washing treatments, the quails were placed on a sterile tray. The spray washing treatment using different antimicrobial agents were applied using a 1 L spray bottle. The quails were sprayed for 30 seconds for each side.

Microbiological Analysis. 25g of the quail carcasses was serial diluted by adding 225 mL of 0.1 % sterile peptone water to the stomacher bags containing the carcasses and homogenized using a stomacher machine for 1 min.

The total plate count (TPC) and yeast and mold count of the carcass were enumerated on plate count agar, incubated at 37°C for 1 d, and yeast and mold count were enumerated on acidified potato dextrose agar incubated at 37°C for 3 d. Meanwhile, *Salmonella* spp incubated in hektoen enteric agar at 37°C for 5 d.

Psychochemical Analysis. The pH of each sample was recorded before and after the samples had been treated by their respective treatments. The external appearance and condition of the quails also being observed to examined any physical effect of the antimicrobial agents and temperature.

Statistical Analyses. Data from the 3 trials were combined for statistical analyses due to insignificant trial differences or interactions. Group means of data for the number of microorganisms recovered from the carcasses were compared to determine significant differences in the size of microbial populations recovered from carcasses sprayed with tap, chlorinated, STPP water via spraying treatment. Data were also analyzed to determine significant differences in the number of microorganisms recovered from the carcasses sprayed with the same solution. The lower limit of detection of the plating procedure used was 30 CFU/g and highest limit was 300 CFU/g.

3. Results

Total plate count (TPC) of spray washed quails at 30 and 60°C were presented in Fig.1 and 2, respectively. The result also proved that temperature is an essential factor in reducing the bacterial number.

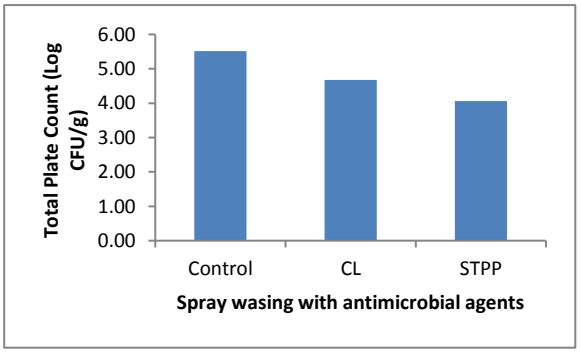

Fig. 1 Total plate count of quails treated with chlorinated and STPP solution at 30°C

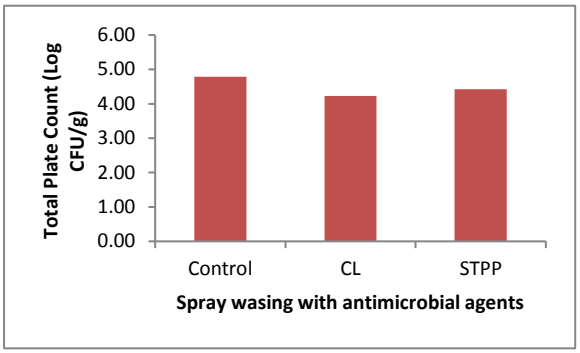

Fig. 2 Total plate count of quails treated with chlorinated and STPP solution at 60°C

Yeast and mold count (YMC) of spray washed quails at 30 and 60°C were presented in Fig.3 and 4, respectively. By comparison, TPC (Fig. 1) and YMC (Fig 3) displayed a similar pattern of microbial reduction effect, meanwhile, when applied at a higher temperature (60°C), the pattern was disturbed as can be seen in TPC (Fig. 2) and YMC (Fig. 4).

In addition, as expected quails treated with tap water (control) showed the highest TPC, however, a distinct results were obtained (fFg. 2). These result were discussed which included the possibility effect of each treatment and temperature independently and collectively.

Salmonella spp was not detected for all treated quails.

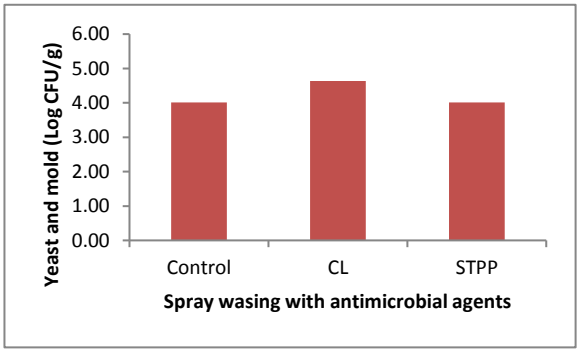

Fig. 3. Yeast and mold count of quails treated with chlorinated and STPP solution at 30°C

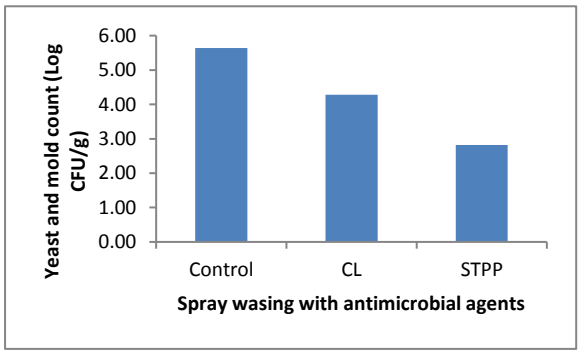

Fig. 4. Yeast and mold count of quails treated with chlorinated and STPP solution at 60°C

4. Discussion

Effect of Antimicrobial Agents on Microbial Count of Quail

Fig. 1 and 2 showed the effect of tap water (control), chlorinated water and STPP treatments on the microorganism count of quails. Based on the result obtained there was negative presence of *Salmonella* spp. There was significance different in total bacteria count between the control (5.51 log cfu/g) and the CL-treated as well as STPP-treated quails, when applied at 30°C, with the log reduction of 0.83 log cfu/g and 1.45 log cfu/g, respectively. A similar pattern can be observed in yeast and mold count, with STPP had the lowest count, meanwhile, as expected, quails sprayed with control recorded with the highest. These findings were compared with previous research, which showed that STPP had a greater antimicrobial effect than chlorine [10]. Other than that, STPP also had been proved to be effective in decreasing spoilage flora [11], reducing both *S.* Typhimurium and yeast and mold count up to 3.2 log cfu/g and 0.7 log cfu/g [12], respectively. This exhibited anti-fungal activity [13] and effective antimicrobial agent in beef [14] and pork [15].

The effectiveness of STPP in inhibiting bacterial growth on the quail was due to its ability to form a stable complex with metallic ions such as cobalt, copper, and iron, hence, competing with the bacteria's cell membrane chelators for available free ions [16]. As further discussed, this will eventually remove calcium, magnesium and others ions presented on the cell wall that induced the lysis of gram-negative bacteria and retard the growth of gram-positive bacteria and fungi. In one research, the mechanism by hindering the function of STPP using pyoverdine causing poultry spoilage to be fasten [17]. The chickens then can be kept longer after continuous contact with STPP [17]. Hence, the efficacy of STPP in reducing microbial load at temperature of 30°C was better than chlorinated water and control.

Effect of Temperature on Microbial Count of Quail

Result obtained at temperature 60 °C, for total plate count were different where the count in CL-treated quail was lower than STPP-treated quails.. This reveals that temperature affected the efficacy of the antimicrobial agents. It had been shown that a higher temperature gave out a higher reduction of bacterial count than at 30°C [18].

This may be due to, the effectiveness of the chlorine was highly depended on the production of hypochlorous acid, once chlorine

contacted with water. As described in [19], hypochlorous acid has a strong oxidizing power and electrical neutrality which caused it to pass through the cell membrane of microorganisms. A pH range of 4 - 7 was required for maximum antimicrobial efficacy [7]. At a higher temperature as the fact that pH falls as temperature increases [20]. This is due to chlorine exhibited corrosive property in high temperature and increasing free chlorine residual at low pH level. Other than that, the result recorded was also follow the pattern by [19] as they found that any changes in pH did not improve the bactericidal action of the chlorine, but the significant bacterial reduction was observed when the temperature was manipulated. CL demanded a very strict parameter to prevent it to exhibit its toxicity such that a maximum concentration of 50 mg/kg of free available chlorine is allowed in poultry processing based on Food Safety and Inspection Service (FSIS) policy [26], optimally work at a low temperature and a pH between 4.0 and 6.0 [7]

However, in another study, [21] reported that chicken samples treated with 50 mg/L at20 °C, 55 °C, or 60 °C no significant differences. Similarly, Northcutt (2005) stated that the addition of chlorine either with or without temperature increased did not improve the reduction number of bacterial count on broiler carcasses.

Meanwhile, *Salmonella* spp. were assumed as absence because no count was enumerated for both the bacteria species on all the quail samples. In addition, bacterial count in control-treated samples was always the highest for both the temperature as well as for all the treated samples. However, control with high temperature had recorded a similar fungal count of 4.01 log cfu/mL with the STPP-treated quail. This may occur due to the synergistic effect of the high temperature condition with the natural residual free chlorine presence in the tap water, an average of 0.75 mg/L chlorine concentration. [9].

Effect of the Treatments on the pH and External Appearance of Quail

For pH analysis, almost all treated quails have a pH within pH 6 to 7 (Fig. 5), regardless of the temperature. No obvious pH changes were observed.

By observation, there was no significant difference in term of the texture and the skin colour of the quail for all the samples before and after the antimicrobial treatment at 30°C (Fig. 6). This is fact as many researchers had proved that chlorine and STPP did not greatly impact the morphology of the quail. It had found that chicken breast treated with chlorine had no changes in their color and texture even after being stored for 7 days [23], and this also supported by [22], as they, when treated with spray washing for the bird, did not affect carcass skin color. As for STTP, in research done by [24], the sample was found to be reduced in drip loss as well as cooking loss and increase the shear force up to 33 % due to the ability of STPP to water-bind effectively. Meanwhile, at 60 °C (Fig. 7) of all treatments, the sample seems to be appeared white stripping of degree 1, with lighter color compared to the previous temperature that shown reddish meat Based on [25] works, it is due to the heat affecting the meat texture and allow changed in proteins and cook loss.

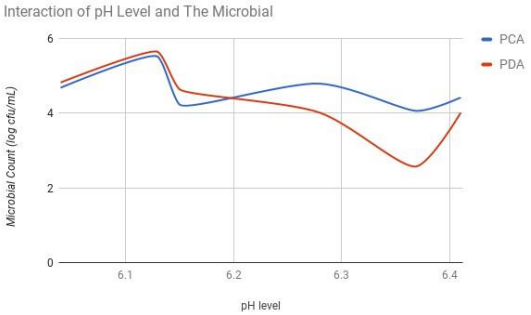

Fig 5. pH of treated quails at 30°C and 60°C

Fig 6. The external appearance of the quail at 30°C.Before spray washing treatment on the left and after treatment on the right.

Fig 7. The external appearance of the quail at 60°C. Before spray washing treatment on the left and after treatment on the right

5. Conclusion

In conclusion, STPP had shown a stronger antimicrobial activity in compared with CL and control, at 30°C. Meanwhile, for a higher temperature (60°C), CL showed a lower bacterial count. Therefore, the application of spray washing on quails is able to reduce the microbial load and maintain a good quality of raw quails.

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