Systematic review of the magnitude of change in the prevalence of *Salmonella* and the quantity of *Salmonella* after administration of pathogen reduction treatments on Pork Carcasses: Interim summary

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**Introduction**

Our objective was to review and describe the change in prevalence and/or quantity of *Salmonella* associated with pathogen reduction treatments (washes, sprays, etc.) on pork carcasses or carcass parts with skin in comparative experimental designs. This is an interim summary.

**Material and Methods**

A review conducted consistent with the systematic review methodology. In January 2015, CABI (1910-2015) (Web of Science interface), Science Citation Index and CPCI-S (1900-2015) (Web of Science interface), Medline and Medline in process (1946-Present) (OVIDSP interface), Science.gov (http://www.science.gov/scigov/), and Proceedings of The International Symposium on Epidemiology and Control of *Salmonella* in Pork (1996–2012) were searched with no restrictions on language or publication type. Reference lists of 24 review article were also checked. Two independent reviewers screened 4001 titles/abstracts and assessed 122 full-text articles for eligibility using pre-tested forms. Non-English-language records were not translated.

**Results**

Data were extracted from 14 studies and risk of bias assessed independently by two reviewers. The following interventions were examined: citric acid + steam, steam + ultrasound, physiological saline, water + acetic acid, acidified sodium chlorite, electrolyzed oxidizing water, distilled water, water (at various temperatures), stannous chloride, hydrogen peroxide, trisodium phosphate, sodium hypochlorite, lactic acid, and acetic acid. Only 5 studies were conducted in a commercial abattoir, the remainder where challenge studies. For summarizing the data we focused on interventions likely to be used in commercial setting i.e. lactic acid, acetic acid, chlorine based washes and water washes. First, we present a forest plot the data for studies that assessed lactic acid based interventions and reported measures of *Salmonella* that were concentration based (Figure 1). The measure of effect used was the standardized mean difference because the studies did not use the same metric. One study used the mean reduction in *Salmonella* between two time points, while others used on the mean concentration post treatment as the metric for comparison.

Figure 1 have no summary effect because it graphs all possible pairwise comparisons and therefore reuses control arm data, as such sample size estimates would be inflated and variance underestimate if a summary effect was calculated. In Figure 1 there is little evidence of a consistent positive or negative effect of acid washing compared to water washes, as most estimates center around the null value of zero. In Figure 2 we present the *Salmonella* prevalence estimates for studies that uses acid treatments (they are varied) with some water treatment (either standard or warm/hot). Again, no summary effect is not reported as it is not suitable for these data as control arms are repeated. This plot provides a more consistent picture of a positive effect of acid-based treatments on *Salmonella* prevalence.
Discussion

When discussing the conclusions we use the GRADE evidence framework as (strength of association, consistency, directness) as a basis for considering the conclusions however we did not conduct a formal GRADE process. We considered risk of bias for the overall body of work due to systematic error to be moderate overall for the body of work (results not shown). The major issue source of bias was the potential for differential recovery of Salmonella from treated carcasses due to knowledge of the intervention. With respect to the strength of association, there does not seem to be strong evidence that one intervention or form of intervention (acid, hot water, cool) is clearly superior to others for control of Salmonella on carcasses. The preliminary conclusion we reach from these data is that there is no strong evidence for the efficacy of one particular intervention. With respect to consistency, the most consistently observed association was a positive effect of acids washes on the reduction in Salmonella, however this is based on individual results and not a summary result which was not calculated for reasons already discussed. The directness of the findings is mixed, some studies were conducted in abattoir settings, which are clearly relevant to the target population. As laboratory studies occur in controlled settings, and we would expect interventions to have smaller and more variables effects when used in commercial settings The conduct of the review was consistent with current standards for reviews. Steps were taken to ensure an a priori protocol was available, a comprehensive search, duplicate data extraction was used. We would propose that the major limitation in the review is the approach to reporting the underlying data.

Conclusion

The interim conclusion we would reach is that there is weak evidence that acid washes might be more effective than water/standard washes at reducing the prevalence of Salmonella on pork carcasses with skin-on. This finding is only weak for several mitigating reasons in particular the fining is not repeated for Salmonella concentration, the number of studies contributing data is small and the body of work uses multiple interventions.

Acknowledgements

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References


Figure 1:
Forest plot showing measures of Salmonella concentration from interventions studies that assessed lactic acid washes in commercial abattoirs. Standardized mean difference is used as the summary effect measure as the metrics for Salmonella where not consistent across studies. These data represent all possible comparisons so control groups appear multiple times and summary effects are invalid. (Christiansen et al., Fabrizio and Cutter, 2004) (Morild et al., 2011)

Figure 2:
Forest plot showing prevalence of Salmonella for interventions that compared variations of acid interventions with standard/controls. These data represent all possible comparisons so control groups appear multiple times and summary effects are invalid.
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