

Effect of changes in processing to improve hygiene control on contamination of poultry carcasses with campylobacter

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SUMMARY

Examination of neck skin and caecal samples taken at a commercial processing plant from 15 randomly chosen poultry flocks showed that all flocks were contaminated initially with thermophilic *Campylobacter* spp., even in the apparent absence of caecal carriage. During processing, numbers of campylobacter on skin samples were reduced by between 10 and 1000-fold.

To improve hygiene control generally, chlorinated-water sprays were used to limit microbial contamination on equipment and working surfaces. In addition, chlorine concentrations in process water were increased and any unnecessary carcass contact surfaces in the processing plant were removed. When comparing flocks before and after the changes, it was found that numbers of campylobacter on packaged carcasses were significantly lower after the changes had been made ($P < 0.001$). In practice, however, the reduction would be likely to have little impact on consumer exposure to campylobacter infection.

INTRODUCTION

Thermophilic campylobacters, especially *Campylobacter jejuni*, are a major cause of acute gastrointestinal infection in man, with more than 38 000 reported cases in the UK during 1992 [1]. Studies of both outbreaks and sporadic cases have implicated chicken as a major source of infection; chicken meat may be hazardous in this respect when eaten undercooked [2–5] or merely handled in the raw state [6].

Poultry meat becomes contaminated with campylobacters because the live bird is frequently a symptomless intestinal carrier of the organisms and dissemination readily occurs during processing [7–10]. Measures to reduce such contamination in the processing plant could also reduce subsequent cross-contamination in the kitchen and thus the risk to consumers. In attempting to identify and control those sites in poultry processing at which microbial transmission occurs, Mead and colleagues [11] utilized a readily identifiable, non-pathogenic strain of *Escherichia coli*, which was used experimentally to inoculate carcasses, equipment and working surfaces. The spread of the organism among carcasses being processed was monitored both before and after introducing additional control measures.

These included use of chlorinated-water sprays to control the build-up of microorganisms on various items of equipment and elimination of unnecessary carcass contact surfaces. The purpose of this study was to determine the effect of similar changes in processing on the contamination of poultry carcasses with naturally occurring campylobacters.

MATERIALS AND METHODS

Processing plant changes

The processing plant used has been described earlier and designated Plant 1 [12]. A preliminary requirement for some of the changes introduced was improvement of the existing ventilation system to allow more extensive use of chlorinated-water sprays and higher chlorine concentrations in process water. The changes made were as follows. Unless stated otherwise, water sprays contained 40 mg per litre of free available chlorine.

Automatic killing machine. The rotating blade was sprayed continuously with chlorinated water.

Defeathering machines. The water used in the series of three machines was chlorinated; previously, no chlorine had been used.

Head puller. A low-pressure, chlorinated-water spray was installed on either side of the carcass entry point to wash the head and neck of each carcass.

Conveyor belt to evisceration line. The catchment conveyor belt used to recover carcasses that failed to transfer automatically from the slaughter line to the evisceration line was equipped with three flood jets to wash debris into the drainage system and reduce recontamination of the belt. The water contained 35–46 mg per litre of free available chlorine.

Vent opening machine. A metal support at the exit to the machine came into contact with every bird being processed. The support was re-positioned to avoid carcass contact.

Evisceration machines and other machinery. Water sprays were used to clean working parts in contact with carcasses, chlorine concentrations being increased from 10 to 40 mg per litre. The sprays were located in machines used for vent opening, extraction of viscera, crop removal, neck cracking and trimming of neck skin.

Splash-guard. A metal splash-guard on the side of the chilling system was cut back to avoid contact with carcasses on the processing line.

Chilling system. Chlorine concentrations in the three-unit water chilling system were maintained at 23–38 mg per litre of total available chlorine. Thus, concentrations in units 2 and 3 were approximately twice those used originally.

Sampling of carcasses

The 15 flocks examined were chosen at random, with no prior knowledge of their campylobacter status. Of these flocks, four yielded negative caecal samples. The effect of changing the process was determined by comparing flocks with similar levels of caecal carriage, before and after the changes were made. In each case, the carcasses were sampled after (a) exsanguination (neck skin); (b) evisceration (caeca); (c) packaging (neck skin). On each occasion, 15 samples were taken at

stages (a)–(c), with the exception of two of the visits before changes in the process were made, when 10 samples were taken. Aseptic precautions included the use of separate sterile instruments for each bird and placing samples in individual plastic bags. Samples were held on ice for transportation to the laboratory.

Microbiological examination

Each sample of neck skin was weighed and homogenized in Oxoid Maximum Recovery Diluent (MRD), using a Colworth 80 Stomacher (A. J. Seward, London, UK). The homogenate was diluted, as appropriate, in MRD, prior to culture.

One caecum from each bird was briefly submerged in boiling water to destroy vegetative bacteria on the surface and c. 2 g of content removed aseptically and weighed. Samples were homogenized and diluted as described above.

Examination of samples for campylobacters

Appropriate dilutions of each sample were used for surface plating in duplicate on Campylobacter Blood-free Selective Medium – Modified CCDA-Preston (Oxoid CM739+SR155). Plates were incubated at 42–43 °C for 48 h in an atmosphere containing 85% N₂, 10% CO₂ and 5% O₂. A sample (0.5 ml) of each homogenate was also cultured in 4.5 ml of Preston Campylobacter Selective Enrichment Broth (Oxoid CM67+SR48+SR117+SR84) and incubated as before. Enrichment cultures were plated on the selective agar medium.

All colonies from positive samples were examined for the characteristic colonial appearance of thermophilic campylobacters and only these were enumerated. In addition, representative isolates were checked for cell morphology, motility and Gram-stain and oxidase reactions.

Statistical analysis

Flocks processed before and after the above changes were compared. Separate comparisons were made on levels of caecal carriage and numbers of campylobacters on neck skin at the different stages. Thus, the geometric means from all flocks in each category were subjected to an analysis of variance.

RESULTS

In total, 15 flocks were examined, 5 before changing the process to improve hygiene control and 10 afterwards. All birds sampled after exsanguination were contaminated with campylobacter on the neck skin and, with those 11 flocks that were caecal carriers, 97% of caecal samples were also positive. More than 95% of skin samples had 10³–10⁴ campylobacters per g. Table 1 gives the geometric means of numbers in caecal contents and on neck skins. In making calculations, samples positive by enrichment only were assumed to have 10 cfu per g. For flocks that were caecal carriers, processing reduced contamination by 10–1000-fold, as judged by numbers on neck skin samples.

The four flocks in which caecal carriage was virtually absent at slaughter (nos 8, 9, 10 and 14 in Table 1) showed lower mean numbers on neck skins after exsanguination than in flocks that were obvious carriers. Nevertheless, all samples were campylobacter-positive, indicating either that the birds had been carriers at

Table 1. *Caecal carriage of campylobacter and contamination of neck skin after (a) exsanguination of birds and (b) packaging of carcasses*

Flock no.	Caecal content	Neck skin	
		After exsanguination	After packaging
Before changes in processing			
1*	6.1 ± 0.6 (1)†	3.7 ± 0.2	1.9 ± 0.3 (1)
2*	6.2 ± 0.3	4.0 ± 0.1	1.4 ± 0.3 (4)
3	6.6 ± 0.2	3.9 ± 0.1	1.6 ± 0.4 (3)
4	6.8 ± 0.3	3.8 ± 0.1	1.6 ± 0.3 (6)
5	7.6 ± 0.1	3.4 ± 0.1	2.3 ± 0.2 (3)
After changes in processing			
6	6.1 ± 0.5	3.9 ± 0.1	1.7 ± 0.2 (3)
7	5.6 ± 0.7	3.6 ± 0.1	0.6 ± 0.2 (4)
8	NF	2.8 ± 0.1	0.9 ± 0.2
9	NF	1.3 ± 0.2	NF
10	NF (1)	2.3 ± 0.1	NF (1)
11	4.9 ± 0.2	3.5 ± 0.1	1.0 ± 0.2 (5)
12	6.6 ± 0.3	4.3 ± 0.1	1.0 ± 0.2 (9)
13	7.1 ± 0.2	3.9 ± 0.2	1.6 ± 0.1 (4)
14	NF (2)	1.6 ± 0.2	NF
15	6.7 ± 0.3	3.7 ± 0.3 (1)	0.7 ± 0.1 (9)

* Ten birds sampled at each stage.

† Geometric mean (\log_{10} cfu per g ± s.e.).

Samples positive by enrichment only given in parenthesis.

NF. Not found.

Table 2. *Effects of process changes on contamination of neck skin with campylobacter, comparing flocks with similar levels of caecal carriage*

No. of flocks (birds)	Caecal content	Percentage of positive samples and geometric mean count ± s.e.	
		Neck skin	
		After exsanguination	After packaging
Before changes			
5 (65)	100 (*6.8 ± 0.1)	100 (3.7 ± 0.1)	91 (1.8 ± 0.1)
After changes			
4 (60)	100 (6.5 ± 0.1)	100 (3.9 ± 0.1)	85 (1.2 ± 0.1)
<i>P</i> values for counts			
	0.26	0.42	0.001

* Mean of \log_{10} cfu per g.

some time during rearing, or had become contaminated during pre-slaughter handling. With three of the flocks, processing reduced campylobacter contamination of neck skin below the level of detection by direct plating.

Table 2 compares results obtained from the five flocks sampled prior to changes in the process with four carrier flocks studied after the changes, showing similar

levels of caecal carriage (10^6 – 10^7 cfu per g). Numbers on packaged carcasses were significantly lower (P 0.001) following the changes.

DISCUSSION

In this study, carcasses from all 15 flocks examined were positive for campylobacter, even when caecal carriage was apparently absent. Within individual flocks, all neck skins yielded campylobacters when birds were sampled after exsanguination. With those flocks that were not caecal carriers at slaughter, there is a possibility that contamination (*a*) occurred during transportation to the processing plant, since Mead and colleagues [11] showed that routine cleaning of bird transporters was inadequate and residual faecal material from the previous flock could be seen in the majority of crates after cleaning; (*b*) was derived from the waterbath in the stunner or (*c*) was already present on the skin, following a period of campylobacter shedding by the birds during rearing. The relative importance of these potential sources of skin contamination is unknown.

Although there is evidence that carcasses become cross-contaminated during the slaughter process, when campylobacter is present in the intestinal tract [7–10], the net effect of processing in this study was to reduce the overall level of campylobacter contamination, whether or not changes were made in the process to improve hygiene. Thus, a reduction occurred in every flock that was followed through the process and the question of cross-contamination during processing appeared less important. Similar results were obtained previously at the same factory for total viable counts, which also decreased during processing by up to 100-fold [12].

Attempts to improve hygiene control in the processing plant were largely based upon strategic use of water sprays, chlorinated to a level that is known to control the accumulation of microorganisms on equipment and working surfaces [13]. In addition, chlorine concentrations in carcass washing and chilling systems were increased and any unnecessary carcass contact surfaces were removed. Although the changes made produced a statistically significant reduction in campylobacter contamination of carcasses sampled after packaging, the magnitude of the effect was relatively small and likely to have little impact on the risk to consumers. Also, it is possible that the effect would be even less if account had been taken of sublethally injured and viable, non-culturable cells.

Changes in the process of the kind described here, may be more effective in controlling the spread of a minority organism, such as salmonella, as indicated by experiments with a 'marker' strain of *E. coli* [11]. Further reductions in campylobacter contamination could depend upon more stringent control of infection in the live bird [14–16]. When numbers on the skin of in-coming birds are low, as seen in the caeca-negative flocks, the organisms can be virtually eliminated from the carcass surface by hygienic processing.

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