finalreport

FOOD SAFETY

Prepared by:

Jocelyn Midgley and Alison Small
Food Science Australia
PO Box 3312
TINGALPA DC QLD 4173

With additional Information by

Rockdale Beef
PO Box 42
Yanco 2703
www.rockdalebeef.com.au

Grayson Australia
PO Box 134,
Bayswater Vic 3153
www.technica.com.au

Argus Realcold Pty Ltd
PO Box 264
Archerfield, QLD 4108
www.argusrealcold.com

Meat & Livestock Australia
Locked Bag 991
North Sydney, NSW 2059

IN-PLANT EVALUATION OF ACIDIFIED SODIUM CHLORITE AS A MICROBIAL INTERVENTION FOR BEEF CARCASSES

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EXECUTIVE SUMMARY

The antimicrobial activity of acidified sodium chlorite is attributed to the oxidative effect of chlorous acid, which is derived from the conversion of chlorite ion into its acid form under acidic conditions. The reactions happen instantly on mixing the sodium chlorite with an acid (e.g. citric or phosphoric acid) and therefore the antibacterial solution needs to be prepared shortly before spraying – the effective shelf-life is less than one hour. Grayson Australia has developed a system which mixes the chemicals immediately before application to maximise the oxidising power of the solution.

Research has shown that using acidified sodium chlorite to sanitize beef trim reductions of 1.4-2.3 $\log_{10}$ *E. coli* were achieved depending on the feed rate of the spray.

Rockdale Beef Pty Ltd has commissioned Grayson Australia in conjunction with Argus Realcold to design a purpose-built spray cabinet for the application of acidified sodium chlorite (Vibrex™) and install it into the Yanco abattoir. With the treatment cabinet installed, Rockdale Beef asked Meat & Livestock Australia and Food Science Australia to participate in an investigation of acidified sodium chlorite as an in-line microbiological intervention for beef carcasses.

Two trials were conducted for the validation; one on 22nd May 2006 and the second on 25th May 2006. The validation involved the deliberate application of a cocktail of strains of *E. coli* that contained no known virulence markers for pathogenic *E. coli* and which, between them, have characteristics very similar to various known isolates of *E. coli* O157:H7. The culture was applied to localised areas of six beef sides and the reduction in *E. coli* numbers was measured through determination of counts prior to treatment with Vibrex™, immediately after spraying carcasses with Vibrex™, and after 24 hours of chilling.

There were no obvious visual changes in either colour or odour of the carcasses. No tests were conducted to assess changes to the taste of cooked meat but indications from published literature suggest this is highly unlikely.

The average overall reductions in numbers of *E. coli* for the two trials were 1.03 ($\pm$0.39 and 1.77 ($\pm$0.65) $\log_{10}$ units immediately following application and 3.44 ($\pm$0.94) and 3.54 ($\pm$0.55) $\log_{10}$ units after chilling. This overall result is a 99.9% reduction in *E. coli* numbers and was achieved using 1100 ppm Vibrex™ applied at a rate of approximately one litre of final solution per beef side.

Cost Benefit[1]

Capital	$ 30,000
Hot Water Saving ML pa	96.4
Operational Cost pa	$ 45,666
Saving pa	$ 51,025
Pay Back (years)	0.59

[1] 2006 figures

1.0 INTRODUCTION

An FSIS document '*E. coli* O157:H7 contamination of beef products' and accompanying guidance documents were published in the Federal Register in October 2002. *Inter alia*, they stated that beef slaughter establishments should consider interventions that can be validated and verified as CCPs for reducing or eliminating *E. coli* O157:H7.

Acidified sodium chlorite (ASC) is approved by the US Food and Drug Administration as a direct food additive to be used for decontamination of poultry and red meat carcasses, at concentrations between 500-1200 ppm (Code of Federal Regulations, 21CFR173.325). Sodium chlorite is listed as a permitted processing aid in the Australia and New Zealand Food Standards Code (Standard 1.3.3, Clause 14) for use as an antimicrobial agent for meat, fish, fruit and vegetables. An in-use concentration is not specified, but the maximum permitted residual level on the food product is the lowest concentration of chlorite, chlorate, chlorous acid and chlorine dioxide that can be qualitatively detected using a laboratory method (that is, its presence can be detected but not quantified).

In Australia, acidified sodium chlorite is marketed under various trade names including Vibrex™, distributed by Grayson Australia (www.tecnica.com.au) and distributed by Argus Realcold Pty Ltd.

The aim of the investigation was to generate in-plant information on the benefits of acidified sodium chlorite on beef sides. The investigation of this technology as a microbiological intervention would eventually lead to the validation of ASC systems for use on beef sides.

2.0 PROJECT AIM

1. Provide advice to Rockdale Beef on the appropriate residue testing methods and identify testing laboratories for the analytical procedures.

2. Evaluate the antimicrobial effect of acidified sodium chlorite on beef carcasses using *E. coli* challenge studies.

3.0 METHODS

3.1 Microbiological procedures

Test bacteria

1. A bacterial culture was prepared from a cocktail of five strains of *E. coli* (EC1604, EC1605, EC1606, EC1607, EC1608) that have been found by Food Science Australia (FSA) to contain no known virulence markers for pathogenic *E. coli* and which, between them, have characteristics very similar to various known isolates of *E. coli* O157:H7.
2. Broth cultures of each of the five strains were grown overnight at 37°C in tryptone soya broth (TSB). Equal volumes (1 mL) of the cultures were added to 300 mL of sterile TSB to give an inoculum containing around 10 million cfu per mL.
3. The broth culture was transferred to a sterile plastic screw-capped container. In turn this container was placed within a secure insulated container for transfer to the location on the slaughter floor where the test sides were treated.

Preparation and treatment of test carcasses

1. For each run, at least six sides were selected on the slaughter floor and tagged as test sides for application of the bacterial suspension.
2. Three sites were used for the evaluation – butt, flank, and brisket or as close to the ESAM sites as was accessible. For each of the sites on each test side, an area measuring approximately 30 cm x 10 cm was marked and painted with the mixed broth culture. Protective gloves were used and care taken to avoid runoff of the suspension to areas outside the test sites.

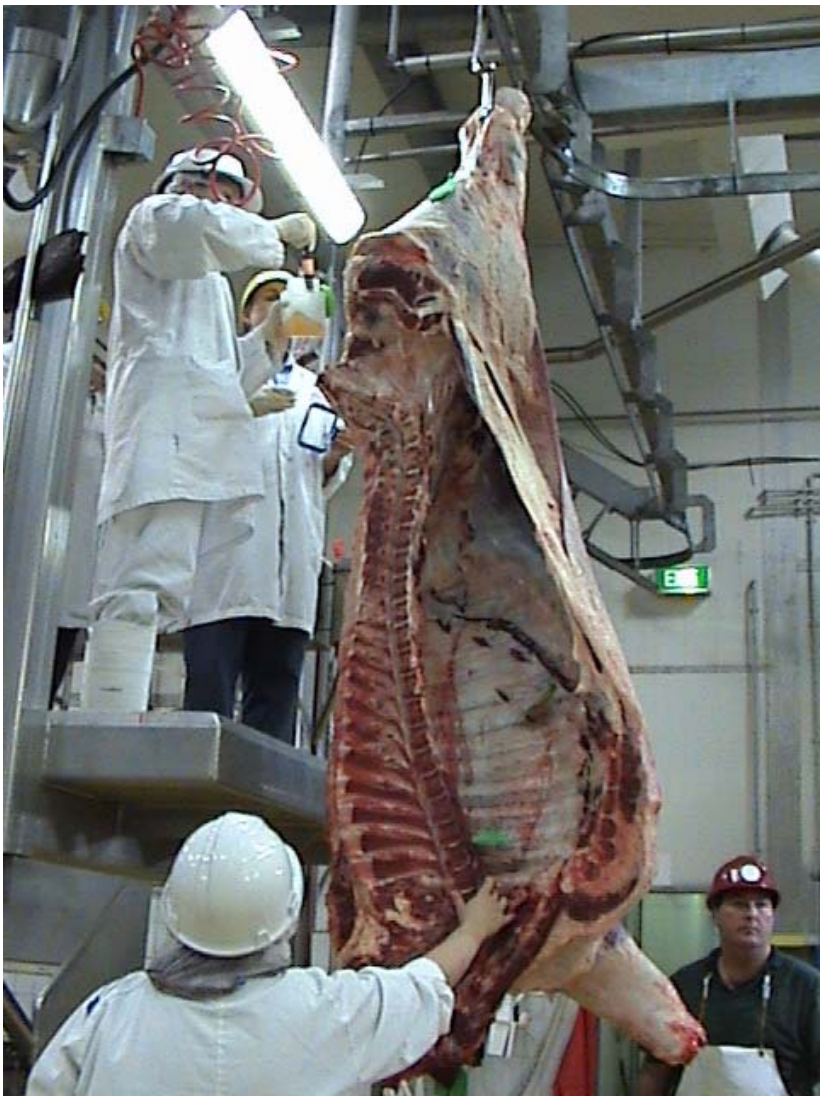

Figure 1 Inoculation of Carcases

3. The test carcasses were held for approximately 10-20 minutes to allow attachment of the bacteria to the painted surfaces and to simulate the interval between the first opportunity for contamination of meat surfaces and sides reaching the acidified sodium chlorite treatment station.

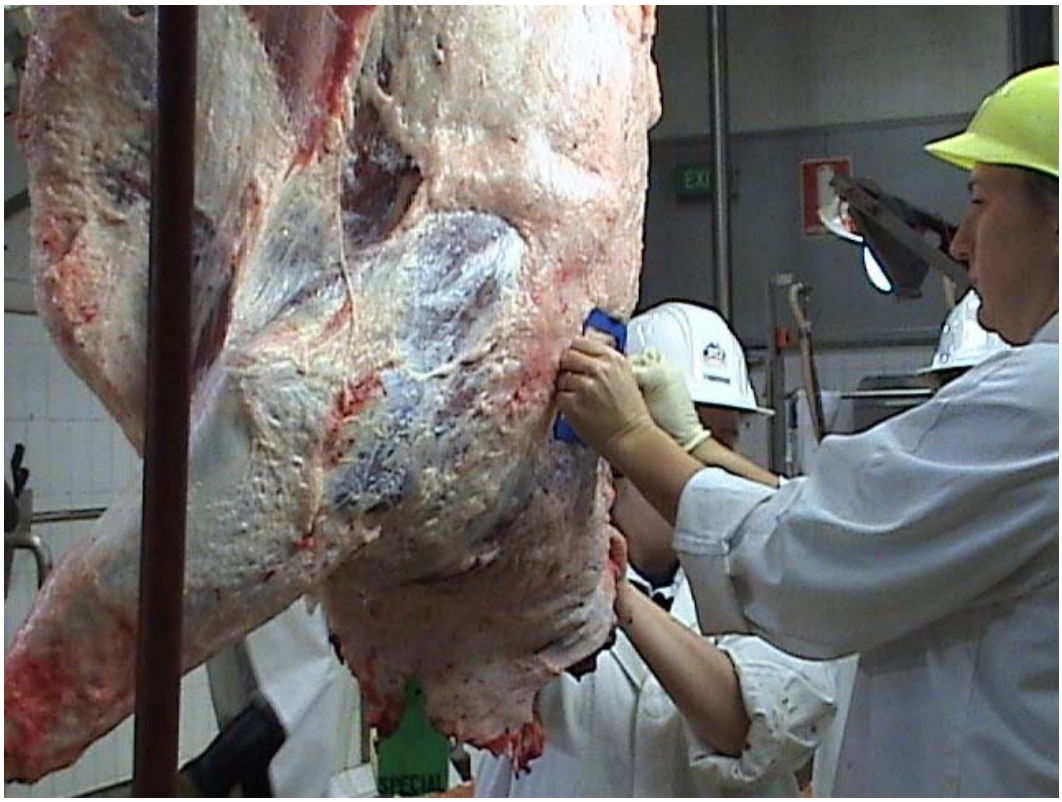

Figure 2 Primary Swabbing 10 minutes after inoculation

4. Prior to treatment areas were swabbed from each of the three sites for each of the six test sides, using the standard procedure as per AQIS Notice Meat 2003/06. Note: these three sites were swabbed as a composite sample, instead of three separate sites – to give a total area of 300 cm^2.
5. Care was taken to note the precise location sampled within the marked area so that after treatment and again after chilling, adjacent areas could be sampled.
6. The test carcasses were sprayed with acidified sodium chlorite solution using the spray cabinet modified by Argus Realcold and that will be used for continued operation if Vibrex™ is approved for use in the Rockdale plant. Grayson staff assisted Rockdale staff with preparation of the intervention solutions to the agreed use concentrations (around 1200 ppm) and with operation of the cabinet.
7. Immediately after treatment, the three sites were again sampled for each of the six carcasses, with care being taken to sample locations adjacent to that sampled for the pre-Vibrex™ treatment.
8. The test carcasses were located together in a chiller separate to non-treated carcasses, as was required by AQIS (i.e. treated product isolated from normal export product).
9. After the test carcasses were chilled overnight, the three sites were again sampled for each of the six carcasses.

Test sides were trimmed (see 'General precautions' below) and further swab samples were taken for testing for *E. coli*.

Microbiological testing

1. The samples were tested for *E. coli* and Aerobic Plate Count (APC) using *E. coli* Petrifilm and Total Aerobic Petrifilm respectively, following the ESAM test procedures specified in AQIS Notice Meat 2003/06.
2. For *E. coli*, 1 mL aliquots of appropriate dilutions were inoculated onto Petrifilm in duplicate and incubated at 35°C for 48 h.
3. For total counts, aliquots of appropriate serial dilutions were inoculated onto Total Aerobic Petrifilm. The plates were incubated for 3 days at 25°C.
4. The counts were expressed as $\log_{10}$ units.
5. Taking the *E. coli* counts for the test sides, the averages and standard deviations were calculated for the:
    i. samples taken from untreated sides;
    ii. samples from the sides shortly after treatment;
    iii. samples taken after chilling.

   The differences between the averages indicate the reductions, in log units, in the numbers of *E. coli*. This was done for each site and also overall for the three sites tested.
6. Taking the total counts for the six test sides, the averages and standard deviations were calculated for the:
    i. samples taken from untreated sides;
    ii. samples from the sides shortly after treatment;
    iii. samples taken after chilling.

General precautions

1. Great care was taken to avoid any cross-contamination between test carcasses and others on the slaughter floor, during transfer to, and within the chiller.
2. The painted areas of chilled test carcasses and surrounding areas were thoroughly trimmed after the third (post-chilling) sampling had been completed. Swab samples were taken adjacent to and below each trimmed area and tested for *E. coli*.
3. The test sides were retained until the (slaughter floor) test results indicated that they no longer carried excessive numbers of *E. coli*, at which time they were released for normal boning.

3.2 Chemical procedures

Four meat tissue samples were collected 24 hours after chilling from carcasses two weeks prior to the microbial inoculation trials; two were from hot water treated carcasses and two from Vibrex™ treated carcasses. None of these carcasses were inoculated with the *E. coli* suspension.

During the microbial inoculation trials, four meat tissue samples were collected after 24 hours chilling – two from each of the two trial days. Tissue, area 10 cm x10 cm and depth 5 mm, was excised from the surface of the treated, beef carcass sites, using a sterile knife. The samples were placed in individual, labelled, sealed plastic bags and frozen. Samples were sent overnight to the testing laboratory (Levay & Co. Environmental Services, Ian Wark Research Institute, University of South Australia) and tested for chlorite and chlorate using ion chromatography (Method *IC-2*) assay.

The modified ion chromatography method involved sample preparation, which included water extraction of the meat sample, followed by clean-up of the water extract to remove any material such as proteins which may have interfered with the analysis. As part of the quality control, measurements of the standards (spiked blank recovery) to validate the chromatographic method and measurements of recovery of each analyte from a spiked sample (spiked recovery) were included. The spiked samples were taken through the full method, including sample storage, extraction and chromatographic analysis.

4.0 RESULTS

The cattle breed used was an Angus/Hereford cross, grain-fed for the domestic market and slaughtered at 24-30 months of age.

Two trials were conducted to assess the microbial efficacy of acidified sodium chlorite as a carcass wash; one on 22 May 2006 and another on 25 May 2006.

4.1 Microbial efficacy

The internal cavity of each beef side routinely received a cold-water spray before it passed into the spray cabinet where Vibrex™ was applied. It was not possible to turn the cold water spray off; therefore, to test the microbial efficacy of acidified sodium chlorite alone, only the external surface of each beef side was inoculated with the bacteria (that is, there would be no 'wetting' of the beef sides where the surface was inoculated, before application of the Vibrex™). Consequently, the total microbial reduction achieved was a result of the Vibrex™ sprays applied to the surface, and not affected by sluicing of the carcass with the cold water spray.

Tables 1 and 2 summarise the results of trial 1 and trial 2 respectively. The average reduction in the numbers of *E. coli* from the first trial immediately after application of the Vibrex™ was 1.03 $\log_{10}$ units and the total reduction after 24 hours of chilling was 3.44 $\log_{10}$ units. In the second trial, an initial reduction of 1.77 $\log_{10}$ units was achieved and a total reduction of 3.54 $\log_{10}$ units after chilling.

Subsequent swabbing indicated that the microbial inoculation procedure followed caused no contamination outside the delineated target area (data not shown), and product was released for boning and distribution to the domestic market.

Table 1. Microbial counts on beef sides before and after spray washing using acidified sodium chlorite, and after chilling.

Test	Pre-Vibrex		Post-Vibrex		Post-Chill		Initial Reduction[a]		Total Reduction[b]	
	Log *E.coli*	Log APC	Log *E.coli*	Log APC	Log *E.coli*	Log APC	Log *E.coli*	Log APC	Log *E.coli*	Log APC
1	4.20	4.36	3.23	3.40	2.20	2.76	0.97	0.96	2.00	1.60
2	3.74	3.80	3.00	4.18	0.52	1.08	0.74	-0.38	3.22	2.72
3	3.79	3.89	2.36	2.84	0.57	1.11	1.42	1.05	3.22	2.78
4	3.65	3.81	3.18	3.51	0.32	1.96	0.48	0.30	3.33	1.85
5	3.88	4.00	2.76	3.04	-0.19	0.30	1.12	0.96	4.07	3.70
6	3.88	4.04	2.40	2.58	-0.92	0.23	1.48	1.46	4.80	3.81
Average	**3.86**	**3.98**	**2.82**	**3.26**	**0.42**	**1.24**	**1.03**	**0.73**	**3.44**	**2.74**
SD	**0.19**	**0.21**	**0.38**	**0.57**	**1.04**	**0.98**	**0.39**	**0.66**	**0.94**	**0.91**

a Reduction achieved by Vibrex™ alone

b Reduction achieved from Vibrex™ and 24 hours of chilling.

Table 2. Microbial counts on beef sides before and after spray washing using acidified sodium chlorite, and after chilling.

Test	Pre-Vibrex		Post-Vibrex		Post-Chill		Initial Reduction[a]		Total Reduction[b]	
	Log *E.coli*	Log APC	Log *E.coli*	Log APC	Log *E.coli*	Log APC	Log *E.coli*	Log APC	Log *E.coli*	Log APC
1	3.94	4.04	2.56	2.76	0.34	0.63	1.39	1.28	3.60	3.41
2	3.90	3.96	2.11	2.20	-0.49	-0.02	1.79	1.75	4.40	3.98
3	3.90	4.00	2.23	2.45	0.73	1.43	1.67	1.55	3.17	2.56
4	3.71	3.94	0.83	0.89	-0.06	0.20	2.88	3.06	3.76	3.74
5	3.76	3.87	1.79	2.04	0.20	0.54	1.97	1.83	3.56	3.33
6	3.73	3.84	2.79	2.93	0.96	1.32	0.95	0.90	2.77	2.52
Average	**3.83**	**3.94**	**2.05**	**2.21**	**0.28**	**0.69**	**1.77**	**1.73**	**3.54**	**3.26**
SD	**0.10**	**0.08**	**0.69**	**0.73**	**0.53**	**0.58**	**0.65**	**0.73**	**0.55**	**0.60**

a Reduction achieved by Vibrex™ alone

b Reduction achieved from Vibrex™ and 24 hours of chilling.

4.2 In-use concentration of acidified sodium chlorite (ASC)

The concentration of the chemical solution (acidified sodium chlorite) used was monitored during operation of the wash cabinet by titration, pH and oxidation reduction potential (ORP). Levels were monitored every 5 minutes by Grayson Australia (Table 3).

The volumes of chemicals used were 24 mL Vibrex™ and approximately 20 mL of citric acid per beef side, applied in approximately 1 L of final solution per side.

Figure 3 Vibrex Chemistry

Carcass fat and lean appeared slightly bleached directly following treatment, but not noticeably more than occurs with the current hot water wash system. This bleaching disappeared after 24 hours chilling.

Table 3. Monitoring parameters for Vibrex™ during operation on trial 1 and trial 2.

Time (min)	Trial 1			Trial 2		
	Titration (ppm)	**pH**	**ORP[a]**	**Titration (ppm)**	**pH**	**ORP**
0	1100	2.45 – 2.35[b]	~720	1150	2.5	681
5	1051			1110	2.42	678
10				1112	2.37	677
15	1105			1140	2.36	675
20	1120			1134	2.36	674
25	1100			1147	2.36	678
30	1126			1147	2.38	680
35	1107			1150	2.38	681
40	1148			1150	2.38	681
45					2.37	681
50				1155	2.37	681
55					2.36	680
60				1155	2.36	677
65				1155	2.36	674
70				1160	2.37	673
75				1160	2.39	670
Average:	**1107**			**1157**	**2.38**	**678**

a Oxidation-reduction potential
b Average range monitored for trial 1 by Grayson Australia.

4.3 Chemical residue analysis

A total of eight meat tissue samples were sent for chemical analysis for chlorite and chlorate. The first two samples were excised from hot water treated carcasses (data not shown), the next two were from Vibrex™ treated carcasses (data not shown). The next four samples were from *E. coli*-inoculated, Vibrex™-treated carcasses (Table 4).

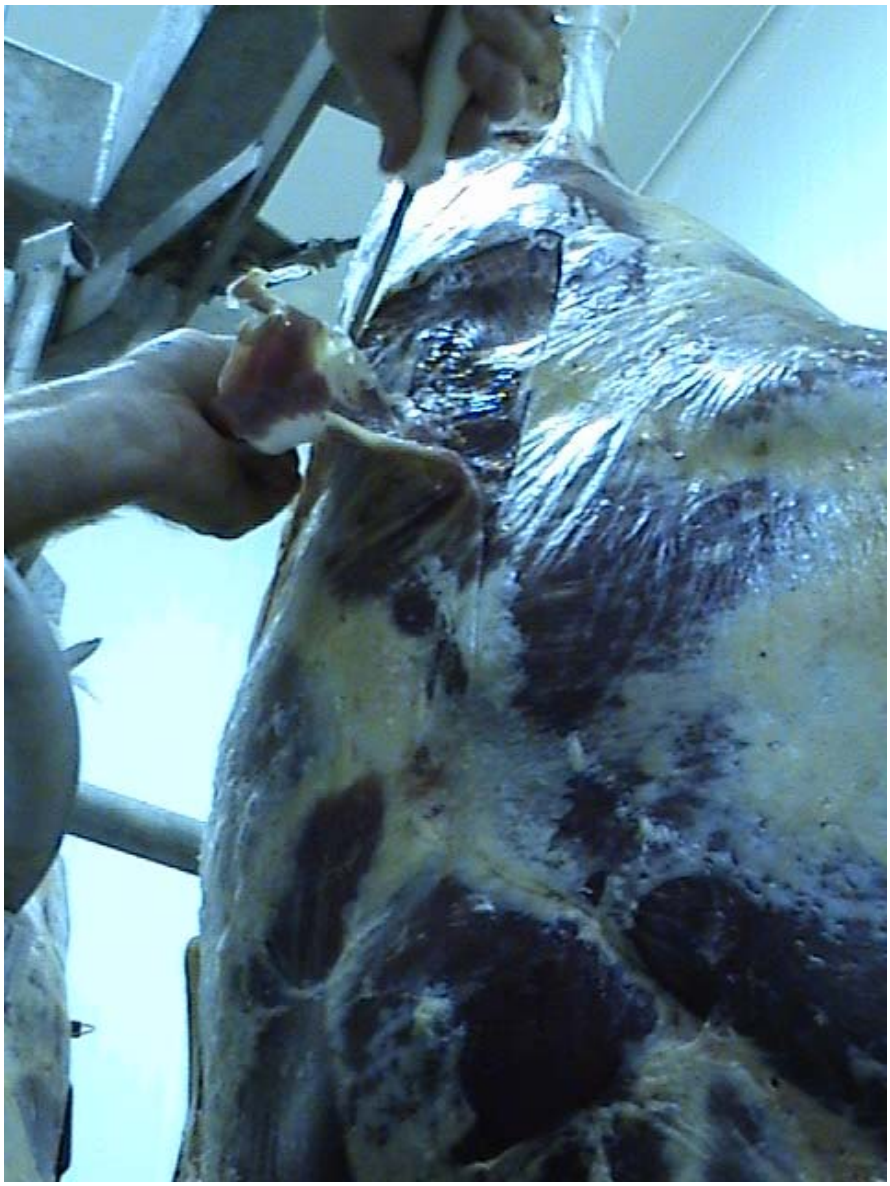

Figure 4 Sampling carcase surface for residue testing

Chlorite and chlorate concentrations were below the level of detection using the modified ion chromatography procedure for all meat tissue samples tested in this study.

Table 4. Analysis of chlorite and chlorate in meat trimmings by ion chromatography (Method IC-2) for samples collected in trial 1 and trial 2.

Sample	Chlorite (mg/kg wet wt)	Chlorate (mg/kg wet wt)
Trial 1 - Beef tissue 1	< 1.0	< 2.0
Trial 1 - Beef tissue 2	< 1.0	< 2.0
Trial 2 - Beef tissue 1	< 1.0	< 2.0
Trial 2 - Beef tissue 2	< 1.0	< 2.0
Detection Limit	1.0	2.0
Blank[a]	<1.0	<2.0
Spiked blank recovery[b]	98%	102%
Spiked recovery[c]	0%	97%

[a] Blank – water only
[b] Known quantity of the analyte (chlorite or chlorate) added to the blank
[c] Known quantity of the analyte (chlorite or chlorate) added to the meat tissue sample

4.4 Suitability of wash cabinet design

In conjunction with trial 2, a seventh beef side was inoculated on three sites – one high up on the rump near the bung (site 1: external surface), one on the diaphragm/ribs (site 2: internal surface/cavity) and one on the neck (site 3: external surface with lots of tissue folds). These sites were all swabbed separately. This was to test whether the sprays covered all areas of the carcass. The inoculated sites of this side were only sampled prior to the Vibrex™ treatment and after 24 hour chilling; they were not sampled immediately after the Vibrex™ spray treatment (Table 5). Only the diaphragm/ribs site (internal cavity) received the cold water spray, prior to application of the Vibrex™ spray.

Table 5. Microbial counts on a single beef side at three locations before spray washing using acidified sodium chlorite, and after chilling.

Test site	Log_{10} bacteria/cm^2				Total Reduction	
	Pre-Vibrex™		Post-Chill			
	E. coli	TPC	*E. coli*	TPC	*E. coli*	TPC
1. Butt	3.81	3.11	0.00	0.26	3.81	2.86
2. Rib	3.79	3.95	0.46	1.23	3.33	2.72
3. Neck	3.82	4.00	0.49	1.99	3.33	2.00
Average	**3.81**	**3.69**	**0.32**	**1.16**	**3.49**	**2.53**
SD	**0.01**	**0.50**	**0.28**	**0.87**	**0.28**	**0.46**

5.0 *DISCUSSION*

5.1 Antimicrobial efficacy

Hot water as an intervention step has been extensively researched and a number of automated cabinet designs are in use around the world. Sheep and beef sides are treated for up to around 15 seconds with 75-95°C water, with reductions of up to 3 $\log_{10}$ of pathogenic and spoilage bacteria being reported. Sprays of 95°C for 5 seconds at 165 kPa from 12.5 cm gave reductions of up to 3 $\log_{10}$ in total coliforms, thermotolerant coliforms, *Salmonella* Typhimurium and *E. coli* O157:H7 (Huffman 2002), but maintaining such a high delivery temperature is not easy and may not be an efficient use of energy.

Rockdale Beef currently uses hot water as a decontamination procedure for carcasses, the water used in the cabinet being recirculated after undergoing a holding and treatment time. However, there is a concern that contamination from this recirculated water may be an issue in the future. In addition, hot water spraying may not achieve the desired temperature at the contact surface of some parts of the sides, and may generate condensate and aerosols. Therefore the company wanted to investigate an alternative procedure. It was determined that acidified sodium chlorite may be suitable for such purposes.

The antimicrobial activity of acidified sodium chlorite is attributed to the oxidative effect of chlorous acid, which is derived from the conversion of chlorite ion into its acid form under acidic conditions. The reactions happen instantly on mixing the sodium chlorite with an acid (e.g. citric or phosphoric acid) and therefore the antibacterial solution needs to be prepared shortly before spraying – the effective shelf-life is less than one hour. Grayson Australia has developed a system which mixes the chemicals immediately before application to maximise the oxidising power of the solution. It is claimed the method of activation (i.e. type of acid used), the method of application (e.g. type of sprays), and the contact time with the meat surface are strong influences on the success of this microbial inhibitor.

Research using acidified sodium chlorite to sanitize beef trim achieved reductions of 1.4-2.3 $\log_{10}$ *E. coli* depending on the feed rate of the spray. There is evidence to suggest that ASC may be a long-acting microbial inhibitor and may be suitable for pre-packaged meat. Bosilevac *et al.* (2004) recently published results using a 300 ppm ASC treatment that reduced total microbial counts by 1.0-1.5 $\log_{10}$ and maintained desirable organoleptic qualities of the ground beef. Some studies have demonstrated a 1.9 – 2.3 $\log_{10}$ reduction in *Salmonella* and *E. coli* O157 on beef carcass tissue using a wash or spray of sodium chlorite acidified with lactic acid (Ransom et al 2003). One laboratory trial showed up to 4.6 $\log_{10}$ reduction in *E. coli* O157:H7 and *Salmonella* using a water wash followed by an acidified sodium chlorite spray (1200 ppm) in a model cabinet produced by Chad Company (Castillo *et al*., 1999). The temperature of the water wash was not mentioned. Other studies indicate limited success (Gill and Badoni 2004).

In the current investigation a total of 12 sides were tested over two separate days. The average reduction from these two trials was 3.49 $\log_{10}$ *E. coli*/cm^2 (±0.74). The reduction in *E. coli* was at its best, at least 4 $\log_{10}$, and at the lower end of the scale, greater than 2.5 $\log_{10}$. This is a significant (P<0.001) reduction in bacteria.

In trial 1, test side 1, the total reduction for this side was only 2 $\log_{10}$ units (Table 1). This was the first side through the cabinet. Unfortunately, the pH was not monitored consistently during trial 1 (Table 3). Grayson staff reported that the pH for treatment of the first carcass was not at the optimal level (i.e. around 2.5) and this may account for the lower overall reduction achieved. There is likely to be a synergistic effect of the Vibrex™ treatment and air-drying of the carcass surface during chilling, due to sub-lethal injury of cells during Vibrex™ treatment rendering them more susceptible to desiccation. Thus, if the pH was not optimal, the total reduction after chilling may be limited as fewer cells will be injured after the Vibrex™ treatment. Consequently, for trial 2, the cabinet was operated for one hour before the carcasses were treated and the pH was strictly monitored (Table 3). The results showed that the initial reductions achieved using the Vibrex™ were better than in trial 1; however, this did not greatly effect the total reductions achieved for trial 1 and trial 2.

The beef sides were held in the retain chiller as opposed to using the larger chillers. This was to minimise the potential for the loss of control of treated product and to reduce the potential for

contamination of adjacent beef sides i.e. if workers were to push carcasses against each other while loading non-treated product. The temperature profile of the retain chiller was monitored as were the surface and deep butt temperatures of the treated product (data not shown). The temperature in the retain chiller was not significantly different from that of other chillers used in normal operation, because the chiller was effectively at full capacity with the test beef sides. The temperature profile for the test beef sides showed that the surface was chilled to 7˚C in 7 hours; this is a similar temperature profile to the larger chillers i.e. time to 7˚C is between 7-8 hours. However, it is noted that the surface air drying in the retain chiller may be more effective at inactivating Vibrex-injured cells than what may occur in a larger chiller.

5.2 Chemical residues

Sodium chlorite may be used as a processing aid in meat production, providing that residual chlorite, chlorate, chlorous acid and chlorine dioxide cannot be quantified in the final product (Food Standards Code, Standard 1.3.3, Clause 14). During the two trials, the carcasses were treated with Vibrex™ at an average level of 1100 ppm. Untreated meat tissue samples showed no detectable levels of chlorate (data not shown). This is expected because the "natural" level of chlorate in beef tissue should be zero as this analyte is not a nutrient for cattle and there are no natural sources to which the animals are likely to be exposed.

Chlorous acid and chlorine dioxide were not included in the analyses as these compounds readily oxidise with air and are difficult to detect even immediately after the reaction. Considering that the meat tissue was excised 24 hours after treatment with the Vibrex™ chemical, and the samples were then transported frozen to the laboratory, it is even more unlikely to detect chlorine dioxide or chlorous acid residues.

As yet, there is no standard method (Australian nor international) for testing chlorite and chlorate in meat tissue. Using the modified ion chromatography procedure in this study, the spiked meat samples (Table 4) showed recoveries of 0% for chlorite and 97% for chlorate. Chlorite is a particularly unstable compound, and rapidly decomposes, thus, it is not unexpected that it could not be recovered.

5.3 Suitability of wash cabinet design

The suitability of the current spray positions in the cabinet were assessed by inoculating 3 sites with the *E. coli* inoculum – site 1 was in the internal cavity near the diaphragm, site 2 was high on the rump near the perineum, and site 3 was on the neck. The microbial reductions were 3.81 on the butt (site 1), 3.79 on the rib (site 2) and 3.82 $\log_{10}$ units on the neck (site 3). These individual reductions are equivalent to that achieved for the other 12 test sides where the *E. coli* culture was applied near the ESAM sites, and indicate that there is a reasonable coverage of Vibrex™ over the carcass under the current spray system. Interestingly, site 1 (the internal cavity), which additionally received the cold water spray before the Vibrex™ solution was applied, did not have a greater reduction than was achieved at the other two sites (site 2 and site 3).

The system as it is currently installed allows the solution to be monitored for concentration (ppm of Vibrex™), pH and ORP. Running of the cabinet for over an hour (Table 3) showed no large fluctuation in these readings, but it is recommended that Rockdale monitors levels over an entire shift to observe any fluctuations.

6.0 CONCLUSIONS AND RECOMMENDATION

Vibrex™ had an initial effect on the microbial numbers after treatment, causing at least 1 $\log_{10}$ reduction in *E. coli* and there was a further reduction achieved in combination with surface drying during chilling to produce a total reduction of 3.5 $\log_{10}$ *E. coli.*

The microbial reductions were achieved using a solution of 1100 ppm acidified sodium chlorite. The achievable microbial reduction if a reduced concentration (say 800 ppm) were to be used, was not determined during this evaluation. If it is decided to nominate a use concentration other than 1100 ppm in the application to AQIS, it is recommended that its microbial efficacy be verified.

There were no obvious visual changes in either colour or odour of the carcasses. No tests were conducted to assess changes to the taste of cooked meat but indications from the literature suggest this is highly unlikely (Bosilevac *et al*., 2004; Schneider, *et al*., 2002).

The spray cabinet as it is currently operated does not need to be modified further. At present, hot water is being used in the cabinet. If Vibrex™ is approved for use by AQIS for export product, the only change will be to pipe the Vibrex™ solution through the cabinet instead of the hot water - as was done temporarily for the two trials. The cold water spray that is routinely applied to the internal cavity of the beef side before spraying, will continue to be used as this additionally targets any contamination that may occur during the evisceration process.

There is benefit in applying acidified sodium chlorite to reduce the numbers of *E. coli* on carcasses. The 3.5 average log reduction achieved in this evaluation is a 99.9% reduction.

7.0 Design

The existing hot water decontamination cabinet was used as a framework for the installation of a fine spray system designed to optimise the coverage of the carcase. The side travels through the cabinet in approximately 90 seconds and the desired delivery per carcase was 1 - 1.5 L of Vibrex ™.

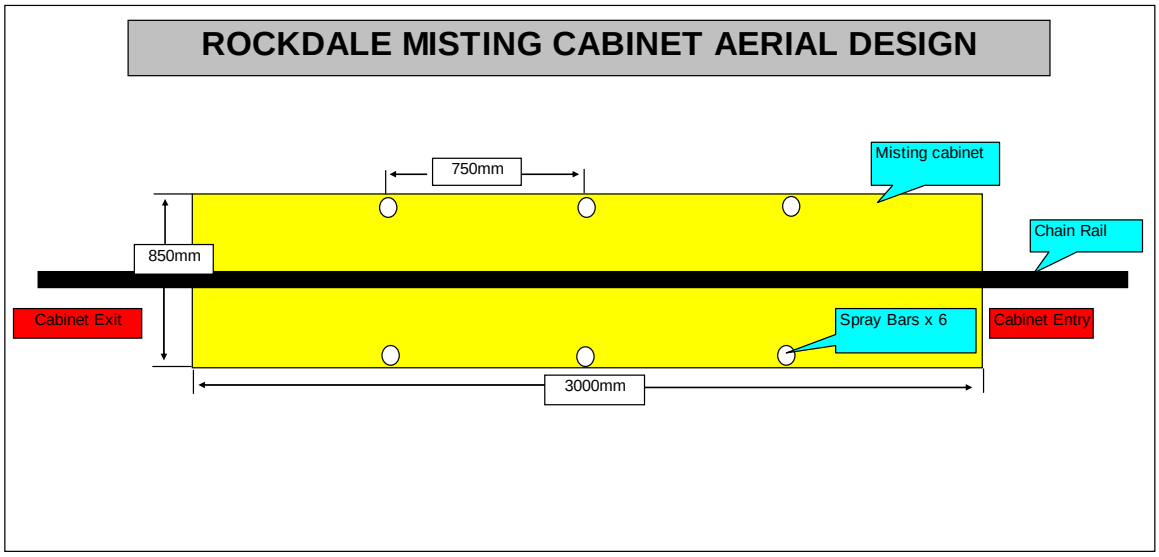

Figure 5 Plan View of Spray Cabinet

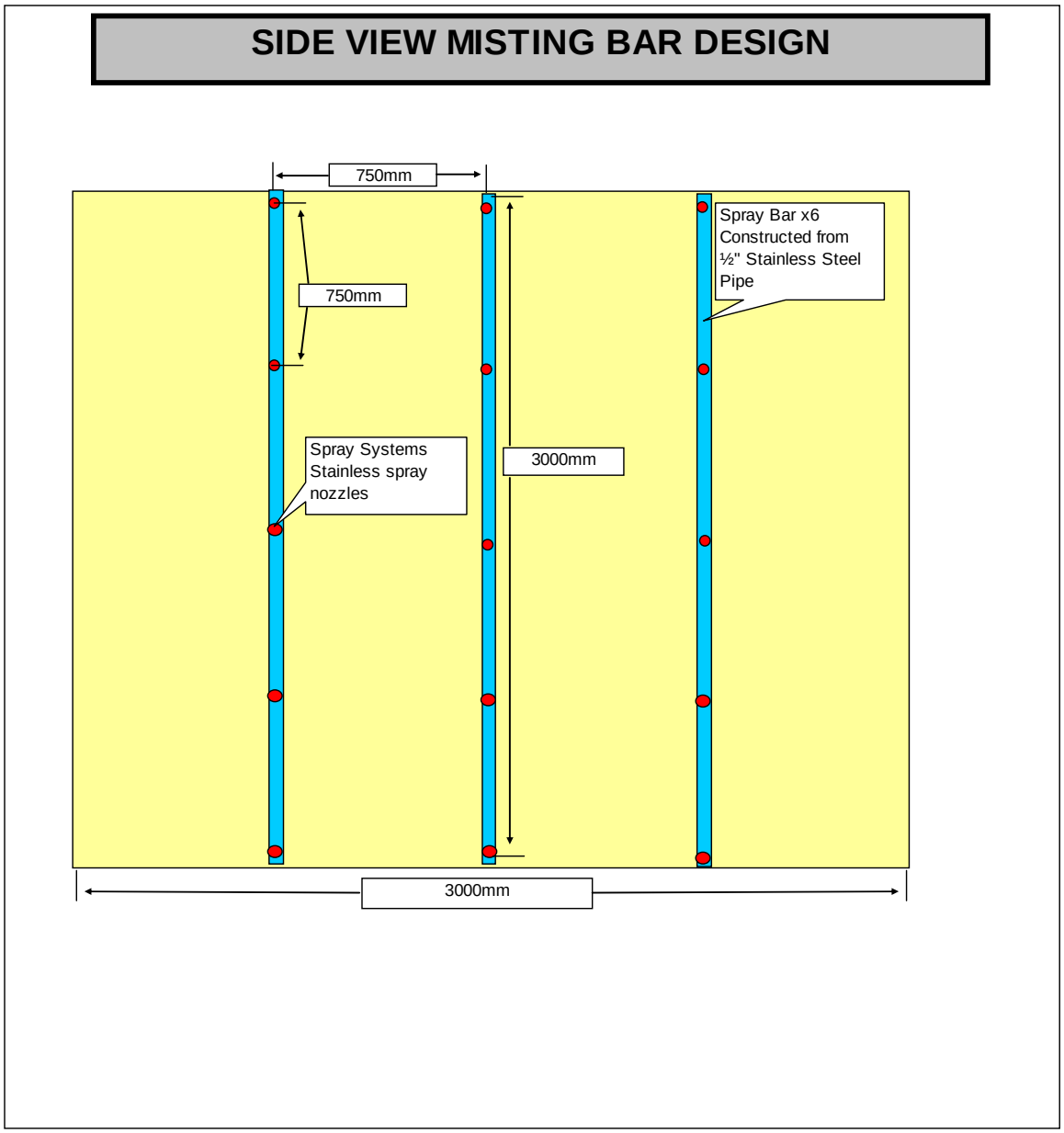

Figure 6 Lateral View of Spray Cabinet

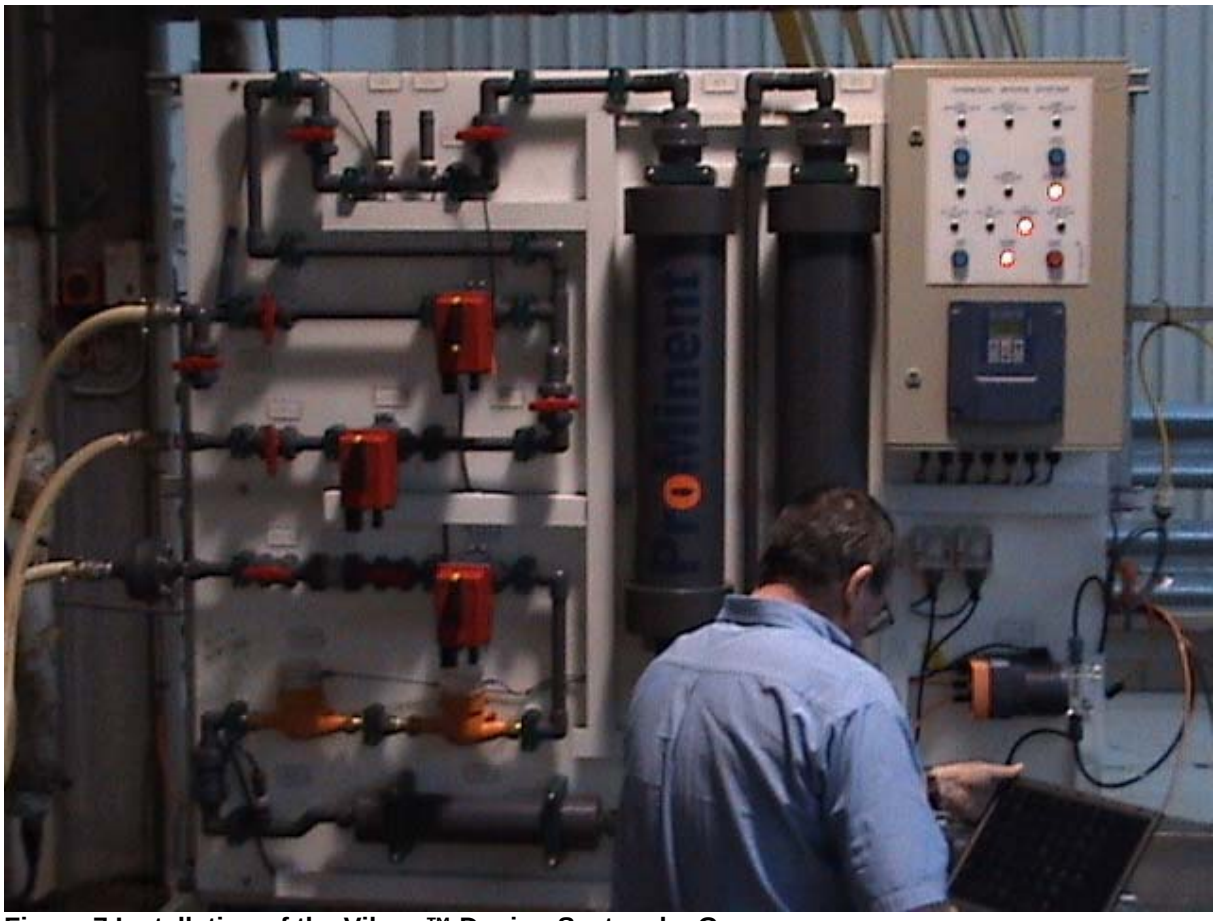

Figure 7 Installation of the Vibrex™ Dosing System by Grayson

8.0 Cost Benefit

	Hot Water (Rockdale)	**Vibrex (Acidified Sodium Chlorite)**
Kill Rate (*E.coli* 0157:H7)	2-3 logs	3-4 logs
Application Concentrations	0	1200 ppm
Temperature	80 degrees	Room temp
Time	90 seconds	60 seconds
Hot Water (L/Carcase)	589	0
Cold Water (L/Carcase)	0	2
Cost Per Carcase (c')	58.9	32.0
Capital Cost	$ -	$30,000
OHS	Potential for scalding	May cause irritation to skin and eyes at higher concentrations
Carcase residue	Nil	Nil - as determined
Carcase damage	Minor discolouration - reversible	Nil - as determined
Australia	Approved	Approved
Japan	Approved	Not Known
US	Approved	Approved
Other	Approved	Not Known
Other disadvantages	Increase load on boiler, raises surface temperature of carcase, additional condensation in kill floor and chillers	Perception that this is a chlorous acid treatment. Unit requires monitoring on Citect to ensure correct dosing
Other advantages	Very easy to monitor, perceived as safe	No problems with effluent. Does not discolour equipment or cause corrosion. Kills a wide range of organisms including insects, fungi, algae, and viruses
Hot Water ML pa	96.7	0.0
Hot water $/ML	$ 1,000	$ 1,000
Cold Water ML pa	0.0	0.3
Cold Water $/ML	$ 200	$ 200
Chemical $/side	$ -	$ 0.38
Chemical $/pa	$ -	$ 45,600
Water Saving pa	0.0	96.4
Cost pa	$ 96,690	$ 45,666
Saving pa	$ -	$ 51,025
Capital	$ -	$ 30,000
Pay Back (years)	-	0.59

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