FACTORS AFFECTING THE MEAT HYGIENE SCORES OF SHEEP ARRIVING AT ABATTOIR AND THE SUBSEQUENT BACTERIAL CARCASE CONTAMINATION

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Background

Healthy sheep are known to be a major source of the foodborne pathogens *E. coli* O157:H7 (1,2), *Salmonella* spp (3) and *Campylobacter* spp (3). The slaughter and dressing processes has been identified as a critical control point for contamination of the carcase with these organisms (4). The fleece of the sheep is considered to be the most significant source of contamination (5), with visible soiling related to the microbial load (4). The Meat Hygiene Service (MHS) scores define sheep cleanliness on a five-point scale; scores 1 and 2 are acceptable for slaughter and scores 3, 4 and 5 indicate increasing degrees of dirtiness (6). The cleanliness of the sheep presented for slaughter may be attributed to factors such as diet (7,8) and dietary changes (9,10), season (11) transport (12,13) and markets and lairage (14,15,16). Therefore the period leading up to slaughter provides the greatest risk for the presence and cross contamination of these major pathogens between sheep and potentially between carcases at slaughter.

Objectives

The main goal was to investigate through a comprehensive study of sheep arriving at abattoirs; a) the geographical, seasonal, farm, transport and marketing factors affecting MHS scores; and b) the contamination of carcases of known history for the presence of pathogenic bacteria including *E. coli O157*, *Salmonella* and *Campylobacter* and for Total Viable Count (TVC), coliforms and *E.coli*.

Methods

Five abattoirs which slaughter 20 or more different batches of sheep per day, on average, were used in this study. A batch is defined as a group of at least 20 sheep from the same source which travelled in the same transport vehicle to the abattoir. These abattoirs were selected to give a wide coverage of Great Britain and, hence, a range of animal production systems. Each plant was visited on three occasions to encompass the slaughter of sheep of different ages as well as from different systems of production, namely Visit 1 in February-March (overwintered lambs born the previous spring), Visit 2 in May-June (early lambs), and Visit 3 in August-September (main season lambs). Where possible, 20 different batches of sheep arriving at each abattoir on each occasion were selected at random for inclusion in the survey. Each batch was assigned an MHS score on arrival. Information on sheep numbers, breed, fleece fibre length and type, and if clipping had taken place were collected on arrival for slaughter. Transport type, time and distance, stocking density, bedding used, flooring material and the cleanliness of the vehicle (scoring 1-10 system) were recorded. The scores were assigned by one person throughout the study. In addition, available information on the diet and husbandry of the batches of sheep prior to slaughter was also collected. A description of the slaughter and dressing method, average line speed, any line breakdowns and gut spillage incidents were recorded at all abattoir sites. Swabs were taken from two carcases per batch to identify the presence of *Salmonella spp. Campylobacter spp* and *E. coli* O157:H7 and the recovery of total *E. coli,* coliforms and TVC. The swab sites were situated on the shoulder and brisket of the carcase.

Results and discussion

Because of the large quantity of data collected in this study only the significant results are presented and discussed below.

Season and management

In this study, the distribution of MHS score varied with the time of year that sheep were sent to the abattoir. At Visit 1, 42.3% of batches had a MHS score $\geq$3, whereas at Visits 2 and 3 the equivalent figures were 24.6% and 30.5% respectively. These results are considerably higher than those reported in the GB Food Standards Agency Meat Hygiene Enforcement Reports, for numbers of animals rejected for slaughter. When results for each marketing season were analysed separately, diet change or restriction immediately prior to transport had a significant effect on batch MHS score only for Visit 2 ($p=0.017$). For these early season lambs, the proportion of MHS scores of 3 or greater for batches whose diet remained unchanged, changed by bringing lambs indoors, or restricted to water only was 41%, 5% and 17%, respectively. This implies that removal of early season lambs from spring pasture or their mother's milk immediately prior to transport may improve visible cleanliness in lairage.

Transport environment

The subjective score of dirtiness of the interior of the transport vehicle over all three visits, assigned on a scale of 1 (clean) to 10 (dirty) and MHS score, proved to be statistically significant overall ($p=0.014$). Microbial load on carcasses from animals transported in trailers with subjective dirtiness score of 4 or greater were highest, whereas those on carcasses from animals transported in trailers with a dirtiness score of 1 were lowest. Differences between mean $\log_{10}$ values on carcases for lorry dirtiness scores of 1 and 4 or greater at the brisket and shoulder sites, respectively, were 0.74 and 1.22 (TVC), 0.91 and 1.35 (coliforms), and 1.05 and 1.29 (*E.coli*). These differences highlight the need to ensure cleanliness of animal transport accommodation. Scores of $\geq$4 were allocated to trailers with evidence of historic soiling rather than unavoidable fresh contamination (scores 2 and 3), and indicates that this may be an important source of cross-contamination between and within batches of animals.

Fleece / clipping

Overall, carcases from sheep with straight fleeces were more heavily contaminated than those from sheep with curly fleeces. For coliforms and *E.coli*, the difference between means were at least 0.5 log orders, and with the exception of *E.coli* at the shoulder, which was borderline ($P=0.064$), were statistically significant ($P=0.022$-0.041). In the case of TVC, these differences were not statistically significance or of practical importance. These findings would imply that straight fibres either retained more faecal contamination in the fleece, or were more likely to result in direct or indirect transfer of this contamination to the brisket and shoulder regions of the carcass during dressing. During Visit 1, the proportion of batches with MHS score of 3 or more decreased from 42% for unclipped sheep, to 40% and 23% for animals clipped on the belly only, or both the belly and rump, respectively. Therefore clipping of both the rump and belly significantly improved the visible cleanliness of sheep. Clipping on the belly would be more likely to be performed on visibly dirty animals on farm.

Carcase contamination

There were significant differences between abattoirs for all microbiological counts and at both sampling sites ($P<0.001$). For means over all three marketing seasons, one of the five abattoirs had consistently higher $\log_{10}$ counts; 5.9 vs. 5.1 for TVC, 5.0 vs. 3.4 for coliforms and 4.0 vs. 2.9 for *E coli* at the brisket site. This abattoir had the highest average line speed over the three visits (463 animals per hour compared with an overall average of 361 animals /hour for the other four abattoirs), and also employed pre-inspection spray washing, which can be a mechanism for spreading contamination down from other regions of the carcass to the brisket/shoulder area.

For the vast majority of factors during each marketing season, the levels of micro-organisms on the 'brisket' sampling site were higher than those at the 'shoulder' site by around 0.5, 1.0 and 1.0 of a $\log_{10}$ score for TVC, coliform and *E. coli* respectively. The brisket is acknowledged as a site of high contamination in modern inverted dressing systems. In the two-way analysis based on factor and visit for each microbiological count at each sampling site, visit proved to be statistically significant ($P<0.001$-0.023). In all cases, the overall mean micro-organism level on carcases derived from Visit 3 were higher than those on carcases at Visits 1 and 2.

The overall batch prevalence from dressed carcass swabs for *E.coli* O157, *Salmonella* and *Campylobacter* were 1.1%, 1.6% and 5.5%, respectively. These compare with recent VLA surveys of faecal carriage by individual animals at abattoir of 1.7%, 0.1% and 17.0%, respectively. For *E.coli* O157 and *Campylobacter* the prevalence on carcasses were similar though lower than those in faeces, indicating that contaminated faeces will not be spread to carcasses during dressing in all cases. In the VLA study, the isolation rate of *Salmonella* was deemed to be low precipitating a method change to collection of 25g of faeces rather than 1g. As a result, improved isolation rates were reported for cattle, though no results were reported for sheep. Prevalence of *Salmonella* on carcasses in this study may be comparable with those determined for faecal carriage using the alternative VLA sampling regime.

Conclusions

- Marketing season affected the MHS score of animals arriving at abattoir, in that overwintered lambs were proportionally dirtier than main season, which in turn were dirtier than early season lambs.
- Diet restriction and/or accommodation change improved the visible cleanliness of early season lambs.
- Increasing dirtiness of transport vehicle trailers was shown to increase both MHS score and carcass contamination.
- Contamination with faecal micro-organisms was greater in lambs with straight fleeces, and clipping of the belly and rump improved the MHS score of overwintered lambs.
- A major influencing factor on post-dressing carcase microbiology would appear to be dressing procedure, in particular the dressing line speed and use of pre-inspection spray washing.
- The 'brisket' carcass swab site had higher levels of micro-organisms than the 'shoulder' site for most factors examined in each marketing season.
- The prevalence of pathogens on carcases was in line with those for faecal carriage in other abattoir surveys.
- The results of this study have provided useful information and highlighted areas for further investigation in more detailed studies on the farm to abattoir production phase of sheep.

Pertinent Literature

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