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Salmonella in Manufacturing Beef Survey

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Abstract

The Food Safety Inspection Service (FSIS) released a notice of its intention to test all beef trim samples for *Salmonella* in addition to testing for the presence of STEC serogroups (*E. coli* O157 and the other Big 6) of interest to FSIS. A survey of Australian manufacturing beef was conducted to estimate the prevalence of *Salmonella*. A total of 1255 manufacturing beef samples was tested for *Salmonella* using the BAX method for screening as per the US FSIS method (MLG 4C.02), and AS 5013.10 for confirmation. The confirmed positive samples were enumerated for the concentration of *Salmonella* using the MPN method, and serotyping was also carried out. There were 9 confirmed *Salmonella* positive samples which translates to a national prevalence rate of 0.7% *Salmonella* in manufacturing beef. The *Salmonella* prevalence in manufacturing beef varied between Australian states with NSW (n=187) at 0.5%, QLD (n=583) at 0.5%, SA (n=80) at 0.0%, TAS (n=79) at 1.3%, VIC (n=325) at 1.2%, and WA (n=1) at 0.0%. *Salmonella* prevalence from Cow/Bull samples (1.5%, n=412) was almost 4 times higher than that from Steer/Heifer samples (0.4%, n=742). Serotyping confirmed the *Salmonella* were *Salmonella* Chailey*, Salmonella* Reading, *Salmonella* Agona*, Salmonella* Jangwani*, Salmonella* Zanzibar*, Salmonella* Orion*, Salmonella* Anatum var 15+*, and Salmonella* Anatum. None of these serotypes are included in the US list of top 4-6 *Salmonella* serotypes of major concern. Indicator tests for TVC, *E. coli* and coliforms were also conducted. The national average was 2.26 log cfu/g, and prevalence of *E. coli* and coliforms was 4.2% and 14.5% respectively. It appeared that there was no correlation between the presence of *Salmonella* and the indicator microorganisms. The data in this survey demonstrated a high standard of hygienic quality in Australian manufactruing beef.

Executive Summary

Background

The Food Safety Inspection Service (FSIS) has released a notice of its intention to test all beef trim samples collected for *Salmonella* in addition to testing for the presence of STEC serogroups (*E. coli* O157 and the other Big 6) of interest to FSIS.

The Australian meat industry needs to be able provide data to the US FSIS and customers to support its position in the market, to understand risks and direct potential risk management actions.

To demonstrate the hygienic quality of meat processing to the US and other importing countries, a microbiological survey of meat processed in Australia was conducted. This survey was therefore conducted to respond to a change in regulatory testing that has been implemented in the US for beef trim.

Objectives

The objectives of this project were to:

1. estimate the prevalence of *Salmonella* in Australian manufacturing beef using the FSIS recommended Bax screening method;
2. determine whether there is a correlation between the presence of *Salmonella* and indicator microorganisms in manufacturing beef.

Methods

Sampling: A total of 1255 samples was submitted to Symbio Alliance laboratories from 31 participating export accredited meat processors around Australia. The N-60 sampling procedure was applied to collect surface slices to achieve approximately 500g of surface slices collected in a single bag, with 375g used for the Salmonella Bax test and the remaining sample (~125g) used for indicator tests and a portion retained for quantifying the *Salmonella* if the sample was found to be positive. The samples were shipped to Symbio Alliance laboratories following the requirements of the Meat Notice 2003/06 Revised ESAM Program.

Testing:

1. Using MLG 4C.02 BAX system for *Salmonella* screening, and MLG 4C.07 (MLG Appendix 4.07) or AS 5013.10 for confirmation.
2. Using MPN method to enumerate *Salmonella*-positive samples to determine the *Salmonella* concentration (MLG Appendix 2.03)
3. Serotyping of *Salmonella*
4. TVC, *E. coli* and coliforms were tested by DA approved methods

Findings: The estimated prevalence of *Salmonella* in Australian manufacturing beef was 0.7%. All 9 potential positive samples in the BAX screening step were confirmed to be positive, which showed reliability of the BAX screening method for *Salmonella* detection. The *Salmonella* concentration was low (< 0.3 MPN/g) in all 9 positive samples. Serotyping confirmed the *Salmonella* were *Salmonella* Zanzibar*, Salmonella* Reading*, Salmonella* Chailey, *Salmonella* Agona, *Salmonella* Orion*, Salmonella* Anatum var 15+, *Salmonella* Jangwani*, and Salmonella* Anatum. The TVC, *E. coli* and coliform counts did not appear to have correlation with the presence of *Salmonella*.

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1 Background

The Food Safety Inspection Service (FSIS) has released a notice of its intention to test all beef trim samples collected for *Salmonella* in addition to testing for the presence of STEC serogroups (*E. coli* O157 and the other Big 6) of interest to FSIS.

The Australian industry needs to be able to provide data to the US FSIS and customers to support its position in the market, to understand risks and direct potential risk management actions.

To demonstrate the hygienic quality of Australian manufacturing beef trim to the US and other importing countries, a microbiological survey of meat processed in Australia was conducted. This survey was therefore conducted to respond to a change in regulatory testing that has been implemented in the US for beef trim.

2 Projective Objectives

The objectives of this project were to:

1. estimate the prevalence of *Salmonella* in Australian manufacturing beef using the FSIS recommended Bax screening method;
2. determine whether there is a correlation between the presence of *Salmonella* and indicator microorganisms in manufacturing beef.

3 Methodology

Sampling

Australian beef processing establishments approved to export to the US were invited to participate and all that volunteered were included in the study. Sample numbers requested from each participant were based, pro rata, on estimated carcase throughput.

A total of 1255 samples was sent for testing from export meat processors around Australia over approximately a one year period in order to account for seasonal variations. The samples were collected in the boning room from cartons of manufacturing beef. Samples consisted of 500g of surface slices or small grab pieces (5-10g each) across a number of cartons, collected the N-60 sampling regime. Samples were placed in a plastic bag, sealed and labelled with date, location, cattle raising system and class of animal noted on the paperwork. Samples were shipped to the Symbio Alliance laboratories at refrigerator temperature at 0 to 10°C (samples were not accepted if frozen), following the requirements of the AQIS Meat Notice 2003/06 Revised ESAM Program.

***Salmonella* testing**

A sample of 375g (which was used to match the Big 6 STEC testing sample size) was sub-sampled from the approximately 500g submitted bulk sample for *Salmonella* testing, and the remaining sample (~ 125g) was used for indicator tests and a portion retained for quantifying the *Salmonella* if sample was found positive (using Most Probable Number method).

The 375g sample was then prepared by modified MLG 4.07 method for *Salmonella* screening using MLG 4C.02 (BAX system) and for confirmation using MLG 4.07 (MLG Appendix 4.07) and AS 5013.10. The detection of *Salmonella* included the following steps: a 1:4 dilution of the sample was enriched in mTSB at 42 ± 1°C for 15 to 24 hours. *Salmonella* was screened using polymerase chain reaction (PCR) technology using the BAX system. Where screen test results were BAX-positive, the enrichment was then tested using AS 5013.10 to confirm for *Salmonella*.

If detected, a portion of the retain sample was tested using the Most Probable Number (MPN) method (a procedure to estimate the population density of viable microorganisms in a test sample) to determine *Salmonella* concentration (MLG Appendix 2.03).

For all positive detections of *Salmonella*, a serotype of *Salmonella* (1 type per positive sample) was also determined by sending an isolate to Qld Health Scientific Services.

Salmonella isolates were held frozen for later analysis, (eg AMR and PFGE) if required.

Indicator microorganisms testing

Indicator tests for TVC, *E. coli* and coliforms were carried out by DA approved methods - TVC using AOAC 990.12 Aerobic plate count (Petrifilm) method. *E. coli* and coliform tests were carried out using AOAC 991.14 (Petrifilm) method.

4 Results and Discussion

4.1 Prevalence of *Salmonella* in Australian manufacturing beef

In the total of 1255 samples, 9 samples were screened as positive by the BAX method, and subsequently all 9 confirmed positive for *Salmonella* by AS 5013.10 method, which resulted in a 0.7% prevalence rate for *Salmonella* in Australian manufacturing beef (table T1). The *Salmonella* prevalence in Australia was more than 3 times lower than that observed in the US from domestic raw beef sampling projects conducted by the US FSIS in the 4th quarter survey of 2014, which showed a 2.3% *Salmonella* prevalence in manufacturing beef trim.

As mentioned above, all of the 9 Bax-screened positive samples were confirmed positive for *Salmonella*. The 100% confirmation rate indicated reliability of the BAX screening method for detection of *Salmonella*.

The *Salmonella* concentration was determined to be < 0.3 MPN/g in all 9 positive samples using the MPN method.

Salmonella Serotyping was carried out on all 9 positive samples and confirmed the serotypes to be *Salmonella* Zanzibar, *Salmonella* Reading, *Salmonella* Chailey, *Salmonella* Agona*, Salmonella* Orion*, Salmonella* Anatum var 15+, *Salmonella* Jangwani*, and Salmonella* Anatum.

Salmonella Enteritidis and *Salmonella* Typhimurium, which are the two most important serotypes of *Salmonella* transmitted from animals to humans in the US, were not found in this study. *Salmonella* Newport*, Salmonella* Javiana, and *Salmonella* Heidelberg, which are the three next most common serotypes associated with foodbourne illness in the US, were also not found in this study.

In Australia, the four most common serotypes associated with foodbourne illness are *Salmonella* Typhimurium, *Salmonella* Enteritidis, *Salmonella* Virchow, and *Salmonella* Saintpaul, none of which were not found in this study.

4.2 Prevalence of *Salmonella* by state, stock type and feed type

The prevalence of *Salmonella* is summarised by state, stock type and feed type in tables T2 and T3. The lowest prevalence of *Salmonella* was in SA with 0%, and highest in Tas with 1.3%, however, the sample size in these two states was n=80 and n=79 respectively, which was relatively smaller than the major states. Both NSW and QLD had a prevalence of *Salmonella* in beef trim of 0.5% which was slightly lower than the national prevalence of 0.7%. VIC had a prevalence rate of 1.2% which was higher than the national prevalence of 0.7%. There was only 1 sample submitted from WA, which had no detection for *Salmonella*.

Within stock types, Cow/Bull samples had a national *Salmonella* prevalence of 1.5%, which was almost 4 times higher than that of Steer/Heifer samples at 0.4%. The proportionate difference was in agreement with the Australian ESAM program data from July 2014 to April 2015, which showed that the national *Salmonella* prevalence was 0.42% (n=1661) in Cow/Bull sponge samples, and 0.03% (n=3341) in Steer/Heifer sponge samples (data not shown). However, the national prevalence of *Salmonella* in Cow/Bull manufacturing beef samples (1.5%) was almost 4 times higher than that in the Cow/Bull ESAM sponge samples (0.42%). Comparing the trim samples to the ESAM sponge samples for Steer/Heifer stock type, *Salmonella* prevalence in manufacturing beef samples (0.4%) was also considerably higher than that in ESAM sponge samples (0.03%). Note: in this study, there were 101 samples that did not have stock type specified and no *Salmonella* was detected in those samples. The *Salmonella* prevalence in Cow/Bull samples was particularly high at 7.1% in NSW, but the sample size was only n=14 in this group.

By feed types, the national *Salmonella* prevalence in grass fed samples was 1.0% (n=708) which was twice that in grain fed samples at 0.5% (n=371), however, there was no significant difference ($p = 0.73$). The highest prevalence in grass fed samples was from VIC at 1.7% followed by TAS at 1.5%. The highest prevalence in grain fed samples was from NSW at 1.5%. There were 175 samples where feed type was not specified.

4.3 Prevalence of *Salmonella* and Indicator Organisms by Season

The prevalence of *Salmonella* and indicator organisms by season nationally is summarised in table T4. Winter had the highest prevalence of *Salmonella*. Overall, winter and summer had the highest *E. coli* detection rates. Autumn had no *Salmonella* detections and the lowest *E. coli* detection rate.

Tables T5 to T9 summarise the prevalence of *Salmonella* and indicator organisms by season for each state respectively.

4.4 Prevalence of *Salmonella* vs Indicator microorganisms

Table T10 shows that the national average TVC was 2.26 log cfu/g (n=1250) in Australian manufacturing beef. The national *E. coli* prevalence was 4.2% (n=1250), with a mean count of 1.4 log cfu/g in the *E. coli* positive samples. These results were comparable to the TVC and *E. coli* results obtained from the Australian ESAM program (July 2014 to April 2015) which were 2.47 log cfu/g (n=22845) and 4.2% (n=22744) for TVC and *E. coli* respectively.

The national Coliforms prevalence in this study was 14.5% (n=1250).

Note: For TVC, Coliforms and *E. coli*, zero values (not detected) were assigned a value of "1" in order to perform log calculations.

4.4.1 *Salmonella* vs Indicator microorganisms by State

The TVC, *E. coli* and Coliforms prevalence and counts are summarised by state in table T10. The TVC counts are also shown by state in box-plot format in Fig. 1 for comparison. The nominal difference between the mean TVC counts between each state was not great, and relatively low, suggesting good hygiene levels, however, there were some significant differences between states (T10). Fig. 1 shows the mean TVC in both NSW and QLD was lower than the national average. In addition, although there were more TVC outliers greater than 4.5 log cfu/g in QLD, the counts varied less, with 75% of the counts less than 2.5 log cfu/g. By comparison, the longer box plot for NSW suggests the TVC counts varied more in samples in NSW. Despite the different spread of TVC, the *Salmonella* prevalence in these 2 states were both at 0.5%. The mean TVC in SA was slightly higher than the national average TVC. Fig. 1 showed that in SA, most of the samples had a higher mean TVC than the national average, yet there was no *Salmonella* detected in SA. A wider TVC distribution was observed in VIC, where the *Salmonella* prevalence was 1.2%. In Tas, the mean TVC was close to the national average TVC with a relatively small spread in samples, yet the *Salmonella* prevalence was at 1.3% in TAS, which was the highest by State.

Fig. 2 shows that the *E. coli* prevalence by state, with QLD the lowest at 2.8%. The *Salmonella* prevalence in QLD was 0.5%. In SA, although the *E. coli* prevalence was 8.8% which was more than double the national *E. coli* prevalence rate of 4.2%, there was no *Salmonella* detection.

It appeared that QLD had the best hygienic quality in this study when compared to other states, with the average TVC count 2.06 log cfu/g, *E. coli* prevalence of 2.8% and Coliforms prevalence of 12.1%. *Salmonella* prevalence in QLD was 0.5% which was close to the national *Salmonella* prevalence 0.7%.

Whilst there were significant differences for TVC between some states, TVC was not, of itself, a predictor for *Salmonella* prevalence.

4.4.2 *Salmonella* vs Indicator Microorganisms and Stock Type

Table T11 shows that *Salmonella* prevalence in Cow/Bull samples in this study (1.5%) was nearly four times higher than in Steer/Heifer samples (0.4%), however, *E. coli* and coliform prevalence was only slightly higher in Cow/Bull samples at 4.4%, compared to the 4.2% for Steer/Heifer samples. Table T12 shows that the Australian ESAM data aligns with this finding, with *Salmonella* prevalence for Cow/Bull (0.42%) many times higher than Steer/Heiferr samples (0.03%), yet *E. coli* prevalence in Cow/Bull samples was 4.75% and Steer/Heifer samples it was 3.9%. In both this study and from the ESAM program data, *Salmonella* prevalence seems to correspond with stock type.

E. coli and coliform prevalence, however, does not seem to correlate with the occurrence of *Salmonella*, when considered both overall and between stock types.

4.4.3 *Salmonella* positives, Serotypes and links to Stock Type, Feed Type and Indicator Microorganisms

As shown in table T13, for the *Salmonella* positive samples, serotyping confirmed the detected *Salmonella* serotypes as: *Salmonella* Chailey*, Salmonella* Reading*, Salmonella* Agona*, Salmonella* Jangwani*, Salmonella* Zanzibar*, Salmonella* Orion*, Salmonella* Anatum var 15+, *and Salmonella* Anatum (x2).

Six out of the 9 *Salmonella* detections were from Cow/Bull.

Seven out of the 9 *Salmonella* detections were from grass fed cattle, although this is more likely to be associated with stock type, given the overall detection rates were similar.

Although there were some higher TVC counts on the Cow/Bull samples detected for *Salmonella*, across the 9 samples, TVC ranged from 1.48 to 3.60 log cfu/g.

There were (only) 3 *E. coli* detections in the 9 *Salmonella* positive samples, with the *E. coli* counts at 1.30, 1.00 and 1.00 log cfu/g, respectively, all of which which were lower than the national average count of *E. coli* at 1.40 log cfu/g (within *E. coli*-detected samples). The other 6 *Salmonella* positive samples were not detected for *E. coli*.

In general, it did not appear there was correlation between the presence of *Salmonella* and the indicator microorganisms examined.

5. Conclusion

The primary objective of this project was to determine the prevalence of *Salmonella* in Australian manufacturing beef, which was 0.7% in this survey. The samples detected as positive in the BAX screening step were all confirmed to be *Salmonella* positive which indicated reliability of the Bax screening method for *Salmonella* detection. Serotyping further confirmed the detected *Salmonella* serotypes as: *Salmonella* Chailey*, Salmonella* Reading*, Salmonella* Agona*, Salmonella* Jangwani*, Salmonella* Zanzibar*, Salmonella* Orion*, Salmonella* Anatum var 15+*, and Salmonella* Anatum (x2). The serotypes did not include the top 4-6 major human pathogens of concern to the FSIS or Australia. The *Salmonella* prevalence was much lower than that in the US which was determined to be 2.3% in the last quarter of 2014. The was no apparent correlation between the presence of *Salmonella* and indicator microorganisms, especially *E. coli*. Data generated in this survey has provided evidence to demonstrate a high standard of hygiene quality of manufacturing beef trim in Australia and can be used further to support the position of Australian meat processing industry in the global market.

6. Tables and Figures

T1. The national prevalence of *Salmonella* in Australian manufacturing beef samples and the average counts and prevalence of indicator microorganisms

Summary Statistics	*Salmonella* BAX screening	*Salmonella* Enumeration MPN method	TVC	Coliforms	*E. coli*
n =	1255	9	1250	1250	1250
Detections	9	<0.3	1186	180	53
% Detections	0.7%	0.0%	94.9%	14.4%	4.2%
Mean Log Counts (detected only)		0	2.38	1.34	1.40
Std Dev Log Counts (detected only)		0	0.79	0.49	0.59
Mean Log Counts (incl ND) *		0	2.26	0.19	0.06
Std Dev Log Counts (incl ND) *		0	0.93	0.51	0.31

*Mean and Std Dev of the log value of the counts for all samples, including those where there was no detection for the indicator organisms. Not detected samples were assigned a nominal value of "1", which equates to a log value of "0".

T2. *Salmonella* prevalence by Stock type and Australian State

	Str/Hfr			Cow/Bull			Unspecified			Total		
	n	Detection	% Detection	n	Detection	% Detection	n	Detection	% Detection	n	Detection	% Detection
NSW	166	0	0.0%	14	1	7.1%	7	0	0.0%	187	1	0.5%
QLD	417	2	0.5%	135	1	0.7%	31	0	0.0%	583	3	0.5%
SA	46	0	0.0%	28	0	0.0%	6	0	0.0%	80	0	0.0%
TAS	67	1	1.5%	9	0	0.0%	3	0	0.0%	79	1	1.3%
VIC	45	0	0.0%	226	4	1.8%	54	0	0.0%	325	4	1.2%
WA	1	0	0.0%	0	0	N/A	0	0	N/A	1	0	0.0%
National	742	3	0.4%	412	6	1.5%	101	0	0.0%	1255	9	0.7%

T3 *Salmonella* prevalence by Feed type and Australian State

	Grain			Grass			Unspecified			Total		
	n	Detection	% Detection	n	Detection	% Detection	n	Detection	% Detection	n	Detection	% Detection
NSW	66	1	1.5%	78	0	0.0%	43	0	0.0%	187	1	0.5%
QLD	279	1	0.4%	280	2	0.7%	24	0	0.0%	583	3	0.5%
SA	16	0	0.0%	50	0	0.0%	14	0	0.0%	80	0	0.0%
TAS	9	0	0.0%	68	1	1.5%	2	0	0.0%	79	1	1.3%
VIC	1	0	0.0%	232	4	1.7%	92	0	0.0%	325	4	1.2%
WA	0	0	N/A	1	0	0	0	0	N/A	1	0	0.0%
National	371	2	0.5%	709	7	1.0%	175	0	0.0%	1255	9	0.7%

T4 National *Salmonella* prevalence and Indicator Organisms by Seasons

	n	*Salmonella* positive counts	*Salmonella* %	n	TVC	*E. coli* %	Coliforms %
Winter	215	3	1.4%	211	2.14	6.6%	18.5%
Spring	589	4	0.7%	589	2.21	3.7%	12.9%
Summer	231	2	0.9%	230	2.43	6.5%	16.5%
Autumn	220	0	0.0%	220	2.35	0.9%	12.7%

T5 Queensland *Salmonella* prevalence and Indicator Organisms by Seasons

	n	*Salmonella* positive counts	*Salmonella* %	n	TVC	*E. coli* %	Coliforms %
Winter	100	1	1.0%	96	1.84	5.2%	11.5%
Spring	286	2	0.7%	286	2.02	2.8%	10.8%
Summer	89	0	0.0%	88	2.34	2.3%	13.6%
Autumn	108	0	0.0%	108	2.15	0.9%	14.8%

T6 NSW *Salmonella* prevalence and Indicator Organisms by Seasons

	n	*Salmonella* positive counts	*Salmonella* %	n	TVC	*E. coli* %	Coliforms %
Winter	47	1	2.1%	47	2.27	6.4%	19.1%
Spring	85	0	0.0%	85	2.02	3.5%	10.6%
Summer	27	0	0.0%	27	2.36	11.1%	14.8%
Autumn	28	0	0.0%	28	1.91	0.0%	0.0%

T7 VIC *Salmonella* prevalence and Indicator Organisms by Seasons

	n	*Salmonella* positive counts	*Salmonella* %	n	TVC	*E. coli* %	Coliforms %
Winter	35	0	0.0%	35	2.4	2.9%	20.0%
Spring	139	2	1.4%	139	2.61	5.8%	15.8%
Summer	86	2	2.3%	86	2.54	7.0%	17.4%
Autumn	65	0	0.0%	65	2.79	1.5%	16.9%

T8 SA *Salmonella* prevalence and Indicator Organisms by Seasons

	n	*Salmonella* positive counts	*Salmonella* %	n	TVC	*E. coli* %	Coliforms %
Winter	20	0	0.0%	20	2.64	20.0%	30.0%
Spring	37	0	0.0%	37	2.54	2.7%	18.9%
Summer	14	0	0.0%	14	2.39	14.3%	35.7%
Autumn	9	0	0.0%	9	2.88	0.0%	0.0%

T9 TAS *Salmonella* prevalence and Indicator Organisms by Seasons

	n	*Salmonella* positive counts	*Salmonella* %	n	TVC	*E. coli* %	Coliforms %
Winter	13	1	7.7%	13	2.43	7.7%	46.2%
Spring	41	0	0.0%	41	2.22	4.9%	17.1%
Summer	15	0	0.0%	15	2.53	6.7%	6.7%
Autumn	10	0	0.0%	10	2.33	0.0%	10.0%

T10. Indicator microorganisms vs *Salmonella* by Australian State

	n	TVC mean (log cfu/g)	% Coliforms	% *E. coli*	% *Salmonella*
NSW	187	2.11_{ab}	11.8%	4.8%	0.5%
QLD	578	2.06_{a}	12.1%	2.8%	0.5%
SA	80	2.58_{c}	22.5%	8.8%	0.0%
TAS	79	2.33_{b}	20.3%	6.3%	1.3%
VIC	325	2.61_{c}	16.9%	4.9%	1.2%
WA	1	2.00	0.0%	0.0%	0.0%
National	1250	2.26	14.5%	4.2%	0.7%

Note: Mean TVC counts with the same subscripts are not significantly different from each other

T11 The indicator microorganism vs *Salmonella* by Stock Type

	N	TVC mean (log cfu/g)	% Coliforms	% *E. coli*	% *Salmonella*
Cow/Bull	411	2.56	16.1%	4.4%	1.5%
Str/Hfr	738	2.08	13.8%	4.2%	0.4%
Unspecified	101	2.37	12.9%	4.0%	0.0%

T12. *E. coli* and *Salmonella* prevalence in the Australian ESAM program (July 2014 to April 2015) by Stock Type

ESAM	N	% *E. coli*	% *Salmonella*
Cow/Bull	7091	4.75%	0.42%
Str/Hfr	15653	3.90%	0.03%

Source: Data supplied by Meat & Livestock Australia

T13 *Salmonella* detections and serotypes vs Stock Type, Feed Type, State and Indicator Microorganisms

Salmonella Bax Screening	Serotypes	Stock Type	Feed Type	States	TVC (log cfu/g)	Coliforms (log cfu/g)	*E. coli* (log cfu/g)
Detected	Salmonella Chailey	Cow/Bull	Grain	NSW	2.84	1.30	1.30
Detected	*Salmonella* Reading	Steer/Heifer	Grass	QLD	2.18	0.00	0.00
Detected	*Salmonella* Agona	Steer/Heifer	Grain	QLD	1.48	0.00	0.00
Detected	*Salmonella* Jangwani	Cow/Bull	Grass	QLD	1.48	0.00	0.00
Detected	*Salmonella* Zanzibar	Steer/Heifer	Grass	TAS	2.86	1.48	0.00
Detected	*Salmonella* Orion	Cow/Bull	Grass	VIC	3.60	1.00	1.00
Detected	*Salmonella* Anatum var 15+	Cow/Bull	Grass	VIC	3.40	0.00	0.00
Detected	*Salmonella* Anatum	Cow/Bull	Grass	VIC	3.04	0.00	0.00
Detected	*Salmonella* Anatum	Cow/Bull	Grass	VIC	3.40	1.00	1.00

Fig 1. TVC (log cfu/g) counts in different states

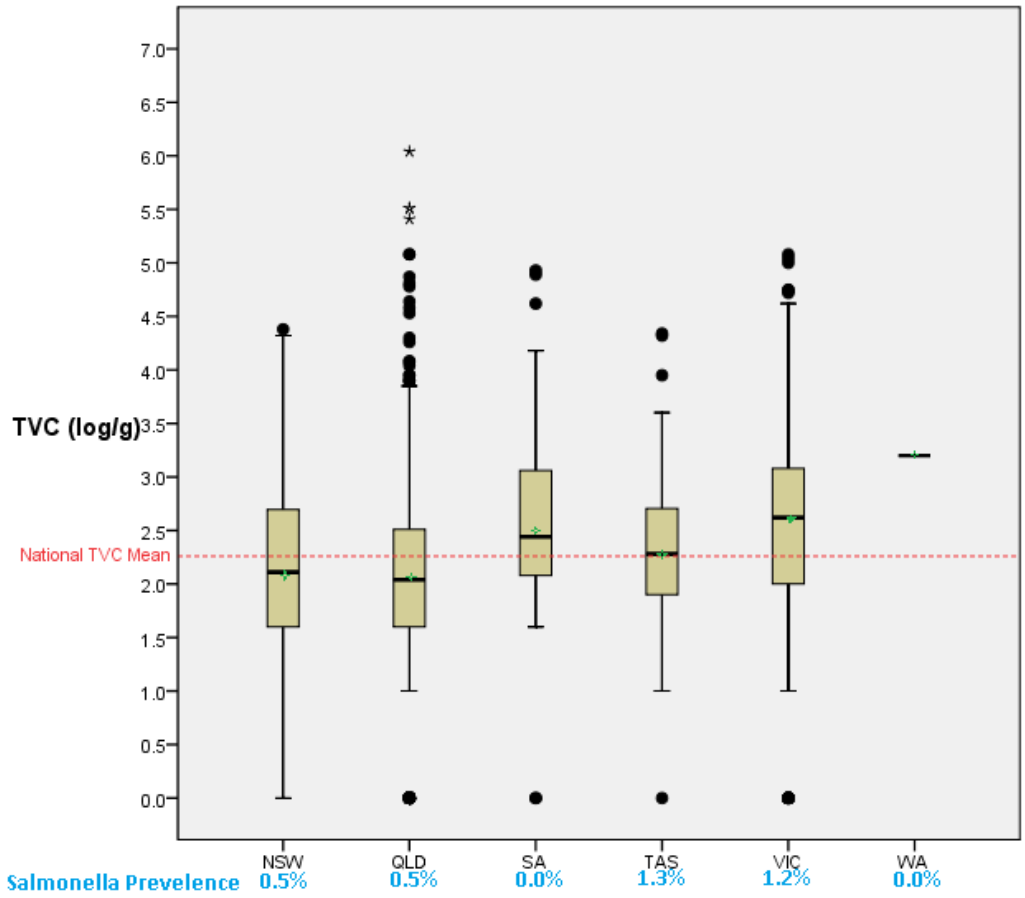
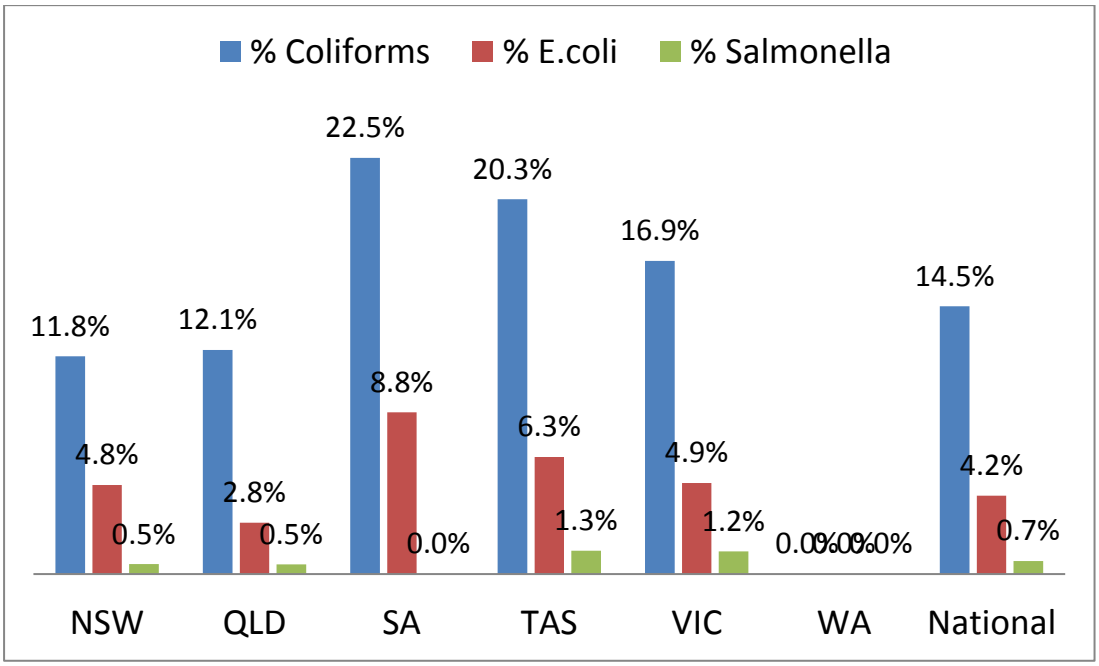


Fig 2. Prevalence of Coliforms, *E. coli* and *Salmonella* by Australian State



APPENDIX 1: Participating Establishments

Company	Suburb	State	Est. No.
E C THROSBY PTY LTD	WHITTINGHAN	NSW	486
GREENHAM HW & SONS	TONGALA	VIC	234
GREENHAM TASMANIA PTY LTD	SMITHTON	TAS	716
HARVEY BEEF	HARVEY	WA	648
JBS AUSTRALIA PTY LTD	DINMORE	QLD	235
JBS AUSTRALIA PTY LTD	PURRAWUNDA	QLD	170
JBS AUSTRALIA PTY LTD	TOWNSVILLE	QLD	4
JBS AUSTRALIA PTY LTD	ROCKHAMPTON	QLD	384
JBS AUSTRALIA PTY LTD	BROOKLYN	VIC	688
JBS AUSTRALIA PTY LTD	YANCO	NSW	517
JBS AUSTRALIA PTY LTD	LONGFORD	TAS	195
JOHN DEE WARWICK PTY LTD	WARWICK	QLD	243
KILCOY PASTORAL COMPANY	KILCOY	QLD	640
MIDFIELD MEAT	WARRNAMBOOL	VIC	180
MONBEEF PTY LTD	COOMA	NSW	952
NOLAN MEATS PTY LTD	GYMPIE	QLD	80
NORTHERN CO-OP MEAT CO.	CASINO	NSW	239
OAKEY BEEF EXPORTS PTY LTD	OAKEY	QLD	558
O'CONNOR G & K PTY LTD	PAKENHAM	VIC	1265
THOMAS FOODS INTERNATIONAL	MURRAY BRIDGE	SA	533
TABRO MEAT PTY LTD	LANCE CREEK	VIC	1912
TABRO MEAT PTY LTD	MOE	VIC	
TEYS AUSTRALIA PTY LTD - BILOELA	BILOELA	QLD	399
TEYS AUSTRALIA Pty Ltd - ROCKHAMPTON	ROCKHAMPTON	QLD	7
TEYS AUSTRALIA PTY LTD - BEENLEIGH	BEENLEIGH	QLD	294
TEYS AUSTRALIA SOUTHERN PTY PTY LTD - NARACOORTE	NARACOORTE	SA	423
TEYS AUSTRALIA SOUTHERN PTY PTY LTD - TAMWORTH	TAMWORTH	NSW	249
TEYS AUSTRALIA SOUTHERN PTY PTY LTD - WAGGA WAGGA	WAGGA WAGGA	NSW	291
THOMAS BORTHWICK & SONS	MACKAY	QLD	67
WINGHAM ABATTOIRS PTY LTD	WINGHAM	NSW	154
WODONGA RENDERING PTY LTD	WODONGA	VIC	612
YOLARNO PTY LTD (BINDAREE BEEF)	INVERELL	NSW	218