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Tracking the spoilage microbiological profile of sheep fleece and derived carcass pre and post chill in a lamb plant

(#624)

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Introduction

During sheep slaughter and dressing, the animal fleece is recognised as an important source of microbial contamination for the carcass. In many countries, including Ireland, a sheep clean livestock policy (CLP) is implemented, based on a visual assessment or scoring of the cleanliness level of the fleece. The aim of the policy, being to reduce the level of dirt and microbial contamination entering the meat plant and ultimately to reduce the microbial contamination levels on the ovine carcass. This study aimed to track the total and spoilage microbiological profile on sheep fleece and derived carcass after dressing and evisceration, and after two different lengths of carcass chilling. The aim being to observe both microbial cross contamination from fleece to carcass and changes in microbial numbers on the carcass, during the slaughter and chilling processes.

Methods

This study was carried out at a commercial sheep slaughtering factory and animal batches of the same CLP category were selected. In Ireland, sheep are visually scored under the CLP using three categories A, B or C based on their cleanliness on arrival at the lairage, with A being satisfactory and C the dirtiest and unacceptable for slaughter. Three trips were made to one plant, trip 1 (50 sheep, CLP B); trip 2 (56 sheep, CLP A); and trip 3 (60 sheep CLP B). Immediately after killing and after clipping, a sterile carcass sampling sponge (polyurethane foam with a high surface area and abrasive in nature, 10 cm x 10 cm area, and 10 mm thick) and pre-moistened with Maximum Recovery Diluent (MRD) were used to swab an area of 200 cm^2 from the fleece, along the animal's midline region. After carcass dressing and before chilling, one side of the carcass was selected at random and swabbed at four different sites (flank, lateral thorax, breast and brisket) (100 cm^2 each) and the swabs pooled. The carcasses were then placed in the chill room (2.9°C) and half of the carcass batch on each trip, were chilled for 24 h and the remainder for 72 h. After 24 h or 72 h chilling, the previously un-swabbed side of the carcass was swabbed as above. All pooled swabs were returned to the laboratory under chilled conditions and microbiologically analysed for mesophilic and psychrophilic aerobic colony counts, *Enterobacteriaceae*, *Pseudomonas* spp., *Brochothrix thermosphacta* and lactic acid bacteria using relevant ISO standard protocols. Microbial counts (log cfu cm^{-2}) were analysed by Analysis of Variance (ANOVA) at a 95% confidence interval coupled to Tukey's test to detect significant differences between stage or treatments. Statistica (v.4.2) (StatSoft) and R (v.3.4.4) were used to perform paired comparisons of counts between samples and the individual animal they derived from.

Results

The mean and range of microbial counts (log_{10} cfu cm^{-2}) on the lamb fleece on each of the three sample trips is summarised in Table 1. Overall, the mean mesophilic aerobic counts was 4.4 ± 0.7 log_{10} cfu cm^{-2}. However, it is noteworthy that there was high variability in the mesophilic aerobic counts within each trip and CLP batch of animals (up to 2 log variation). This animal to animal microbial variation was also the trend for the other microbial counts assessed on the fleece. These levels of microbial contamination on the fleece from micro-organisms typically linked to meat spoilage highlight the risk for carcass contamination. Table 2 shows the microbial counts on dressed carcasses before chilling. Results not shown demonstrated a strong correlation ($P<0.05$) between mesophilic and psychrophilic aerobic counts and lactic acid bacteria counts on fleece and dressed carcasses at an individual animal level. Table 3 shows impact of carcass chilling time (24 h versus 72 h) on the microbial counts on all carcasses (n=166). It is noted that mesophilic aerobic colony counts, Pseudomonads and *B. thermosphacta* were all significantly higher ($P<0.05$) (up to 0.5 log higher) indicating that these groups of micro-organisms were continuing to grow on the carcass during chilled storage.

Conclusion

This study highlights that the fleece is a significant source of microbial contamination linked to meat spoilage and the need for the strictest hygiene in fleece removal, even those which are visually clean (CLP A). It also highlights the level of variability in microbiological counts between animals and carcasses within the same batch and the potential cross contamination impact from one high contaminated animal/carcass. The length of carcass chilling is also shown to support increases in numbers of selected spoilage micro-organisms which may ultimately impact on lamb spoilage and shelf-life.

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Notes

Table 3 Mean microbial counts (log_{10} cfu cm^{-2}) on sheep carcasses (n=166) after 24 or 72 h chilling

Microbiological Assay	Carcass chilling time	
	24 h	72 h
Mesophilic aerobic colony counts	2.5 ± 0.5[a]	2.7 ± 0.5[b]
Psychrophilic aerobic colony counts	2.0 ± 0.6[b]	2.4 ± 0.6[b]
Enterobacteriaceae	-0.2 ± 1.2[b]	-0.3 ± 1.2[b]
Brochothrix thermosphacta	0.2 ± 0.6[b]	0.7 ± 1.0[a]
Pseudomonas spp.	0.9 ± 1.1[b]	1.3 ± 0.8[a]
Lactic acid bacteria	1.1 ± 0.7[b]	1.0 ± 0.9[b]

[a][b]Different letters in the same row indicate significant differences between microbial counts at different chilling times ($P<0.05$). Results are given as average ± standard deviation

Table 3
Mean microbial counts (log10 cfu cm-2) on sheep carcasses (n= 166) after 24 or 72 h chilling

Table 2 Mean and (range) of microbial counts (log_{10} cfu cm^{-2}) on sheep carcasses after dressing and before chilling

Microbiological Assay	Trip number and Lamb CLP Category (Number of carcasses sampled)			
	1, CLP B (n = 50)	2 ,CLP A (n = 56)	3, CLP B (n = 60)	Mean and ± standard deviation all carcasses (n = 166)
Mesophilic aerobic colony counts	2.75 (1.41-4.23)	2.60 (1.32-3.72)	2.24 (1.69-3.34)	2.5 ± 0.5
Psychrophilic aerobic colony counts	2.61 (1.28-4.11)	2.00 (0.27-4.08)	1.36 (0.30-3.31)	1.9 ± 0.8
Enterobacteriaceae	ND (ND-1.30)	1.37 (ND-2.91)	ND (ND-1.26)	0.1 ± 1.2
Brochothrix thermosphacta	ND (ND-1.60)	0.72 (ND-1.72)	ND (ND-0.54)	0.1 ± 0.6
Pseudomonas spp.	0.57 (ND-2.44)	1.96 (0.48-4.59)	0.09 (ND-1.04)	0.9 ± 1.1
Lactic acid bacteria	1.37 (ND-3.52)	0.98 (ND-2.59)	0.72 (ND-2.01)	1.0 ± 0.6

ND = below limit of detection

Table 2 Mean and (range) of microbial counts (log10 cfu cm-2) on sheep carcasses after dressing and
Table 2 Mean and (range) of microbial counts (log10 cfu cm-2) on sheep carcasses after dressing and before chilling

Table 1 Mean and (range) of microbial counts (log_{10} cfu cm^{-2}) on sheep fleece

Microbiological Assay	Trip number and Lamb CLP Category (Number of animals sampled)			
	1, CLP B (n = 50)	2 ,CLP A (n = 56)	3, CLP B (n = 60)	Mean and ± standard deviation on all fleece (n = 166)
Mesophilic aerobic colony counts	4.01 (2.76-4.78)	4.96 (4.03-6.50)	4.27 (3.20-5.96)	4.4 ± 0.7
Psychrophilic aerobic colony counts	3.87 (2.22-4.90)	4.60 (3.44-5.36)	3.70 (2.48-5.55)	4.1 ± 0.7
Enterobacteriaceae	ND (ND-1.78)	1.78 (0.41-3.20)	0.28 (ND-2.57)	0.6 ± 1.2
Brochothrix thermosphacta	1.47 (ND-3.00)	1.55 (0.70-2.91)	0.86 (ND-2.16)	1.3 ± 0.7
Pseudomonas spp.	0.75 (ND-4.38)	2.29 (1.19-3.60)	0.98 (ND-2.87)	1.3 ± 1.1
Lactic acid bacteria	2.08 (ND-4.56)	3.50 (2.48-4.00)	1.87 (048-3.31)	2.5 ± 1.1

ND = below limit of detection

Table 1
Mean and (range) of microbial counts (log10 cfu cm-2) on sheep fleece

Notes