REDUCTION OF CAMPYLOBACTERS ON POULTRY USING STEAM OR HOT WATER HEAT TREATMENTS AND SUBSEQUENT CHILLING

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Introduction

Poultry is well-known to be colonised by *Campylobacter* spp. on the farm, and raw poultry carcasses are therefore often contaminated with campylobacters and are a major source of infection for humans (ACMSF, 2005). It has been predicted that a 2-log reduction in the numbers of campylobacters on poultry could lead to a 30-fold decrease in human campylobacteriosis (Rosenquist *et al.*, 2003). The studies presented here investigated methods of treating raw poultry carcasses to reduce or eliminate surface contamination with campylobacters without adversely affecting carcass appearance.

Materials and Methods

Equipment for controlled heat treatment (Figure 1) was constructed by FRPERC. The hot water immersion system provided controlled treatment temperatures (set point ±1°C) between room ambient and 100°C. The steam treatment cabinet provided a steam environment at atmospheric pressure (≈100°C). Carcasses were transferred to/from the heat treatment zones by pneumatic arms under electronic timer control. The rapid chilling system was an experimental unit (Figure 1) developed by Air Products plc (UK). This was an impingement air chilling system, designed to freeze the surface of the carcass for a limited period during the normal chilling process, and capable of operating at temperatures down to –40°C.

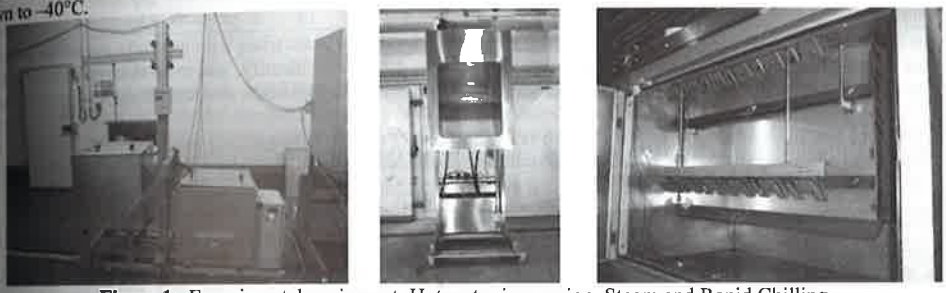

Figure 1: Experimental equipment: Hot water immersion, Steam and Rapid Chilling.

Laboratory studies used an inoculum consisting of equal volumes of *Campylobacter jejuni* (AR6 poultry isolate) grown in biphasic culture medium, and *Escherichia coli* (K12 Laboratory strain resistant to 200 ppm nalidixic acid) grown in BHI broth. Inoculum (3ml) was spread over the breast of each carcass, and at least 15min was allowed at room temperature before application of any decontamination treatments. Pieces of breast skin (10cm^2) were excised before and after treatment for enumeration of the bacteria. Industrial studies used naturally occurring bacteria. Carcasses were taken off the line immediately before chilling, heat treated, and returned to normal production or experimental rapid chilling within 5min. 10g neck skin samples were taken for enumeration of the bacteria. In all cases campylobacters were enumerated on mCCD agar (42°C for 48h in microaerobic atmosphere), and *E. coli* K12 (laboratory studies only) on MacConkey agar no. 3 with 100ppm nalidixic acid (37°C for 24h). During industrial studies, additional carcasses and portions derived from them were assessed by a panel on a 5 point scale for appearance acceptability after chilling.

Results and Discussion

The effect of a variety of treatment time/temperatures on carcass appearance was evaluated. Initial appearance trials established maximum severity heat treatments that could be tolerated without completely unacceptable damage. Steam treatment (≈100°C) for 5s and 10s, and hot water treatment at 80°C for 10s and 20s gave the best compromises between short processes (for industrial practicability) and treatment severity (expected bacterial kill) (Table 1). It was seen that surface appearance improved over time in chilled storage.

Table 1: Surface Appearance scores for carcasses and portions stored at 1°C for 5 or 11 days after treatment. A: acceptable; B: borderline; U: unacceptable.

	Control	Steam (10s, 100°C)	(5s, 100°C)	Hot Water Immersion (20s, 80°C)	(10s, 80°C)
Shelf day 5					
Whole bird	A	A	U	U	B
Thigh	A	U	B	U	A
Drumstick	A	A	A	A	A
Breast	A	U	B	A	A
Skinless breast	A	A	A	A	A
Wing	A	U	U	U	A
Shelf day 11					
Whole bird	A	B	B	A	A
Thigh	A	U	B	B	A
Drumstick	A	A	A	A	A
Breast	A	A	U	A	A
Skinless breast	A	A	A	A	A
Wing	A	U	A	B	A

The selected heat treatments were combined with three chilling regimes on inoculated carcasses (Table 2). Numbers of campylobacters were reduced during chilling even without any heat treatment, but crust freezing during chilling was more effective than other methods. Steam for 5 or 10 s was more effective than water (80°C for 10 or 20s). Crust freezing or 'chilling' at 15°C (probably with a drying effect) was most effective in combination with steam or hot water. Similar results were obtained for *E. coli K12*.

Table 2: Laboratory based reductions in inoculated C. jejuni (log_{10} CFU/cm^2).

	No heat treatment	Steam (10s, 100°C)	(5s, 100°C)	Hot Water Immersion (20s, 80°C)	(10s, 80°C)
Crust Freezing	1.5	3.2	2.3	2.8	2.4
0°C chilling	0.3	n/a	1.8	1.8	n/a
15°C chilling	0.4	n/a	3.2	2.6	n/a

Attempts to replicate the inoculated carcass laboratory results in industrial plant trials with naturally occurring bacteria were less successful. Firstly campylobacter positive flocks were difficult to identify, and even then positive numbers were low. Reductions from plant A (Table 3) were variable and substantially less than expected from laboratory results.

Table 3: Plant A; reductions in naturally occurring campylobacter (log_{10} CFU/cm^2).

	No heat treatment	Steam (10s, 100°C)	(5s, 100°C)	Hot Water Immersion (20s, 80°C)	(10s, 80°C)
Crust Freezing	0.8	0.7	ND	0.5	ND
Plant chilling	-0.3	0.2	ND	0.2	ND

Studies were moved to plant B where carcasses were taken from older flocks after previous thinning to increase likelihood of campylobacter positive flocks. Four experiments, each of 20 treated and 20 control carcasses gave mean campylobacter reductions of 1.15, 0.68, 1.37, and 0.97 log_{10} CFU/cm^2 respectively for the 20s, 80°C heat treatment, 0°C chill process. Whilst higher than in plant A reductions were still below the 1.8 log_{10} CFU/cm^2 seen in the laboratory studies.

Conclusions

Steam at atmospheric pressure or hot water can be used to reduce numbers of viable campylobacters on chicken carcasses. The effect on naturally-contaminated carcasses was less than expected from results using carcasses inoculated with high numbers of campylobacters. A controlled crust freezing regime gave better reductions than normal plant chillers. The reason for this could be that some of the campylobacters on naturally-contaminated carcasses are more protected against the heat treatment, being located in feather follicles or folds in the skin.

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References

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