final report

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Sources of contamination post de-hiding

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Abstract

This study aims to build on previous work that examined the amount of microbial transfer from the initial surface to the carcass at individual operations, in order to indicate which operations have the greatest impact on ultimate carcass microbial load. This may help meat processors better understand the sources of microbial contamination of beef carcasses.
The results indicate that there is a high standard of hygiene at this plant. TVC counts on exposed carcass surface prior to trimming were a maximum of 3.29 $\log_{10}$ cfu/cm² immediately post skinning, and at final inspection ranged from <0.52 to 2.09 $\log_{10}$ cfu/cm². *S. aureus* counts, when present, were less than 1 $\log_{10}$ cfu/cm². No one dressing activity after skinning stands out as being a significant source of carcass contamination. The exception could be chill loading, where an increase in contamination on the flanks was detected, although all staff involved wear rubber gloves and plastic aprons. Chilling decreased the microbial load recovered from rumps and flanks in particular.
As comparison with previous work carried out at this plant (Project A.MFS.0149), TVC at Final Inspection are much lower in this project than in the previous one. In the current project, the mean TVC on hot sides was 0.39 ± 0.31 $\log_{10}$ cfu/cm² (range <0.52 to 2.09), compared with 1.54 ± 0.69 $\log_{10}$ cfu/cm² (range 0.42 to 3.42) in the previous project, whereas the incoming load on hides was similar. This suggests that the processor has already made significant improvements in the process hygiene of slaughter over the preceding 12 month period. It may be important to note that the processor commented that they had been focussing recently on increasing employee commitment to handwashing more regularly during processing. This may well be contributing to the reduced microbial load on carcasses

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1 Background

Previous work at Processor A (Project A.MFS.0149) showed that although the carcass surface immediately following de-hiding operations had a low microbial load, by the time the carcass had reached the ESAM sampling point, the total counts had increased, and Staphylococcus aureus was detectable on a number of carcasses. The contamination may be due to manual handling of the carcass, and the staphylococci in particular may be associated with contact with human skin.
A subsequent visit to the plant in September 2008 identified that all plant staff working on the line and handling carcasses wear rubber gloves, but AQIS staff did not. However, the AQIS staff observed did not handle the carcass tissue to any great extent. Observation of the process suggested that the arms of evisceration workers may be a possible source of human staphylococci, as the arms contact the midline of the carcass during the evisceration operation (figure 1). Although hands are gloved, following splitting there is a significant amount of carcass handling as the sides are turned in order to inspect and trim. The gloves may act as a vector for contamination from one part of the carcass to another.
The trimming process can be compartmentalised into high-level (hindquarter handled), medium (flank and ribcage handled) and low-level (brisket, neck and shin handled) as the sides progress along the line. Following trimming, the carcass is weighed, graded and subject to final inspection before being pushed into the chiller. There is very little handling of the carcass during weighing, grading and final inspection, but pushing into the chiller involves contact particularly between carcasses and contact of the forequarter with the gloved hands and apron of the worker involved (figure 1).
During chilling, it would be expected that microbial counts would reduce as a result of cooling and desiccation, but a further potential means of recontamination exists in pushing the carcasses from the chiller into the boning room. During the site visit, the potential role of aerosol contamination was discussed. The plant originally had a high cathedral-type ceiling, but AQIS requirements led to the installation of a false ceiling to conceal the exposed structural elements. As a result, they lost the 'stack effect' in terms of air flow (hot air rising and drawing cooler air in at ground level), and workers complained of overheating. To overcome this problem, a number of extractor fans have been installed in the walls, and at the majority of stations there is a powerful fan which the workers can switch on as they require. As a result, air flow in the slaughter hall is complex, and may well be counterproductive in terms of pulling microbial contamination away from the exposed carcasses. This current project, however, does not address air flow in the slaughterhall

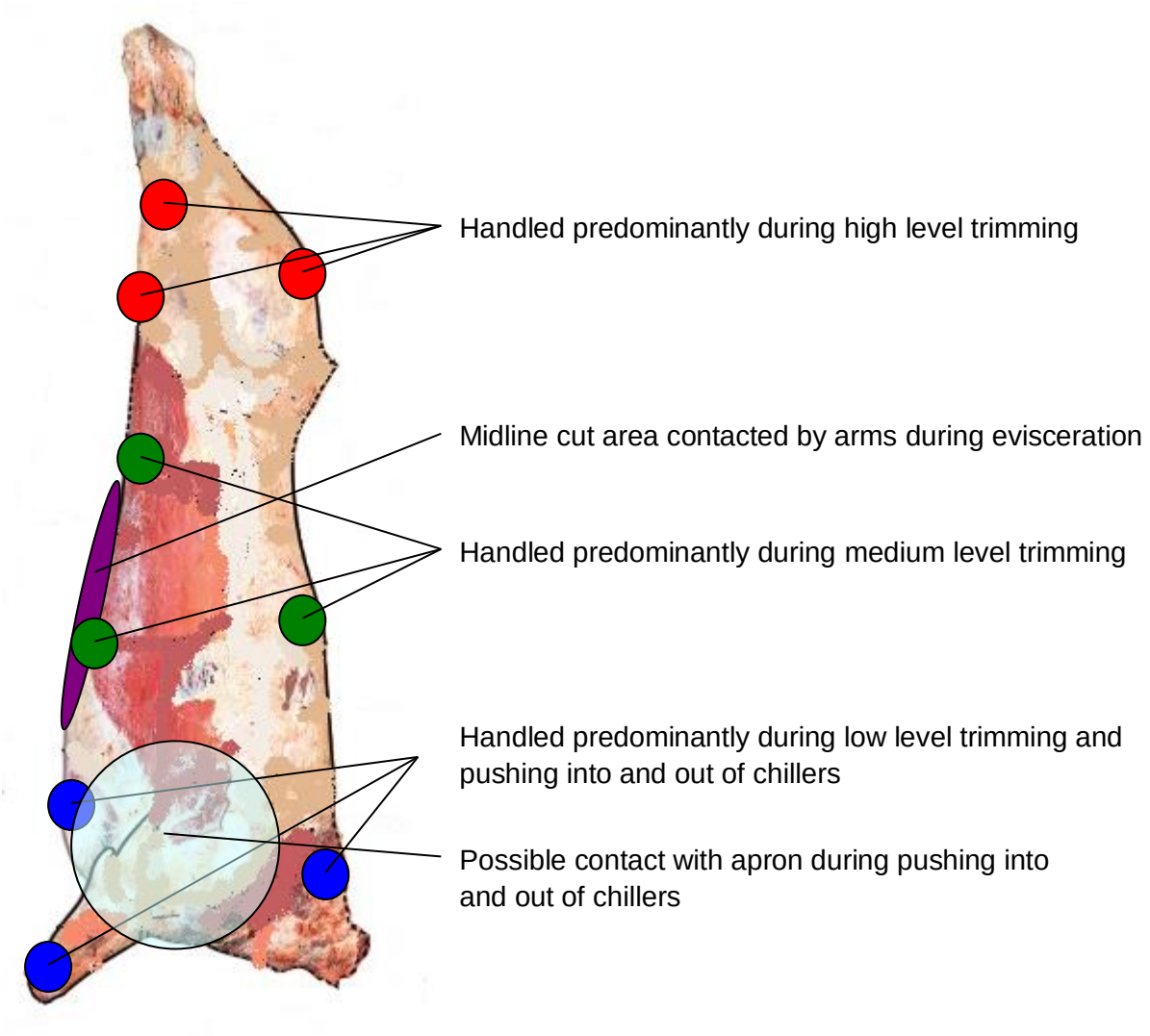

Figure 1: Major handling contact points

2 Project objectives

This study aims to build on previous work that examined the amount of microbial transfer from the initial surface to the carcass at individual operations.
By understanding the levels of contamination at the individual operation, it may be possible to identify the relative importance of particular operations, and give recommendations as to which operations give the greater impact in carcass hygiene. It is hoped that the information produced may be used to help meat processors better understand the sources of microbial contamination of beef carcasses.

3 Methodology

A team of eight staff attended Processor A, Queensland, between 18th and 21st May 2009 to collect samples. All samples were collected on a single processing day, between 7am and 4pm. Whirlpak ® sponge samples (sponges hydrated with 10ml saline) were taken from a 300 cm² area of the carcass

at each of rump, flank and brisket (blue shaded areas in figure 2), at each of the following dressing stations:

- Hide before skinning (designated HB)
- Skinned carcass before evisceration (SC)
- Carcass following high-level trim handling (HL)
- Carcass following low-level trim handling (LL)
- Carcass following weighing, grading and final inspection, prior to chiller loading (FI)
- Carcass following pushing into chill (CH)
- Carcass after overnight chilling (ESAM).

In addition, at evisceration, a sample was taken from approximately 300 cm² of the left and right arm of the worker (EvLA and EvRA) prior to beginning evisceration, and from each side of the midline cut area (300cm² each side, EvLM and EvRM, green shaded area in figure 2) of the carcass following completion of the evisceration process.

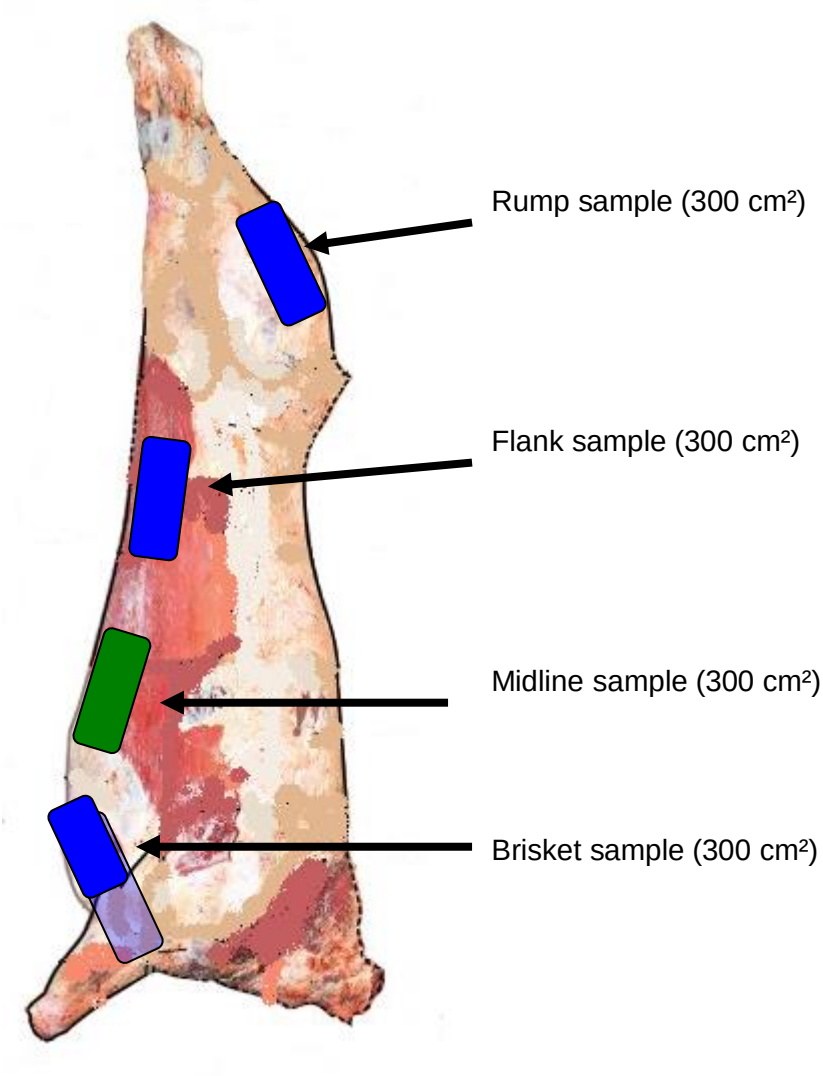

Figure 2: Sample sites on carcass (translucent area indicates that sample was taken from brisket, behind the front leg, and not from the lateral surface of the elbow)

Samples were taken in groups of 5 carcass sets. The carcasses were tagged and tracked throughout the process. A total of 30 carcasses were sampled, but, due to some carcasses being diverted for further QA trimming between evisceration and inspection, only 25 carcasses yielded a full set of samples.

After collection, the sponges were chilled and packed in insulated containers alongside frozen freezer blocks, and were shipped to Cannon Hill for processing. This resulted in a delay between collection and processing of between 28-74 hours. 90mL of peptone water was added to each sponge (which had been rehydrated prior to sampling with 10ml saline), and the sponge vigorously massaged by hand for 30 seconds. A decimal dilution series was made from each sample, and plated onto Petrifilm Aerobic® and Petrifilm Staph Express®. The Petrifilm Staph Express® were incubated at 37°C ± 1°C for 24 hours, and the Petrifilm Aerobic ® at 25°C for 72 hours.

Data gathered was entered into an Excel spreadsheet. Aerobic counts (TVC) per square cm for each sample and the prevalence of *Staphylococcus aureus* at each dressing station were calculated.

4 Results

4.1 Total Viable Count (TVC)

The total viable count of the hide of the animal ranged from 2.22 to 5.77 (mean 3.93) log10 cfu/cm² (figure 3). Counts on brisket tended to be slightly higher than counts on rump or flank, but this was not significantly different.

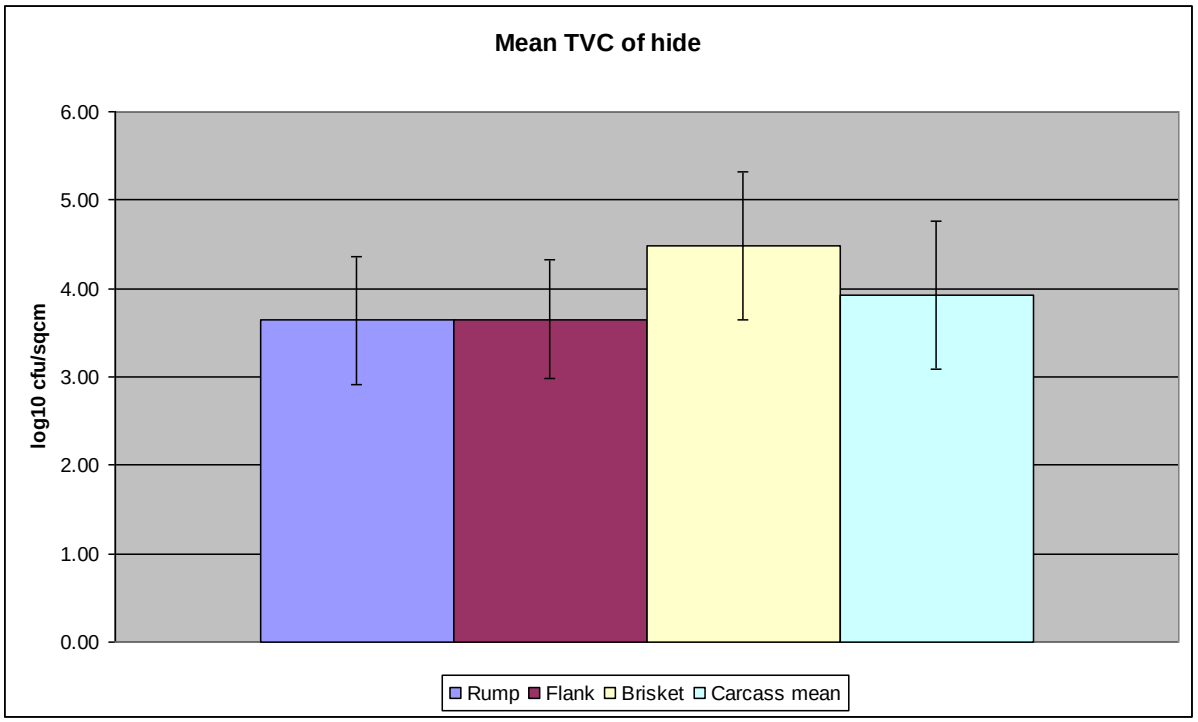

Figure 3: Mean TVC (log_{10} cfu/cm²) of samples taken prior to skinning.

Following skinning, mean TVC was generally below 1 log10 cfu/cm² at all sample sites (figure 4), except for flank immediately after skinning, but before evisceration (mean 1.28 log10 cfu/cm², range

<0.52 to 3.29 log10 cfu/cm²). The counts on rump and flank fell after High Level trimming, but there was a slight increase in counts on brisket until Final Inspection. The mean count on flank increased, from 0.47 log10 cfu/cm² at Final Inspection to 1 log10 cfu/cm² post Chill loading, which could be due to the manual handling of the carcass during Chill loading. However, the chilling process resulted in a substantial reduction in counts, particularly on flank and rump. This is probably due to the desiccation and cooling effect of air chilling.

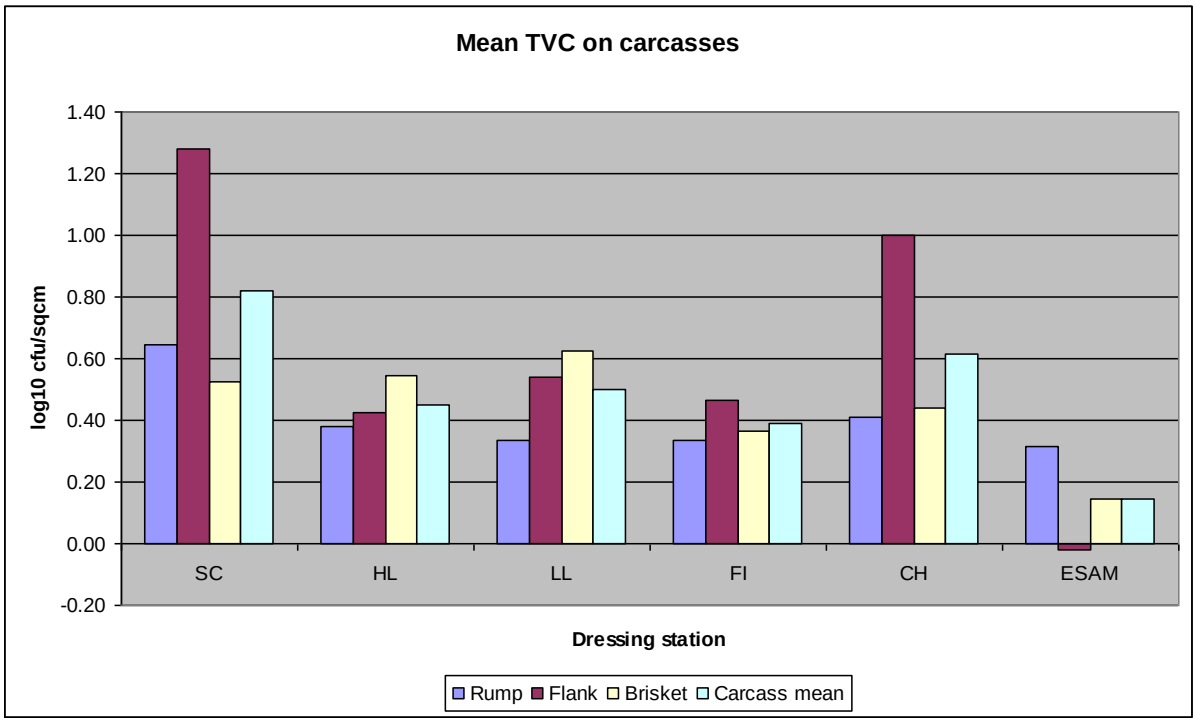

Figure 4: Mean TVC (log_{10} cfu/cm²) of samples taken at dressing stations after skinning. Key to dressing station codes: SC = Skinned Carcass prior to evisceration; HL = post High Level trimming; LL = post Low Level trimming; FI = Final Inspection post grading, prior to chill loading; CH = post CHill loading; ESAM = post chilling, prior to boning room entry.

The mean TVC on each carcass at each dressing station (calculated by taking the average of rump, flank and brisket) was plotted in figure 5. No consistent trend was detected, although in general, counts decreased between Skinned Carcass and post High Level trim, and there was a slight increase between Final Inspection and post Chill loading. None of these changes were statistically significant at P<0.1

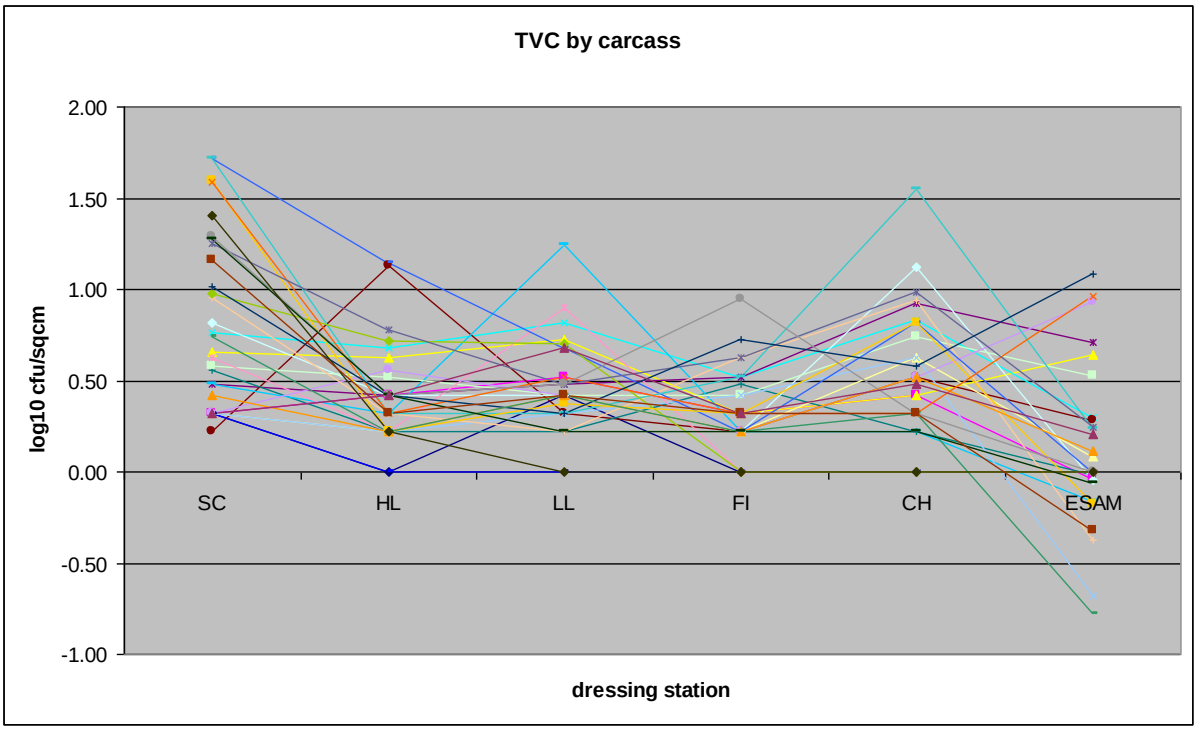

Figure 5: Mean TVC of each individual carcass (log_{10} cfu/cm²) of samples taken post skinning (Key to dressing codes as per figure 4).

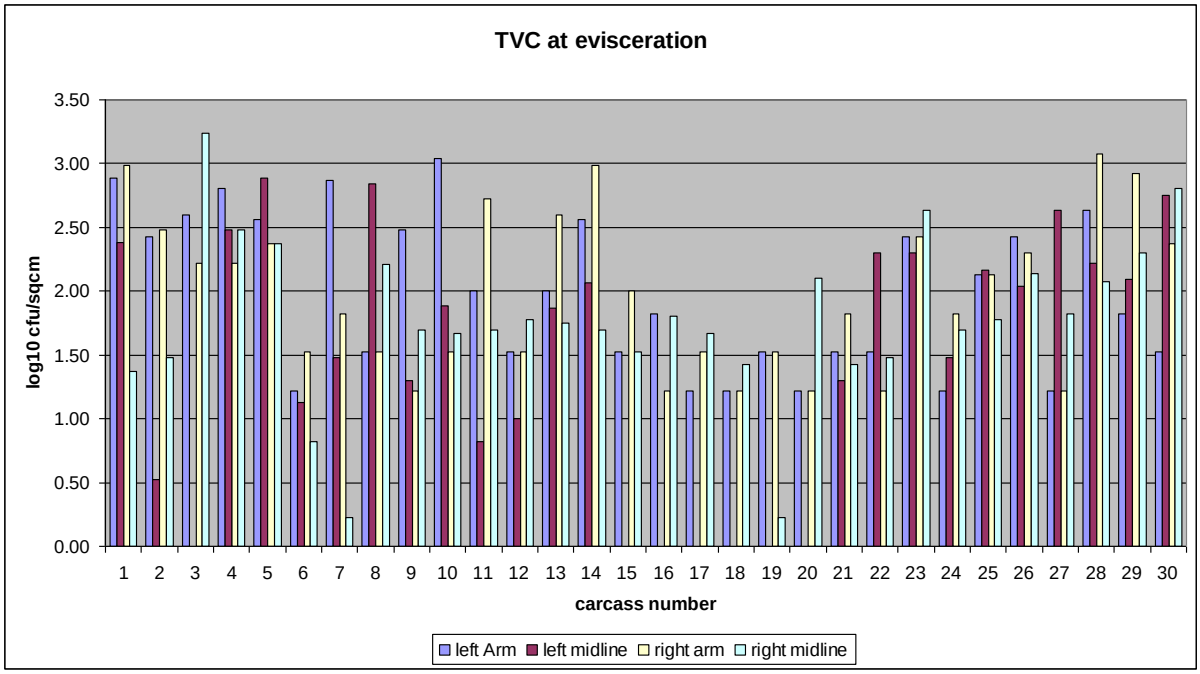

Figure 6: TVC (log_{10} cfu/cm²) of samples taken at the evisceration station, grouped by individual carcass (carcasses 15-20, left midline samples were not processed due to an error made in the laboratory).

The TVC on each arm of the slaughterman carrying out evisceration was plotted with the TVC on the corresponding carcass midline in figure 6. Although the mean count on each arm was very similar to

the mean count on the corresponding carcass midline (table 1), there was no true correlation (figures 7 and 8).

Table 1: Mean TVC (log_{10} cfu/cm²) on arms and carcass midline at evisceration

	left	right	mean
Ev Arms	1.98	1.99	1.99
Ev Midline	1.91	1.78	1.84

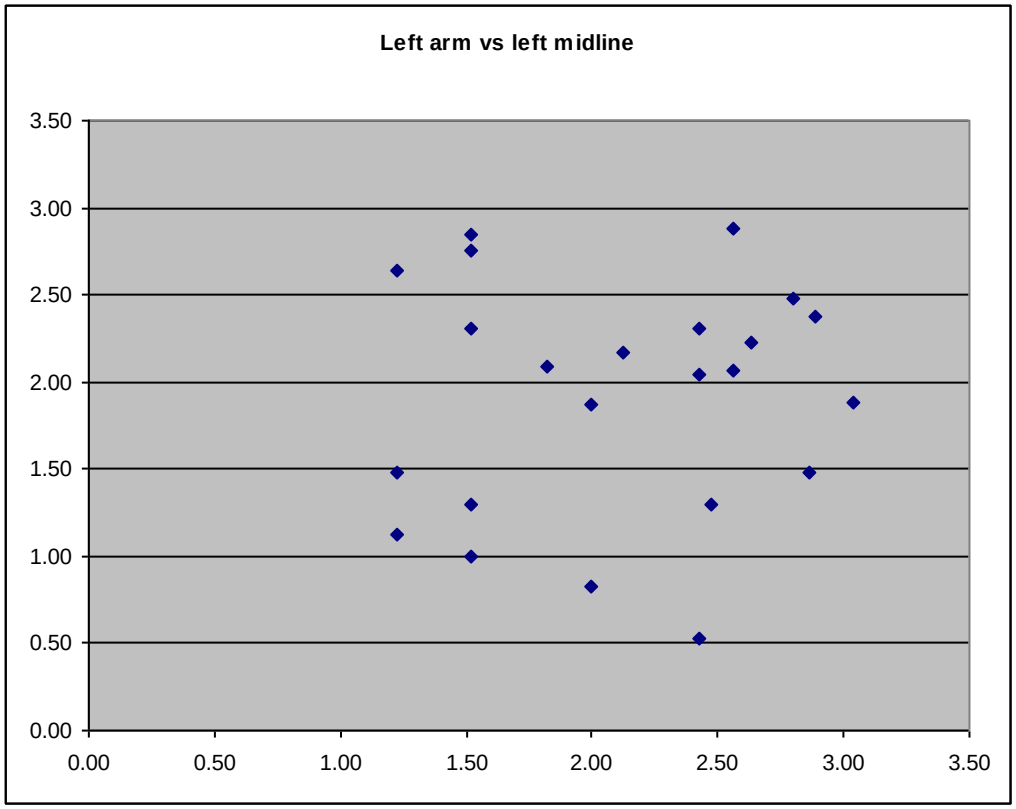

Figure 7: Scatter plot of TVC (log_{10} cfu/cm²) on Left arm versus Left carcass midline

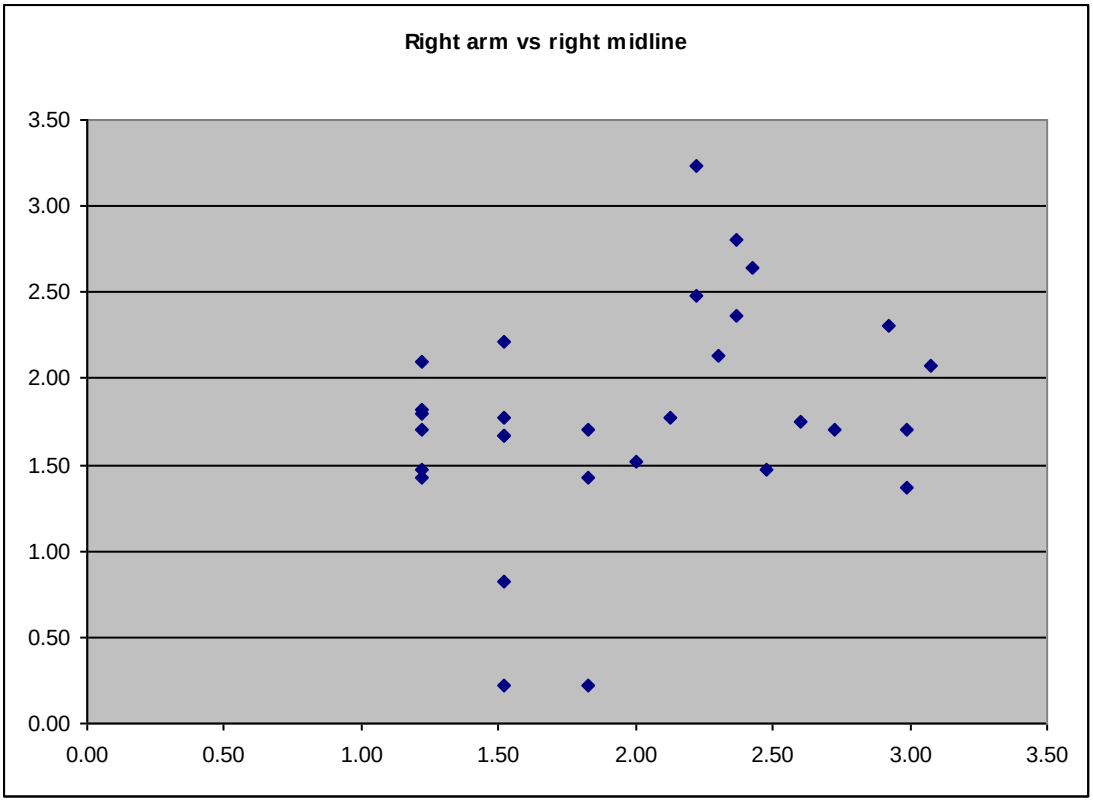

Figure 8: Scatter plot of TVC (log_{10} cfu/cm²) on Right arm versus Right carcass midline

4.2 Staphylococcus aureus

The proportion of hide samples testing positive (figure 9) for Staphylococcus aureus (S. aureus) was 74% (70% of flank samples; 77% of rump and brisket samples). After skinning, the prevalence on rump and brisket was substantially less (27% and 37% respectively), but the prevalence on flank remained high (67%). Similar to the trend indicated by the TVC on carcasses, the proportion of samples testing positive for S. aureus reduced following High Level trim, and was substantially reduced during chilling. Prevalence also increased on flanks and briskets between Final Inspection and Chill Loading. This may be due to the manual handling involved in chill loading, even though the personnel involved all wear rubber gloves and plastic aprons.

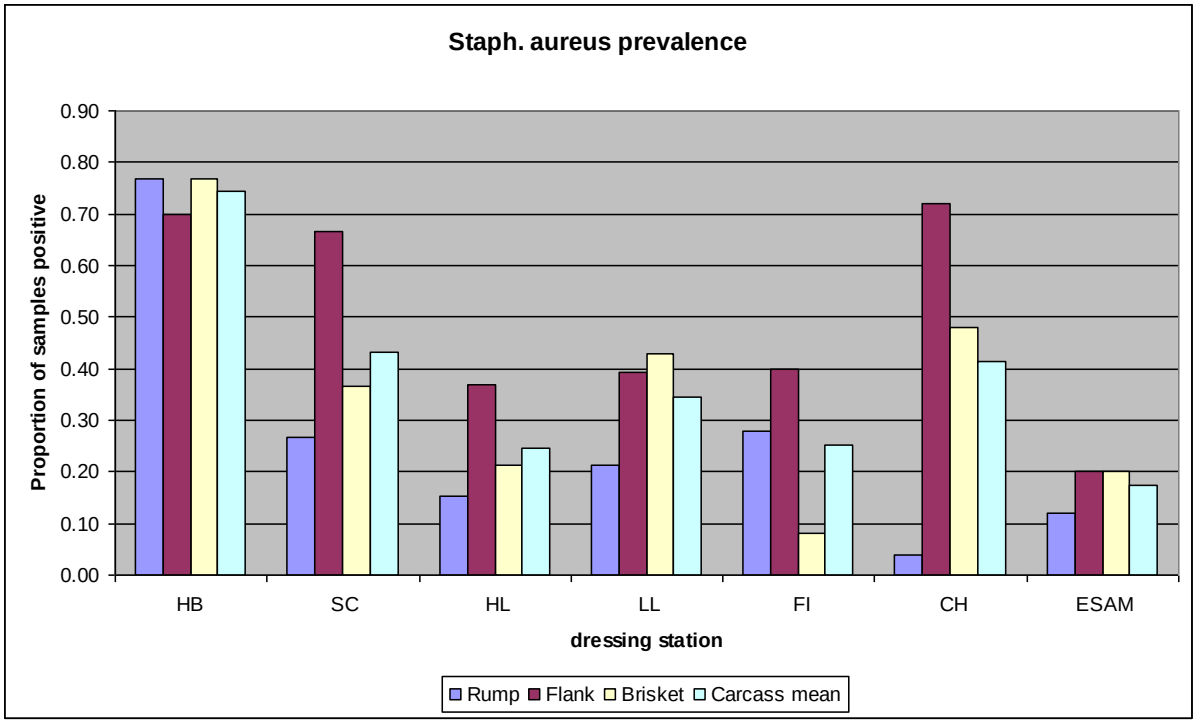

Figure 9: Proportion of samples taken at each dressing station testing positive for *Staphylococcus aureus* (*n* = 30 at HB and SC; *n* = 25 at remaining dressing stations).
Key to dressing station codes: HB = Hide Before skinning; SC = Skinned Carcass prior to evisceration; HL = post High Level trimming; LL = post Low Level trimming; FI = Final Inspection post grading, prior to chill loading; CH = post CHill loading; ESAM = post chilling, prior to boning room entry.

Mean *S. aureus* counts ($\log_{10}$ cfu/cm²) for individual carcasses were plotted for dressing stations subsequent to skinning (figure 10), but again no particular trend was discernible. Similarly the counts obtained from arms and carcass midline at evisceration were plotted for each carcass (figure 11), but no correlations were apparent, although the prevalence of *S. aureus* detections on each arm was similar to that on the corresponding carcass midline (table 2). Also, there was no relationship between *S. aureus* count on hide and subsequent detection at other dressing stations (table 3).

Table 2: Prevalence of *S. aureus* on arms and carcass midline at evisceration

	left	right	overall
ev arms	0.73	0.80	0.77
ev midline	0.80	0.80	0.80

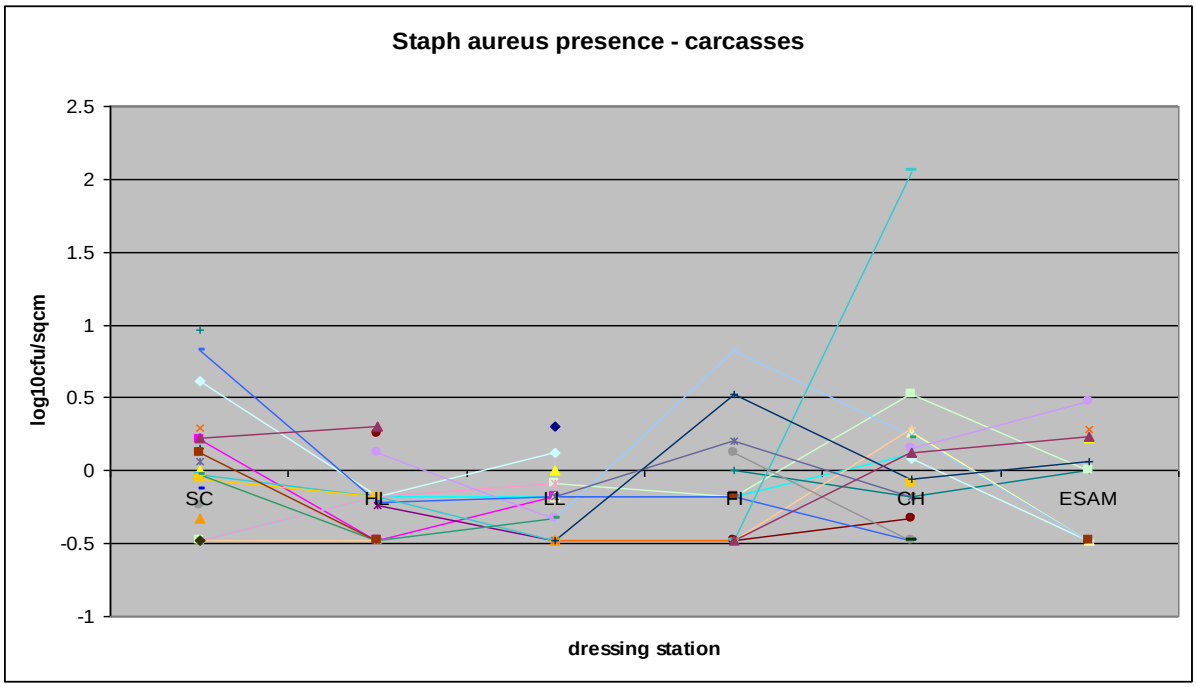

Figure 10: Mean *Staphylococcus aureus* count of each individual carcass testing positive (log_{10} cfu/cm²) of samples taken post skinning (Key to dressing codes as per figures 4 and 7).

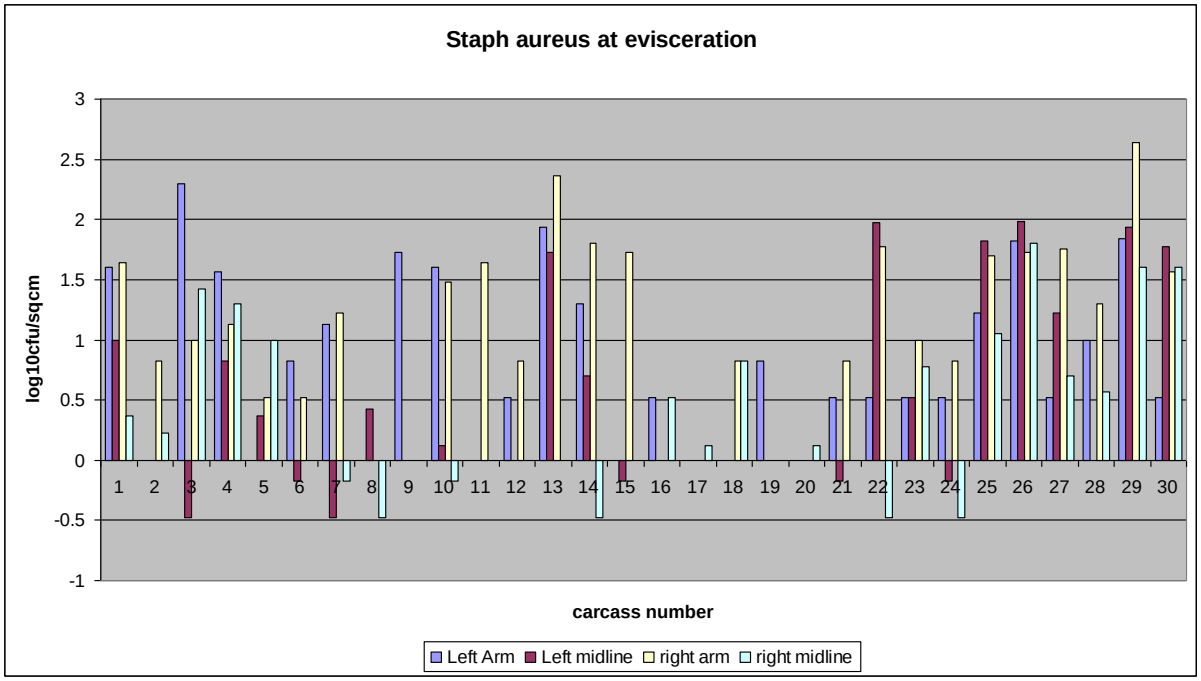

Figure 11: *Staphylococcus aureus* count (log_{10} cfu/cm²) of samples testing positive taken at the evisceration station, grouped by individual carcass (carcasses 15-20, left midline samples were not processed due to an error made in the laboratory).

Table 3: *S. aureus* counts (log_{10} cfu/cm^2) from each carcass (blank cell indicates no detection)

carcass number	HB	SC	HL	LL	FI	CH	ESAM
1	2.32	-0.48		0.30			
2	2.97	0.21	-0.48	-0.18	-0.18		
3	3.03	0.00		0.00			0.22
4	2.71	-0.48	-0.18	-0.18	-0.18	0.11	
5	2.72		-0.24	-0.48			
6	2.41		0.25		-0.48	-0.33	
7	3.36	0.97			0.00	-0.18	0.00
8	3.01	-0.13					
9	2.62	-0.24		-0.48		-0.48	
10	2.98	0.61	-0.18	0.12		0.08	-0.48
11	2.91	-0.48		-0.09	-0.18	0.52	0.00
12	2.33			-0.18		0.26	-0.48
13	2.42		-0.48	-0.33	0.82	0.25	-0.48
14	2.35	-0.48	-0.18	-0.09			
15	2.37		0.12	-0.33		0.15	0.48
16		-0.48	-0.48		-0.48	0.29	
17	2.33	0.82	-0.22	-0.18	-0.18	-0.48	
18	2.59	-0.03	-0.18	-0.48	-0.48	2.05	
19	2.43	-0.48		-0.48			
20	2.65	-0.06	-0.18			-0.09	
21	2.21	-0.33		-0.48			
22	2.04	0.30		-0.48	-0.48		0.28
23	2.02	0.06		-0.18	0.20	-0.18	
24	2.89	-0.24			0.12	-0.48	
25	2.29	0.15		-0.48	0.52	-0.05	0.06
26	2.50	-0.03	-0.48	-0.33		0.22	
27	3.43					-0.48	
28		-0.48					
29	2.87	0.12	-0.48		-0.18		-0.48
30		0.22	0.30		-0.48	0.12	0.23
Limit of detection	1.82	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48

5 Conclusions

The results indicate that there is a high standard of hygiene at this plant, and no one dressing activity after skinning stands out as being a significant source of carcass contamination. The exception could be chill loading, where an increase in contamination on the flanks was detected, although all staff involved wear rubber gloves and plastic aprons. The level of contamination present on these gloves and aprons was not evaluated in the current project, so it is difficult to ascertain their importance. However, the processor may consider increasing the frequency of sanitisation of these gloves and aprons to reduce post chill loading contamination.

The chilling process itself substantially decreased the microbial load recovered from rumps and flanks. Brisket counts, however, remained stable. This could be due to decreased air-flow at the level of the brisket in comparison with the rumps and flank. Although the chillers were loaded carefully, with the carcasses spaced to allow good air circulation, the shape of the carcasses means that air flow round the brisket will be hampered by the shins and close proximity of carcasses on the adjacent rail.

As comparison with previous work carried out at this plant (Project A.MFS.0149), TVC at Final Inspection are much lower in this project than in the previous one, although S. aureus prevalence was slightly higher (25% compared with 17% in the previous project). In the current project, the mean TVC on hot sides was 0.39 ± 0.31 log10 cfu/cm² (range <0.52 to 2.09), compared with 1.54 ± 0.69 log10 cfu/cm² (range 0.42 to 3.42) in the previous project, whereas the incoming load on hides was similar. This suggests that the processor has already made significant improvements in the process hygiene of slaughter over the preceding 12 month period. It may be important to note that the processor commented that they had been focussing recently on increasing employee commitment to handwashing more regularly during processing. This may well be contributing to the reduced microbial load on carcasses.