Assessment of processes and operating conditions in UK pork abattoirs.


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Abstract

In order to determine typical and atypical operations in the slaughtering and dressing of pigs for pork and bacon practices and operations were recorded at eight pig abattoirs. Data included physical parameters such as temperatures and durations. The results indicate that plants are reasonably similar if processing pigs mainly for pork, but those processing mainly for bacon had more aggressive singeing and polishing (black scraper) arrangements. The plants visited used either hot water (tank) or vertical (sprayed hot water) scalding systems prior to dehairing.

This study was carried out to establish a microbiological and physical process baseline which would then enable effective existing practices to be identified, as well as identifying those existing, and also novel, practices which have the potential to be developed in order to reduce carcass contamination by Salmonella.

Introduction

Although great strides have been made in trying to reduce the incidence of pigs with salmonella it is logical that efforts should be made in the abattoir to further reduce the contamination of pork by Salmonella. Alban et al (2005) indicated that effort applied in Danish slaughterhouses would be more effective at reducing salmonella than further effort on the farms.

The processes, and operating conditions, at the slaughterhouse have an important impact on the microbiological load of the carcasses. Two related projects, funded by the UK's Food Standards Agency (FSA), are attempting to determine which processes can be modified or inserted into a pork line to reduce the contamination of pig carcasses by salmonella. One project, led by the University of Nottingham, is focussing on modifying existing practices that can be shown to have a worthwhile impact on salmonella contamination. The other project, led by the University of Bristol, is investigating novel practices that may be more effective but are likely to require major equipment changes or be included in new plants.

Both projects require a sound understanding of existing practices used in UK pork plants and how these practices impact on carcass contamination. Equipment used for meat plants always has to be reliable, both in the consistency of processing carcasses and also in avoiding mechanical breakdown. The additional impact of equipment design on carcass hygiene is increasingly important.

These two research projects aim to show how current UK pork lines can make best use of existing equipment and practices to reduce salmonella contamination and how, either additions or alterations to the current slaughtering and dressing protocols could reduce the contamination, or cross-contamination, of carcasses by Salmonella.
Materials and methods

An initial phase, and relevant to both projects, has been to determine what processes and operating conditions are found in pigmeat plants in the UK. A checklist was prepared covering 50 general points and 27 processes on which operating parameters would be collected. Visits were made, during spring 2006, to eight plants with nominal throughputs of 150-390 pigs per hour. A diagram of each plant was made and measurements taken for certain process durations and conditions. The information was used to determine a) which plants offer typical processes and operating conditions, b) which plants offer atypical processes for further investigation, c) how the processes interrelate, d) what processes, current or novel, might be expected to control or reduce Salmonella contamination and e) to give the researchers a sound understanding of how and why these current practices have evolved.

Results

General

All the plants surveyed slaughtered, dressed, chilled, cut and packed pigmeat. The majority of plants killed in the range 5,000-8,000 pigs per week but two plants killed over 12,000 pig per week. Pigs were typically 70-78 kg (the range was 55-110 kg overall). Across all plants the throughput ranged from 50 pigs per hour to 390 pigs per hour; the mean being 270 pigs per hour.

Three plants specialised in producing bacon while the others produced carcasses mainly for pork with some bacon. All plants supply UK supermarkets, with two plants having close ties with one supermarket and the others supplying several supermarkets and niche outlets.

All plants have made minor process changes and refurbished existing equipment since the original plant construction. Recent changes have been in stunning and scalung equipment for perceived improvements to welfare, water use, effluent costs or microbiology. Many changes were under consideration to tackle specific processing issues; common ones being introduction of CO2 stunning and steam scalung equipment.

Plants had 30-100 abattoir staff, including those in the lairage. The transit time from kill to chill was between 30 mins and 60 mins; the mean was 38 mins. Every plant processed carcasses identically, whether for pork or bacon, as the final products were not known until grading.

Microbiology

All plants stated that they produced a safe product. Reasons for this confidence included the bacterial kill potential of the singeing operation, and that all products would be cooked before consumption. If microbiological results on the final product are good then it is often assumed the production process must be hygienic.

Generally plants are content with current microbial information but most would find microbiological profiles along the line interesting, although these have not been carried out by the plants themselves. The majority of plants perform shelf life microbiology on the finished product.

All plants specify visually clean animals from supplier farms. Excessively dirty pigs are commonly washed with the sprinklers in the lairage (if air temperature is warm enough). Producers of habitually dirty animals are typically dropped from supplier lists.

The majority of plants use the UK Meat Hygiene Service Inspectors to record contamination incidents, but a few make their own records. Typically the incident type (gut rupture, machine damage, trimming/cutting errors, etc) is notified by a coloured tag or band. Corrective actions for all but the most serious problems take place on the line for lower speed plants while higher speed plants have a detain rail for corrective action. Some plants feed information back to the farm regarding diseases or defects found, and to dressing staff for gut spillage incidents.

The majority of plants are not considering carcass decontamination measures as final product microbiology results are good and cooking will occur before consumption. However one plant would use a chlorine-based carcass wash if it were legal and two plants were considering steam pasteurisation units and one a hot water decontamination unit for the final carcass. As a principle, processors attempt to keep the carcass as dry as possible.
Robotics and automation technologies are seen as the only major processing development in the last 10 years, but the expensive commitment is not currently financially prudent for the UK pork industry.

**Slaughterline and Dressing Operations**

Figure 1 shows schematically the main stages of a bacon plant. Table 1 provides a summary of UK pigmeat production processes seen across the plants surveyed.

![Diagram of slaughterline and dressing operations for a bacon plant](image)

**Table 1.** Summary of UK pigmeat production processes.

<table>
<thead>
<tr>
<th>Abattoir Process</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1. Lairage</td>
<td>All plants had similar lairages.</td>
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<td>2. Stunning</td>
<td>Six plants used electrical stunning. Two had CO₂ stunning.</td>
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<tr>
<td>3. Sticking</td>
<td>Similar in all plants</td>
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<tr>
<td>4. Bleeding</td>
<td>Similar in all plants</td>
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<tr>
<td>5. Scalding</td>
<td>Six plants used hot water scalding. Two had vertical scalding units. Scald tank designs included pull, push, and “waterwheel” types (both continuous and intermittent). Scalding temperatures and durations were between 58-64°C and 4-6.75min respectively. Carcass surface temperatures at scalder outlet, measured across all plants, ranged between 48.6 and 63°C. The mean was 57.8°C.</td>
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<td>6. Dehairing</td>
<td>Spiral type dehairers were the most common. A few plants used 2-stage horizontal flail types and one used a single stage horizontal flail type. Carcass surface temperatures at dehairer outlet, measured across all plants, ranged between 33.5 and 53.7°C. The mean was 43.4°C.</td>
</tr>
<tr>
<td>7. Gambrelling</td>
<td>Similar in all plants</td>
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<tr>
<td>8. Dry polishing</td>
<td>All dry polishers used combinations of rotary whip flails on vertical and horizontal axes. Polisher length was generally around 2m. Two plants did not have a dry polish operation and a third used a dry scraper instead.</td>
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| 9. Singeing | Vertical, intermittent gas flame singe units predominated with a few plants (specifically those specialising in bacon) using an enclosed unit that enclosed the carcass and had a single flame from the base.  
Measured singe durations ranged from 5s to 16s with a mean of 8.75s.  
Carcass surface temperatures at singe outlet measured across all plants ranged between 58 and 109.1°C. The mean surface temperature was 78.3°C. Where measured, the temperature varied by at least 20°C over the length of the carcass. |
| 10. Wet polishing | The most popular type of wet polisher consisted of various numbers and combinations of vertical and horizontal rotary whip flails. The mean length of these types of polisher was 3.3m.  
Three plants, specifically those specialising in bacon, used black scrapers rather than polishers which had metal-tipped compliant scrapers on moving belts, and additional brushing and scraping components. The mean length of these types of polisher was 17.5m.  
Carcass surface temperatures at outlet measured across all plants ranged between 15.8 and 40.2°C. The mean surface temperature was 34.5°C. |

For evisceration and final dressing all plants followed the same general sequence of rectum loosening, ventral opening, viscera removal, splitting, inspection, grading and chilling. However there were substantial differences in trimming, washing, additional cutting, etc. These variations are too numerous to describe in this document.

**Discussion**

Each plant had some aspect that was substantially different. The major difference between the eight plants was whether they were dedicated bacon plants, with a more severe, enclosed, singe and different scraping and polishing procedures, or whether they were plants producing mainly pork. The type of scalding used, whether it was a hot water tank or vertical spray, was another difference expected to have a major impact on carcass contamination. Processes such as evisceration, splitting, inspection and grading were broadly similar in all plants. A further microbiological baseline study along with information from literature will be used to focus research effort on operations most likely to offer major reductions in *Salmonella* contamination.

This information, together with the baseline data, could be used in mathematical models to help determine operations most likely to have a major impact on the final carcass contamination levels.

**Conclusions**

All plants exhibit generally similar processes and encounter the same problems. The differences between plants, particularly in type of scalding and singe unit (and associated polishing system), has indicated where to take further baseline microbiological measurements. However because of practical and safety reasons it will prove difficult to directly compare all stages between all plants. Many operations are enclosed or guarded at one or both ends, forcing swabbing of carcasses to be undertaken away from the target operation. Certain plants are more suitable for further measurements based on equipment in place and accessibility of line for sampling.

**References**

Alban, L. and Stärk, K., 2005. Where should the effort be put to reduce the *Salmonella* prevalence in the slaughtered swine carcass effectively? Preventative Veterinary Medicine 68 (1), 63-79.