Efficacy and Practicality of Lactic Acid Solutions, Ozonated Water, and Cold Plasma for Campylobacter Reduction

Area of research interest: Foodborne pathogens
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Background

Campylobacter species are the most common cause of bacterial foodborne disease in the UK and are most often transmitted by poultry. This project investigated three interventions to reduce Campylobacter numbers on poultry carcasses that would or may require EU approval before they could be used by industry in the UK.

Research Approach

This project reviewed the existing data including the following three interventions which industry had indicated showed significant potential to reduce Campylobacter contamination:

- lactic acid
- ozonated water
- ozonated carbon dioxide pellets

This information was used to carry out preliminary and full scale trials, and provided data that would be needed for a submission for use in the EU. Samples were tested for Campylobacter on the day of treatment and at the end of storage to examine whether any change (recovery) occurred during storage. Microbiological sampling and testing followed a common protocol developed with the parallel project examining other interventions (FS121014A).

Results

Published reviews on decontamination methods for poultry, including lactic acid indicate that bactericidal effect and cost, increase with acid concentration but the use of high concentrations or long contact times can lead to greying of the poultry skin. Previous research into the effect of lactic acid on Campylobacter on poultry had focussed on testing inoculated samples, often with application times, concentrations, and pH levels that are not practical in a UK processing plant. No published data were found on the effects of ozonated water on Campylobacter.

Lactic acid - Eight trials were carried out to examine the reduction in Campylobacter numbers that could be achieved by spraying of lactic acid onto the carcasses. The earliest trials applied the acid using a hand sprayer, electrostatic sprayer or an in-line tunnel. Those trials showed that pre-

chill spraying was more effective than post-chill spraying. One of the trials reduced presumptive Campylobacter counts on carcasses from 2.7 log10 cfu/g to below the limit of detection of 10 cfu/g. In all other trials, only confirmed Campylobacter were considered and that high level of reduction was not achieved. That early work identified the conditions to be tested in the three FSA-funded trials that used the in-line tunnel. Those trials concluded that applying a 4% solution of lactic acid, buffered using sodium lactate to pH?3.8, at the rate of 100g of acid solution per kg of carcass, applied over 7s, produced up to a 0.4-log10 reduction on breast skin and 0.8 log10 reduction on back/neck skin samples. Using an 8% solution buffered to the same pH, produced a 1.9-log reduction in the numbers of Campylobacter. During some trials, but not all, a change in the appearance of the Campylobacter was caused by the acid treatment; this would explain why presumptive Campylobacter was not a good test in the one trial showing very high microbial reductions. Applying an 8% solution adversely affects the appearance of the carcasses causing greying of the leaf fat and skin but use of a 4% solution is acceptable as judged by poultry processors. Further testing using a 5% solution, supported by consumer panelling, has the potential to offer greater microbial reductions.

Ozonated water - Pre-chill spraying of ozonated water on to carcasses was carried out in three trials. No evidence was found of a statistically significant reduction in Campylobacter numbers due to a 30s treatment and 5.6 kg/min flow rate. The average ozone concentration was 3.7ppm. Increasing the concentration above 6ppm might increase the microbial reduction but it would require specific measures to avoid safety hazards to workers and risks oxidising the materials of the process equipment.

Ozonated carbon dioxide pellets - This technique offers the potential for Campylobacter reductions due to oxidation and temperature reduction, but the company due to supply the pellets made the commercial decision not to pursue this technology at the current time. An alternative approach using plasma was investigated as this also involves the application of ozone. The plasma includes atoms, excited species (including ozone), ions and electrons. Although various types of plasma generators exist, the one of most interest to this project was the cold atmospheric pressure plasma generated from air. Treatment of skin-on chicken breast fillets with cold plasma for 20s followed by a 280s holding period produced no statistically significant reduction in Campylobacter numbers despite producing a peak ozone concentration of 270 ppm.

Out of the systems tested, the application of lactic acid appeared to offer the greatest potential for use as an intervention for Campylobacter.

Research report

England, Northern Ireland and Wales

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