Comparison of acidified sodium chlorite (ASC), chlorine dioxide (CD), peroxyacetic acid (PAA) and tri-sodium phosphate (TSP) 30s chemical washes for decontamination of chicken carcasses and subsequent post-treatment rinsing.

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Abstract – **The aim of this study was to compare the anti-microbial effect of acidified sodium chlorite (ASC), chlorine dioxide (CD), peroxyacetic acid (PAA) and tri-sodium phosphate (TSP) on naturally occurring *Campylobacter*, Enterobacteriaceae and *Pseudomonas* spp. on the breastskin and neckskin of chicken carcasses.**

Chicken carcasses were collected before chilling from a local processor and treated in a purpose-built automated spray rig simulating application of a chemical spray treatment in a commercial poultry processing plant. Replicated batch treatments for 30 s of spray wash were completed for each chemical. The washing effect of the chemical sprays was evaluated by subjecting additional control batches to a potable water only (WO) spray for the same durations. Untreated control carcasses were examined to provide baseline data for the initial microflora levels. The effects of post-treatment rinsing were also investigated. Microbe counts per g were determined using colony count techniques on selective agar media.

For statistical analysis, the results were subdivided into six microbe-type/skin-part combinations.

No single chemical treatment gave the best antimicrobial effect across all divisions although generally ASC and TSP performed better than CD, PAA or WO. Thirty second ASC and TSP treatments gave mean reductions over all microbe-type/skin-part combinations of 1.50 and 1.85 $\log_{10}$ CFU/g respectively, whilst 30s CD, PAA and water washing treatments gave mean reductions over all microbe-type/skin-part combinations of 0.24, 0.80 and 0.13 $\log_{10}$ CFU/g. Rinsing after treatment substantially reduced the efficacy of chemical treatment.

Keywords— **Poultry, Chemical Wash, Rinsing.**

I. INTRODUCTION

Raw poultry meat has been implicated as a major source of human infection, due to cross-contamination in the kitchen to other foods eaten without further cooking, undercooking and probably direct hand-to-mouth transfer during food preparation [1]. In a UK Food Standards Agency survey in 2009 of chicken meat at retail, *Campylobacter* was present in 65% of the samples tested [2]. A European Union (EU) wide baseline survey in 2008 found that at a Community level the prevalence of *Campylobacter*-contaminated broiler carcasses was 75.8%, although it should be noted that the level of prevalence varied widely, from 4.9 to 100%, between Member States [3].

A wide range of chemicals are known that will kill or severely limit the growth of pathogenic and spoilage bacteria, however, the number of chemicals that are, or may be, approved for food use is severely limited and some may only be effective against particular bacteria.

The European Food Safety Authority (EFSA) has examined the safety concerns over chemical treatments of poultry and concluded that: "*On the basis of available data and taking into account that processing of poultry carcasses (washing, cooking) would take place before consumption, the Panel considers that treatment with trisodium phosphate, acidified sodium chlorite, chlorine dioxide, or peroxyacid solutions, under the described conditions of use, would be of no safety concern.*" [4].

Whilst numerous studies have assessed these 'safer' chemicals for antimicrobial efficacy on poultry carcasses and meat, no single published study has directly compared their efficacy using identical application methods.

The EFSA Panel favoured spraying as a treatment method since they also concluded, "*spraying of poultry carcasses with antimicrobials, by comparison to dipping and immersion treatments, will reduce the exposure to residues and by-products that might arise.*" [4].

The spray approach also reduces the need for continuous monitoring and control of chemical concentration that would be required for an immersion approach.

It is clear from published studies that the use of chemical antimicrobials has much to offer in reducing the levels of contamination on chicken carcasses. In addition to the problem of legislation and toxicological issues, there are a number of technical questions that need to be answered before many of these chemicals could be recommended for commercial use. This work needs to be carried out under actual, or near actual, commercial conditions to minimise the problems of extrapolating from laboratory studies.

The study reported in this paper aimed to directly compare the relative efficacy of the chemicals favoured by EFSA (ASC, CD, PAA, TSP) using identical spray application methods at industrial pilot scale using whole, naturally contaminated chicken carcasses. This would go some way to evaluating the effects and addressing practical issues for implementation by the poultry meat industry.

II. MATERIALS AND METHODS

Carcass collection procedures were designed to provide experimental carcasses as close as possible to those that would be seen at the point on a commercial line where the chemical spray treatment would be implemented.

Carcasses were treated in a purpose built automated spray rig simulating the application of a chemical spray treatment as would be seen in a commercial poultry processing plant. A 'misting' spray configuration was used to produce fine droplets suited to surface deposition of the active chemical. Carcasses were driven through the spray on an overhead shackle line (Figure 1).

The same equipment was used for water only spray applications to act as control for the washing effect of the sprays.

Separate rinse spray equipment with substantially higher flow and pressure than the misting chemical application rig was used for rinsing after chemical treatments as the purpose was to rinse and wash chemical residues from the carcass surface.

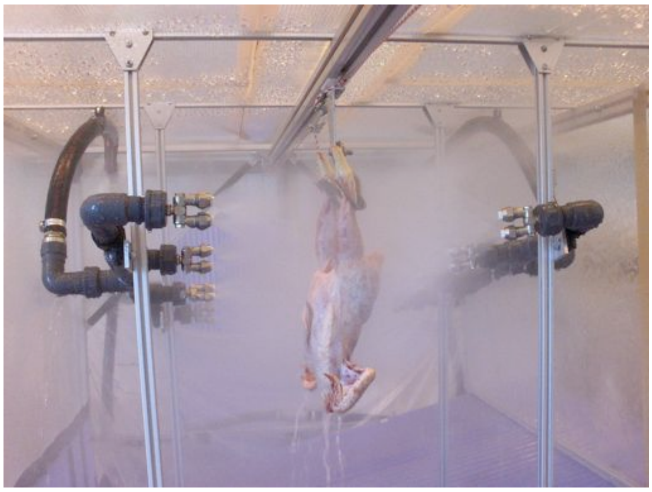

Figure 1. Carcass in mist spray equipment.

The chemical solutions used were formulated to highest permissible concentrations permitted by EFSA for food use.

Normally, batches of five chickens were used for each kind of treatment, five controls treated only with water to evaluate the washing effect, and five controls without any treatment to determine initial microbial levels as a baseline for treatments. The treatments of groups of five were replicated across different trial days to reduce effect of any flock/process/transport idiosyncrasies. EFSA guidelines recommend rinsing carcasses after chemical treatment. In order to assess the effect of rinsing, carcasses from some treatments were rinsed after a pause for chemicals to act.

Neckskins and the whole of the breastskin were removed from each carcass after treatment and examined for numbers of viable *Campylobacter*, Enterobacteriaceae and presumptive *Pseudomonas* spp. All bacterial counts were transformed to $\log_{10}$ CFU/g values for subsequent data analysis. The mean and variance were calculated from replicate results on all experimental days of that treatment.

The mean and variance for the controls for each treatment were derived from the untreated controls for each of the days on which that particular treatment was performed.

Results were collated and analysed in MS Excel, using Student T-test (2 tailed) at 99% confidence for all tests of significance.

III. RESULTS

The mean and variance of microbial levels before treatment (control) and after treatment (treated) are shown in Figure 2 for all microbe-type/carcass-part combinations treated for 30 s mist spraying. For most combinations either ASC or TSP performed best.

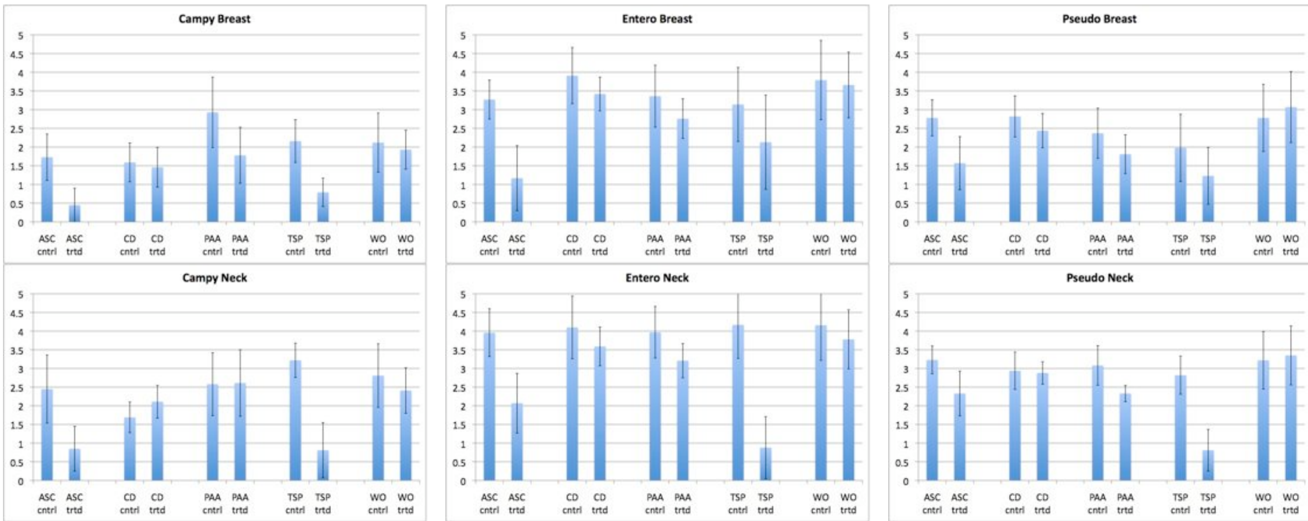

Figure 2. Mean $\log_{10}$ CFU/g (±1SD) of 30s ASC, CD, PAA, TSP and water only mist spray treatments.

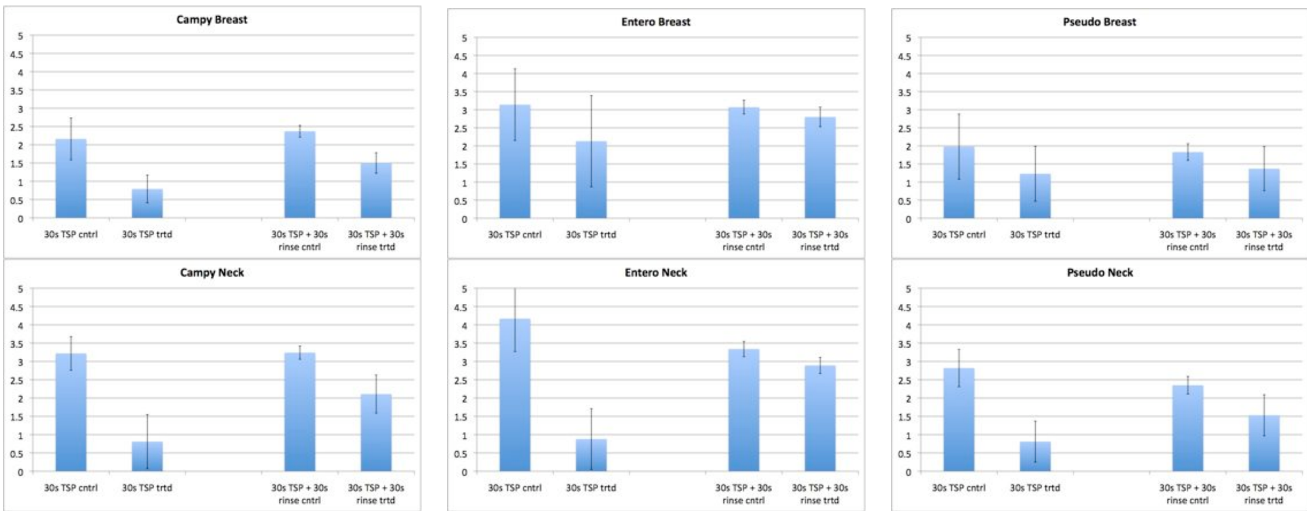

Figure 3. Mean $\log_{10}$ CFU/g (±1SD) of 30s TSP mist spray treatment without and with 30s rinse post treatment.

The effect of a 30 s water rinse after chemical treatment was evaluated for the 30 s TSP mist spray treatment that performed well in the trials without rinsing. The mean and variance of microbial levels before (control) and after (treated) un-rinsed and rinsed treatments are given in Figure 3 for all microbe-type/carcass-part combinations. Since control levels in all cases are broadly equivalent and it can be clearly seen that rinsing substantially reduces the reductions achieved.

IV. DISCUSSION

All ASC and TSP treatments (Figure 2) gave significant reductions ($P<0.01$) with the exception of TSP on Enterobacteriaceae and P*seudomonas* spp on neckskins. The water only (WO) values show that only small proportions of the changes seen with the chemical treatments are due to the washing effect of the sprays. TSP appears more effective on the neckskin than breastskin and this could be due to the drainage of surface droplets to this area giving a concentrating effect, although similar effects are not seen for the other chemicals. It is interesting to note a *Pseudomonas* spp rise during WO treatments on both breastskin and neckskin; this suggested possible contamination from the water supply, but when tested no high levels could be found in the water supply, hence it was concluded that *Pseudomonas* spp had multiplied in the static water inside the spray equipment between trials.

The majority of the un-rinsed treatments (Figure 3) gave significant ($P<0.01$) reductions, whereas the only rinsed treatments giving significant reductions were for *Campylobacter* where the low variances appear to have influenced the statistics.

V. CONCLUSIONS

No single treatment gave the best antimicrobial effect across all organism-type/carcass-part although generally ASC and TSP performed better than CD, PAA and WO.

Rinsing substantially reduced the anti-microbial efficacy of chemical treatments.

ACKNOWLEDGMENT

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