Salmonella contamination of pork carcasses: UK baseline culture-based data determined by sponge sampling during 2006


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Abstract

During 2006-7, microbiological baseline data on the frequency and distribution of Salmonella contamination of pig carcasses in UK slaughterhouses were collected. Data were generated from four separate abattoirs which were determined as having practices representative of the UK slaughter industry. Studies were designed to provide estimates of the prevalence and levels of Salmonella contamination of the UK pork industry. Results allowed a comparison of variations in process to be assessed, including differences in methods of slaughter, scalding, dehairing, singeing, polishing and dressing practices. Salmonella were rarely isolated from the process after the scalding stage and never from the final carcasses. The use of E. coli counts as a means of evaluating process control was a more consistent marker for examining enteric pathogen cross-contamination.

Introduction

Pork and pork products are recognised as one of the sources for human salmonellosis. The importance of focusing control at the slaughterhouse, once controls have been established at the farm level, has been demonstrated by Alban et al. (2005). They demonstrated, through modelling the procedures in Danish slaughterhouses, that it is economically advantageous to achieve a reduction in the contamination of pork post-slaughter through minimum modification of the existing slaughter process. None of the current processes which exert control over contamination levels on the carcass were introduced specifically for this purpose. In the UK this project, funded by the Food Standards Agency, is attempting to determine which of the currently used processing practices can be modified or, where not routinely used, inserted into a pork line to reduce the contamination of pig carcasses by Salmonella.

Materials and methods

Following an assessment study of processes and operating conditions in UK pork abattoirs (Tinker et al., 2007), four abattoirs were chosen as following practices representative of those of the UK industry. Differences in practice which were encompassed were differences in scalding (hot water tank scald; injected/sprayed hot water scalding), dehairing (integral scald/dehairer; separate dehairer) and singeing (multi-flame open unit; enclosed style with a main flame at the base). Microbiological sampling of carcasses for Salmonella was carried out by the Food Standards Agency recommended swab-sampling method for carcass sampling in abattoirs (Anon, 2006), so that contamination rates obtained would reflect the levels routinely determined by UK abattoirs. Individual carcasses were sampled following each key stage of processing (after bleeding, scalding, dehairing, singeing, polishing, evisceration and splitting) with ten carcasses evaluated on each slaughter house visit. In some instances sources of cross contamination such as scald water and fomites were also sampled. Salmonella was determined as presence/absence by standard enrichment techniques and levels of the organism were estimated by a semi-quantitative approach. As well as sampling for Salmonella, other microbiological contamination levels (Escherichia coli, Enterobacteriaceae and total aerobic bacteria) were enumerated throughout the slaughtering process to allow effective decontamination/cross contamination stages to be readily identified.
Results

Viable count data

Total aerobic counts (TAC), Enterobacteriaceae and E. coli counts and prevalence of Salmonella were obtained for all four slaughterhouses. Figure 1 shows a comparison of mean total aerobic counts from ten pig carcasses at each stage of processing at four of the slaughterhouses which showed differing processing procedures. These are expressed as log cfu cm⁻² with the standard deviation (SD) adjacent plotted. Slaughterhouses A and D had an integral hot water tank scald and dehauling system and so no counts could be obtained post scalding due to lack of access. Slaughterhouses B and E had an injected/sprayed scald system (condensation scalding). At slaughterhouse E there was also a small carcass washer unit (flails and sprayed water) immediately before, and integrated into, the scalder. B had an enclosed style singe giving a heavy (bacon) singe and produced primarily bacon; the rest had openingers and produced primarily pork; no post-singe samples were available from Slaughterhouses D or E due to lack of accessibility.

As expected, scalding and singeing (where measurable) reduced the total aerobic counts significantly, but subsequent stages recontaminated the carcasses. This was particularly evident post-scalding in E where counts increased 4 log cfu cm⁻² at the dehauling stage. In this plant dehauling was a particularly vigorous process and escape of faecal material from the carcasses was noticeable. This is also reflected in the Enterobacteriaceae and E. coli counts at this stage (Figure 2). Scalding in slaughterhouse E was much more effective than in slaughterhouse B despite both slaughterhouses using condensation scalding. A more detailed study of this is presented in Richards et al. (2007). In slaughterhouse A singeing significantly reduced the total aerobic counts by 5 log cfu cm⁻² but levels of reduction in B & E were much less despite the much harder singe given in B. The final TAC on the carcasses ranged from 1-3 log cfu cm⁻² although E. coli and Enterobacteriaceae were not significant components of these.

![Figure 1: Total aerobic counts on pork carcasses after (a) bleeding; (b) scalding; (c) dehauling; (d) singeing; (e) polishing; (f) evisceration; (g) halving and prior to (h) washing and (i) chilling. SD; standard deviation.](image-url)
The level of variation in TAC seen between carcasses, as demonstrated by the standard deviation, was generally low (0.5 log cfu cm\(^{-2}\)); this suggests the processes produced pigs of a consistent microbiological standard. However, one exception was slaughterhouse B where the standard deviation for TAC was between 0.5 and 2 log cfu cm\(^{-2}\). In particular it is noticeable that the two potential control procedures, scalding and singeing, produced a variation in counts of 1.5-2 log cfu cm\(^{-2}\) variation in this slaughterhouse. This shows a greater level of pig-pig variation and thus the potential for some pigs to show good count levels and some much poorer ones. This level of variation was also evident in the *E. coli* counts (Figure 2).

![Graph showing Escherichia coli counts on pork carcasses after different stages of processing.](image)

**Figure 2.** *Escherichia coli* counts on pork carcasses after (a) bleeding; (b) scalding; (c) dehairing; (d) singeing; (e) polishing; (f) evisceration; (g) halving and prior to (h) washing and (i) chilling. SD; standard deviation.

**Distribution of Salmonella**

At Slaughterhouse A, 10% (1 pig) of carcasses were found to be positive at the bleeding stage and at the dehairing stage but the organism was not found at any other stage. The gambrelling table was shown to be positive for *Salmonella* prior to isolation of the organism from the dehaired pig and so may represent a source of cross contamination. At Slaughterhouse B, 40% of the carcasses were found to be positive post bleeding; one of these was later positive following evisceration but no *Salmonella* were detected in the interim stages. At Slaughterhouse D, 80% of carcasses were found to be positive post-bleeding but the organism was not found at any of the stages thereafter, although *Salmonella* was again isolated from the gambrelling table. At Slaughterhouse E 70% surface carriage of *Salmonella* was isolated post bleed but no isolations were made thereafter. All these results would suggest that surface contamination is removed by the scald process and subsequent recontamination may be as a result of rectal leakage reintroducing the organism onto the surface of the carcass directly or through cross contamination of fomites.

The intermittent isolation of *Salmonella* is typical of what is found in examining the cross contamination events occurring in slaughterhouses and demonstrates the difficulties found in understanding where control processes need to be focussed.
Discussion

These studies have provided a set of base-line data for abattoirs processing pigs in the UK. The process in general reduces total aerobic counts on the carcass surface by 2-3 log cfu cm$^{-2}$ with individual processing stages such as singeing reducing counts by 5 log cfu cm$^{-2}$ in some plants. However the effectiveness of such stages varied and this level of reduction was not consistently seen in all plants. Plants operating the same type of scald systems showed significant variation in their level of effectiveness, being important control points in some plants and giving only minor control of the flora levels in others. However, following both scalding and singeing processes, subsequent operations always increased the levels of the flora. Control of numbers of Enterobacteriaceae and *E. coli* were effective with very low levels ($10^1$ to $10^2$ log cfu cm$^{-2}$) seen on the final carcasses. *E. coli* was a more consistent marker for examining enteric pathogen cross-contamination than isolation of *Salmonella* which was infrequent and sporadic in its isolation after the scalding stage. Although *Salmonella* was found on 10-80% of pigs at the start, it was never found on the final carcasses.

References

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