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Evaluation of steam vacuuming equipment for removal of contamination from beef sides MSQS.004

Prepared by:
Australian Meat Technology

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Executive summary

In early 1996 the USDA Food Safety and Inspection Service (FSIS) approved the use of steam vacuuming treatments to remove faecal and ingesta contamination from beef carcases with the provision that areas of contamination of 25 mm or greater in the greatest dimension must continue to be removed by trimming.

In August 1996, AQIS advised its technical staff that the equipment was not yet approved for use in Australian export establishments. At the request of the Meat Research Corporation, investigations were undertaken to determine the suitability of two steam vacuuming units for use in Australian abattoirs.

The units were evaluated at two export-registered establishments. The evaluations involved both visual and microbiological assessments of sides and carcases. Visual assessments of carcases and sides were undertaken to determine the initial level of visual contamination and then to determine if the units were able to remove visible contamination. Microbiological testing was undertaken to determine if the units were able to reduce the bacterial load on contaminated surfaces.

The units were found to be capable of removing contamination and reducing the numbers of coliform bacteria and *E. coli* present by at least 90%. These findings support work previously carried out in the United States by Dorsa et al.

Recommendations

1. Based on the test findings presented in the attached report, MRC should recommend to AQIS that it accept the Jarvis Steam Vac steam vacuuming systems for use on beef sides subject to the conditions listed in EMIAC 20 Agenda item 3(1).

2. AQIS should extend the approval to the Kentmaster Vac San system subject to the same conditions and an additional condition that these units be modified by the use of a temperature gauge so that the water or steam temperature at the vacuum head can be monitored.

3. The method of application of the steam vacuuming equipment be dependent on the type of contamination present. For faecal material and clusters of hairs, the unit should be used for localised 'spot' treatment of an area of approximately 100 cm^2 over and in the immediate vicinity of the contamination. For the incidental removal of single loose hairs or small groups of hairs which are not readily visible, a sweeping motion is more effective and is recommended.

Background

In early 1996, the USDA Food Safety and Inspection Service (FSIS) approved the use of steam vacuuming treatments to remove visible faecal and ingesta contamination from beef carcases that is less than 25 mm in its greatest dimension (FSIS Directive 6350.1, 8 April 1996). Steam vacuuming is not approved for use on areas of contamination larger than this or on open abscesses, septic bruises, parasites or parasitic lesions or spilt milk from lactating udders. These defects must be removed by knife trimming. The approval followed extensive in-plant trials which demonstrated the physical and microbiological effectiveness of the steam vacuuming units for use instead of knife trimming (Kochevar et al, 1996; Dorsa et al, 1996). At the present time AQIS has not approved the use of these units in Australian export establishments.

This report describes the work undertaken at two export establishments - one in Queensland, the other in N.S.W. Two Steam Vac units (Jarvis ANZ) were installed at two locations at the N.S.W. abattoir, with the Vac-San unit (Kentmaster Australia) temporally set up in the Queensland abattoir. The evaluation of the steam vacuuming units was undertaken to determine whether the units were capable of removing visible contamination from the surface of carcases and reducing the bacterial load on the area surrounding the contamination.

Methodology

The evaluation of the Steam-Vac unit was carried out over a one week period. Over this time, continuous visual assessment of carcases and sides for faecal and hair contamination was carried out at two locations on the slaughter floor. Over the week, samples for microbiological testing were collected from 200 of the visibly contaminated carcases and sides.

A less extensive evaluation of the Vac-San unit was carried out at the final trim stand on the slaughter floor, with visual assessment of sides for faecal and hair contamination undertaken over a four day period. Over two days, samples for microbiological testing were collected from 60 of the visibly contaminated sides.

Visual Assessment

For the evaluation of the Steam Vac unit, visual assessments of carcases or sides were carried out at two locations on the slaughter floor. The first location was immediately after leg change-over, with the shank, butt, flank and the mid-line of the carcases being assessed. The second location was at the final trim/QA inspection area where the shank, butt, flank, rump and the mid-line of the sides were assessed. The evaluation of Vac-San was carried out at the final trim area with the shank, butt and flank of sides being assessed.

For each carcase or side, the level of faecal matter and other material (such as hair) was assessed using a rating system developed specifically for this trial and the score was recorded. The scoring system is shown in Appendix 1. Steam-vacuumed carcases and sides were assessed again immediately after treatment.

Microbiological Assessment

Of the 200 samples collected for the Steam Vac evaluation, 100 were collected at the leg change-over location and 100 at final trim. The Vac-San evaluation involved a total of 60 samples collected at final trim. In both evaluations, samples were collected after visual assessment and generally collected alternately before and after steam vacuuming was applied. It was not practicable to collect samples before and after treatment from the same sites. Samples were collected using the sponge sampling technique recommended by FSIS, (See Appendix 2). Enumerations for total viable count, coliforms and *E. coli* were performed on all of the samples according to Australian Standard 1766.

Steam Vacuuming

Both steam vacuuming devices are hand-held units designed to remove faecal material from the surface of carcases by loosening the material and drawing it away from the surface by vacuum. In one, steam is emitted from vents surrounding the vacuuming opening to sterilise the unit head and also to help loosen the material. The vacuum at the carcase surface is sufficient to remove the contamination and condensed water from the surface of the carcase to prevent dripping. The vacuum and the steam temperature at the head of the unit were monitored and recorded at half-hourly intervals during the day. The other unit uses hot water instead of steam to loosen material and sterilise the area. When the head of the unit is placed on the carcase, hot water is aspirated onto the surface. The unit draws the water and any contaminating material away from the surface by vacuum. Steam is emitted from an orifice on the head to sterilise the unit head.

When an area of the surface of the carcase or side was observed to be contaminated, the head of the unit was applied over the contamination and during a period of approximately five seconds was moved slowly back and forth over a limited area not exceeding 100 cm^2. Hereafter in this report this action is referred to as spotting.

Results and Discussion

Visual Assessment

The trial using the Steam Vac was carried out over five consecutive days. In that time, 1567 carcases and 3205 sides were assessed visually at leg change-over and final trim respectively. Overall, hairs and/or faecal material were observed on 32% of the carcases at leg change-over and on 30% of the sides at final trim. Table 1 summarises the visual assessment findings at the two locations.

	Proportion of carcases or sides contaminated (%)							
Day	Overall		Hairs		Faecal smears		Faecal mass	
	Leg	Trim	Leg	Trim	Leg	Trim	Leg	Trim
1	15	33	6	26	4	4	5	3
2	29	38	12	32	13	4	4	2
3	34	24	12	19	11	2	11	3
4	37	24	9	18	11	2	17	4
5	46	31	16	27	17	3	12	1
Overall	32	30	11	25	12	3	9	2

Table 1: Type of contamination and percentage breakdown at legging and trim areas observed during the Steam Vac trial

During the Steam Vac trial, of the carcases found to be contaminated at leg change-over, the majority were contaminated with smears or small fragments of faecal material. In contrast, the vast majority of material found on the sides at final trim were hairs.

On the third, fourth and fifth days of the trial there was a considerable increase in the number of carcases with faecal material present. This increase was probably due to the large number of lot-fed cattle being slaughtered. The cattle were very dirty with large faecal dags on the underside of their bodies. When the hides were opened around the flank area, the dags caused them to roll onto the exposed meat surface, depositing hair and faecal material.

Over the first four days there were 200 carcases or sides which were assessed visually and then sampled for microbiological testing. A statistical analysis of the initial visual scores for these indicated that there was no significant statistical difference between the pre-treatment scores for carcases or sides sampled before treatment and the pre-treatment scores of those sampled after treatment. This means that any differences in the microbiological results are attributable to the steam-vacuuming treatment, rather than possible differences in the amounts of faecal material initially present.

The trial of the Vac-San was held over four consecutive days with 1695 sides assessed visually at the final trim location. Overall, hairs and/or faecal material were observed on 11% of the sides at final trim. On each of two days of the trial, 30 sides were assessed visually and then sampled for microbiological testing. A statistical analysis of the pre-treatment scores showed there was no difference between the scores for carcases sampled before treatment and for carcases sampled after treatment. Table 2 summarises the visual assessment findings at this location

	Proportion of sides contaminated (%)			
Day	Overall	Hairs	Faecal smears	Faecal mass
1	13	9	3	2
2	16	10	6	0
3	9	5	4	0
4	11	5	5	1
Overall	11	6	4	1

Table 2: Type of contamination and percentage breakdown at trim area observed during the Vac-San trial

Of the carcases found during this trial to have contamination present, the majority were contaminated with hairs. The animals slaughtered during the trial were dry, grass-fed animals, with short summer coats. The low level of visual contamination may also have been due to the butt area being papered. The papering of the area is done routinely at the abattoir to prevent contamination which may be flicked onto the area when the tail is moved. Also a two knife policy, where two knives are used to clear the area and both are sterilised between each cut, is enforced at first and second leg. This could explain the low level of contamination with hairs on the topside and shank area. Also as the cattle were relatively free of dags, the incidence of faecal material on the side was also low.

The visual assessment of carcases after the use of either of the steam vacuuming units showed that in over 99% of cases the unit was able to remove all visible signs of contamination. The few exceptions were where there had been a faecal mass that had been rubbed into the surface of the carcase, and the unit was unable to remove all the material. There were occasions after application of the Steam Vac when the surface of carcases had a brown discolouration which appeared to be coagulation of blood, due to the heat of the steam. There were also areas of temporary bleaching on the fat surfaces after application of the unit, although this bleaching faded during chilling. This discolouration did not appear as noticeable with the Vac-San unit.

Microbiological Results

The total viable count (TVC), coliform and *E. coli* results for areas treated with the Steam Vac were significantly lower than results for areas sampled before treatment. In Table 3 it can be seen that the reduction in TVC was greater after the first day of the trial. At the end of the first day of the trial it was agreed to enforce the procedure documented in the trial protocol and specify that the steam vacuuming units be used for spotting directly onto areas of contamination on the surface of the carcase, rather than using a sweeping motion. It is likely that the change in the way the unit was applied and also the contact time of the unit caused the improved reductions.

	Day			
	1	2	3	4
% Reduction	90%	98%	98%	96%

Table 3: Reductions in TVC on each of four days of steam vacuuming

For the second, third and fourth days (i.e. after modification of the steam vacuuming technique), the mean TVC for samples taken before steam vacuuming had an average count of 67,571 per cm^2, while samples taken after steam vacuuming had a mean TVC of 1,670 per cm^2, i.e a reduction of 97.5% (Table 4).

	Before Treatment Average count /cm^2	After Treatment Average count/cm^2	% Reduction
TVC	67,571	1,670	97.5%
Coliforms	8.2	0.9	89%*
E. coli	5.5	0.6	89%*
	n=75	n=75	

Table 4: The mean TVC, coliform and *E. coli* counts for samples before and after treatment with the Steam Vac unit

* Minimum reductions, for explanation see text below.

The initial load of *E. coli* on the surface of untreated carcases was very low, the mean count being 5.5 per cm^2. The steam vacuuming treatment reduced the *E. coli* levels on carcases by at least 89%. It must be noted that the reductions presented in Table 4 for coliforms and *E. coli* are minimum reductions. For almost 40% of the 'after' samples, the levels of *E. coli* were less than the limit of detection of 3 organisms. per 100 cm^2. All counts below the level of detection were taken as 3 organisms per 100 cm^2 for the statistical analysis, which influenced the value of the overall average of the post-treatment counts.

With the limited data gathered from the Queensland trial, the overall counts from sides tested either before or after the treatment with the Vac-San were extremely low. The low counts may be due to the fact that the sides were clean and dry.

	Before Treatment Average count / cm^2	After Treatment Average count /cm^2	% Reduction
TVC	1 651	479	71%
Coliforms	1	0. 09	88%*
E. coli	0.42	0.05	89%*
	n=30	n=30	

Table 5: The mean TVC, coliform count and *E. coli* counts for samples before and after treatment with the Vac-San

* Minimum reductions, for explanation see text below Table 4.

The number of samples which had a level of *E. coli* less than the limits of detection was almost 90%. Although the mean counts were lower than expected, there was a noticeable reduction in the total viable counts and the coliform and *E. coli* counts after the use of the Vac-San. There were minimum reductions of almost 90% in the levels of coliforms and *E. coli* over the two days of the trial.

Conclusions and recommendations

The work undertaken at the two export plants supports the work carried out by Dorsa et al. (1996) and Kochevar et al. (1996) in the United States, proving that the use of the steam vacuuming units are capable of efficient reductions in coliform and *E.coli* count in the order of at least 90%. When used in accordance with the manufacturer's recommendations, these units are effective in removing visible contamination and decreasing the total bacterial load on the surfaces of sides and carcases.

Based on the test findings presented in the attached report, MRC should recommend to AQIS that it accept the Jarvis Steam Vac steam vacuuming system for use on beef sides subject to the conditions listed in EMIAC 20 Agenda item 3(1). AQIS should extend the approval to the Kentmaster Vac San system subject to the same conditions and an additional condition that these units be modified by the use of a temperature gauge so that the water or steam temperature at the vacuum head can be readily monitored.

It is recommended that the method of application of the steam vacuuming equipment be dependent on the type of contamination present. For faecal material and clusters of hairs, the unit should be used for spot treatment. The minimum period of contact over and near the material (a nominal area of 100 cm^2) should be five seconds and until the surface is visibly clean. However, a sweeping motion is more effective for removal of single loose hairs or small groups of hairs.

It is possible to monitor certain operating parameters of the equipment to ensure its reliability. The vacuum and steam temperature should be checked regularly and compared with the settings recommended by the manufacturer, as part of the plant's QA/HACCP program. The head of the unit should also be checked regularly and cleaned when required.

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Appendix 1

Criteria for visual assessment at the legging area.

0	No faecal or other material
1	No faecal material, but hair present
2	Smear of faecal material smaller than 6.3 mm x 6.3 mm (0.41 cm^2)
3	Smear of faecal material between 6.3 mm x 6.3 mm and (0.41 cm^2) and 12.5 mm x 12.5 mm (1.61 cm^2)
4	Smear of faecal material, 12 mm x 12 mm (1.61 cm^2) and 3.65 cm^2 (19.0 mm x 19.0 mm)
5	Mass of faecal material <6 mm x 6 mm (0.41 cm^2)
6	Mass of faecal material >6 mm x 6 mm (0.41 cm^2)

Criteria for visual assessment at the final trim inspection stand

0	No contaminating material
1	<10 hair strands or 1 hair cluster
2	>10 hair strands or >1 clusters of hairs
3	Smear of faecal material < 6 mm x 6 mm (0.41 cm^2)
4	Smear of faecal material > 6 mm x 6 mm (0.41 cm^2)
5	Mass of faecal material > 6 mm x 6 mm (0.41 cm^2)
6	Mass of faecal material< 6 mm x 6 mm (0.41 cm^2)

Appendix 2

Collection of Microbiological Samples

Microbiological samples were collected by the following method.

1. A 100 cm^2 metal template was sterilised in the knife steriliser.

2. A special collection sponge in a whirl-pak bag was pre-moistened with 25 ml sterile peptone water

3. While wearing a pair of sterile gloves, the sponge was removed from the bag. The template was placed into the selected surface of the carcase.

4. The sample was collected by wiping the sponge over the enclosed sampling area of 10 cm x 10 cm, for a total of 10 times in the vertical and 10 times in the horizontal direction. The sponge was placed back into the bag, air expelled and the top was folded down.

5. Samples were held in a refrigerator and at the end of the day were packed into an Esky with a Gel-Pak at 0 -2 °C. Samples were sent by a courier for overnight delivery to the N.A.T.A registered testing laboratory .

6. Total viable count, coliform and *E. coli* analyses were performed on each of the submitted samples, according to Australian Standard 1766.

TVC - AS 1766.1.4 Colony Count - Surface spread method
Coliforms - AS 1766 2.3 Section 5
E. coli - AS 1766 2.3 Section 7 - Most probable number (MPN) method