



NSW Food Authority

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# Microbiological quality of packaged sliced ready- to-eat meat products

A survey to determine the safety of  
ready-to-eat meat products sold in NSW

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## Contents

Executive summary .....	2
Introduction .....	3
Methods .....	4
Assessing microbiological quality of ready-to-eat meat products.....	4
Results .....	5
Discussion .....	6
<i>Escherichia coli</i> .....	7
Coagulase positive staphylococci .....	7
<i>Salmonella</i> .....	7
<i>Listeria monocytogenes</i> .....	8
Verotoxigenic <i>E. coli</i> (VTEC) in uncooked comminuted fermented meats (UCFM).....	9
Conclusion.....	10
References .....	11
Appendices.....	15
Appendix 1: Survey results .....	16
Appendix 2: Food recalls in Australia for RTE meat and poultry products (2004–2009).....	23
Appendix 3: Foodborne illness outbreaks attributed to RTE meat and poultry products (1984–2008) .....	24
Appendix 4. Summary of selected microbiological surveys of RTE meats.....	25

## Executive summary

During August to November 2008, a total of 154 packaged sliced ready-to-eat (RTE) meat products were purchased from supermarkets, greengrocers, farmers markets and retail butcher shops in the greater Sydney area.

These samples were tested for compliance with microbiological limits in *Standard 1.6.1 – Microbiological limits for foods* of the Food Standards Code and NSW requirements for producers of packaged RTE meat and poultry products.

The survey found that 147/154 of samples (95.5%) complied with microbiological regulatory limits. Of those samples found not to comply with microbiological limits, one sample contained *E. coli* at a level of 4 cfu/g (just above the regulatory limit of <3 cfu/g) and six samples were found to contain *L. monocytogenes* at levels of 10 cfu/g and less. No samples were found to contain *Salmonella* or verotoxigenic *E. coli* (VTEC).

Risk management action was taken in response to the non-compliant samples. Follow-up action included inspection of the premises where the product was manufactured to assess compliance with Food Standards Code requirements.

## Introduction

The Food Standards Code (FSANZ, 2008) defines ready-to-eat (RTE) meat as meat products (including poultry) intended to be consumed without further heating or cooking, and includes:

- cooked or uncooked fermented meat
- pâté
- dried meat
- slow cured meat
- luncheon meat
- cooked cured or uncured muscle meat
- other ready-to-eat meat that is susceptible to the growth of pathogens or the production of toxins

On any given day, between 20% and 50% of the Australian population consume RTE meats, including smallgoods, deli meats, manufactured, fermented and processed meats. Meat and Livestock Australia (MLA) estimated the daily serving size of these products to be between 28 and 58 grams per person (MLA, 2006).

The *National Risk Validation Project* report (Food Science Australia & Minter Ellison Consulting, 2002) identified producers of fermented and manufactured meat products to be high risk businesses. That project estimated that foodborne illness attributable to fermented and manufactured meats in Australia to be in the order of \$77 million per year. This was based on the nature of food operations, the frequency of illness in relation to product consumption rates and the severity of illness.

Several studies have categorised deli meats as high risk foods due to the potential for contamination with *Listeria monocytogenes* (Food Science Australia & Minter Ellison Consulting, 2002; FDA/USDA; 2003; MLA, 2003). Indeed, the FDA/USDA risk assessment for *L. monocytogenes* identified deli meats as the highest risk food from the 23 RTE foods examined (FDA/USDA, 2003). This high risk rating is due to either the absence of a listericidal step such as cooking, extended shelf life or contamination during handling subsequent to a listericidal step (ie during slicing) and the ability of many of these products to support the growth of *L. monocytogenes* during storage, even under refrigeration.

Cured meats such as ham, roast beef and silverside are normally injected with brine containing salt and nitrite, followed by soaking or massaging. The products are then cooked to a minimum cooking standard of 65°C for 10 minutes, which ensures a 6 log reduction in *L. monocytogenes* present on the meat. However, subsequent handling may re-introduce this organism (Lianou & Sofos, 2007). As indicated by food survey data (Uyttendaele, de Troy, & Debevere, 1999) and by environmental sampling data from retail premises (Little & de Louvois, 1998), slicing is one of the handling activities that may contribute considerably to the contamination of RTE meat products with pathogenic bacteria.

In addition, many of these products are packed in vacuum packed or modified atmosphere packaging (MAP), which extends the refrigerated shelf life to several weeks by inhibiting the growth of spoilage organisms. While refrigeration can control other pathogenic organisms such as *Salmonella*, the growth of psychrotrophic (cold tolerant) organisms such as *L. monocytogenes* will not be inhibited. Beumer *et al* (1996) found that when a sample of ham was inoculated with 10 cfu/g of *L. monocytogenes*, the organism grew to levels of 10<sup>8</sup> cfu/g within 35 days, with the presence of CO<sub>2</sub> in the packaging.

Fermented sausages are considered high risk due primarily to contamination and survival of pathogenic *Escherichia coli*, particularly if the fermentation process is not adequately controlled (MLA, 2003). This was graphically illustrated by the 1995 Garibaldi outbreak in South Australia from uncooked fermented Mettwurst contaminated with *E. coli* O111. Dry and

semi dry fermented sausages are classified as low risk (MLA, 2003) to moderate risk (FDA/USDA, 2003) on a per serving basis for contamination with *L. monocytogenes*.

Since 2004, according to Food Standards Australia New Zealand (FSANZ) there have been 30 recalls of RTE meat products in Australia, with 26 (86.7%) due to microbiological contamination (Appendix 2). In addition, there have been documented food poisoning outbreaks from RTE meats in Australia and overseas, due to *L. monocytogenes*, *Clostridium perfringens*, *E. coli* O157 and O111, *Staphylococcus* and *Salmonella* (Zimomra *et al*, 1994; Cameron *et al*, 1995; Ward *et al*, 1997; OzFoodNet, 2006b; Webster, Cowden, & Locking, 2007). Details on these and other outbreaks are found in Appendix 3.

Due to a lack of current data, the NSW Food Authority conducted this survey with the aim of gathering up-to-date information on the microbiological quality of packaged sliced RTE meats sold in NSW. This survey specifically targeted the RTE meat products considered to be high risk, namely those which had been further processed by slicing and then packaged to extend shelf life.

## Methods

From August to November 2008, a total of 154 packaged sliced RTE meat products were purchased from supermarkets, greengrocers, farmers markets and retail butcher shops in the greater Sydney area.

All samples were analysed within 24 hours of receipt at the laboratory using the appropriate Australian Standard method as detailed in Table 1. Fifteen UCFM samples were randomly selected to be tested for the presence of verotoxigenic *E. coli* (VTEC) using a commercial ELISA kit.

UCFM and slow cured products were also tested for pH and water activity ( $a_w$ ). pH was determined by using an in-house NATA accredited method (F 50.39) based on the AOAC 981.12 method using a pH meter and buffer solutions. The determination of  $a_w$  used an in-house method (M14) based on the AOAC 978.18 method using detector liquid and a refractometer.

**Table 1: Methods used in the analysis of samples**

Tests undertaken	Method
Coagulase positive staphylococci - enumeration	AS 1766.2.4 (UCFM products only)
<i>Escherichia coli</i> - enumeration	AS 1766.2.3
<i>Salmonella</i> spp. - detection	AS 1766.2.5
<i>Listeria monocytogenes</i> - detection	AS/NZS 1766.16.1
<i>Listeria monocytogenes</i> - enumeration	ISO 11290-2:1998/Amd.1:2004-10-15
Verotoxigenic <i>E. coli</i> (VTEC) - detection	ELISA (Premier™ EHEC manufactured by Meridian BioScience Inc.)
pH, water activity	F 50.39, M14

## Assessing microbiological quality of ready-to-eat meat products

RTE meat products must comply with the microbiological limits specified in *Standard 1.6.1 – Microbiological limits for foods* of the Food Standards Code. However, *Standard 1.6.1* only

specifies microbiological limits for packaged cured/salted meat and UCFM products. To ensure adequate verification of food safety programs in facilities manufacturing RTE meat and poultry products, in 2003, the NSW Food Authority (then as SafeFood NSW) issued a General Circular (06/2003-updated 2007) to meat and poultry processing facilities in the state (NSW Food Authority, 2007). This Circular introduced minimum testing requirements for all RTE packaged meat and poultry products to ensure adequate verification of the HACCP-based food safety programs in place. These requirements were in addition to those requirements specified in the Food Standards Code.

All samples tested in this survey were assessed against requirements from the Food Standards Code and General Circular 06/2003, as specified in Table 2.

**Table 2: Microbiological limits for RTE meat products**

Standard	Product	Microorganism	Limit <sup>1</sup>
<i>Standard 1.6.1 - Food Standards Code</i>	Packaged cooked cured/salted meat	Coagulase positive staphylococci <i>L. monocytogenes</i> <i>Salmonella</i>	100 cfu/g Detected/25 g Detected/25 g
<i>Standard 1.6.1 - Food Standards Code</i>	All comminuted fermented meat which has not been cooked during the production process	Coagulase positive staphylococci <i>E. coli</i>	1000 cfu/g 3.6 cfu/g
<i>NSW Food Authority General Circular 06/2003</i>	RTE packaged meat & poultry products	<i>E. coli</i> <i>L. monocytogenes</i> <i>Salmonella</i>	< 3 cfu/g Detected/25 g Detected/25 g

## Results

A summary of results for the samples are shown in Table 3.

The survey found that 95.5% of samples complied with the microbiological criteria in *Standard 1.6.1* of the Food Standards Code and NSW Food Authority General Circular 06/2003. Of those samples found not to comply, one sample of ham contained *E. coli* at a level slightly above the limit (4 cfu/g) and six samples (two ham, two salami, one silverside, one roast beef) were positive for the presence of *L. monocytogenes* at low levels ( $\leq 10$ cfu/g).

Where samples of RTE meat were found to not comply with requirements, follow-up action was undertaken by NSW Food Authority officers in accordance with the level of risk posed. Follow-up action included inspection of the premises where the product was manufactured to assess compliance with Food Standards Code requirements.

<sup>1</sup> In this survey, only single samples were analysed (ie 'n' = 1) so the acceptable microbiological level (listed as 'm' in column 5 of the Schedule to *Standard 1.6.1*) was used as the limit to determine if the sample was satisfactory

**Table 3: Assessment of results against *Standard 1.6.1* of the Food Standards Code and General Circular 06/2003**

Microorganism	Number of samples analysed	Number of failed samples
<i>E. coli</i>	154	1 (0.6%)
<i>Salmonella</i>	154	0
<i>L. monocytogenes</i>	154	6 (3.9%)
Coagulase positive staphylococci	44	0
Verotoxigenic <i>E. coli</i> (VTEC)	15	0

## Discussion

In NSW, there have been two previous surveys of RTE meats conducted since 1988. In a survey from 1988 to 1993, 103 samples were collected with *Listeria* spp. detected in 34 samples (33%), of which 18 (17.5% of the total) were *L. monocytogenes* (Arnold & Coble, 1995). In 2001, the NSW Food Authority undertook a survey of UCFM products to assess levels of compliance by the industry. A total of 86 samples were collected and tested for *E. coli*, pH and  $a_w$ . The survey found that 13 samples (15%) exceeded the regulatory limit for *E. coli*.

As part of its routine microbiological verification program, the NSW Food Authority regularly collects samples of RTE meat products and tests them for the presence of *L. monocytogenes*, *Salmonella* or *E. coli*. Between 2003 and 2008, 532 RTE meat samples were analysed. *Listeria* spp. was detected in 21 samples (3.9%), and *L. monocytogenes* was detected in nine samples (1.7%). *Salmonella* and *E. coli* were not found in any samples.

Many countries have in place microbiological requirements for RTE meat products and numerous surveys have been conducted around the world for regulatory and non-regulatory purposes. Examples of selected studies are summarised in Appendix 4. The pathogen most commonly tested for is *L. monocytogenes*, with the reported prevalence ranging from not detected (ND) to 50% in the literature. Other organisms tested for include *Salmonella*, *Clostridium perfringens*, *Campylobacter*, *Staphylococcus aureus*, *Bacillus cereus* and *Escherichia coli*. These organisms were detected at various levels with prevalence ranging from not detected to 3%.

It must be acknowledged that there are many confounders when attempting to draw conclusions from prevalence data of different pathogens and indicator organisms reported in the literature. For example, type and size of sample analysed, method of analysis, design, seasonality, and use of intervention strategies each influence survey results. In the sections that follow, differences in survey results are noted but, due to many confounders, do not provide a basis for comparative benchmarking.

### ***Escherichia coli***

This survey detected *E. coli* in 1/154 samples (0.6%), at a level of 4 cfu/g in a sample of ham. This level is just above the limit set by the NSW Food Authority of <3 cfu/g in these products, as a potential indicator of faecal contamination.

The reported prevalence and level of *E. coli* in this survey is lower than that reported in some other studies. Wojtas & Christen (1997) detected *E. coli* in 3/44 samples (6.8%) in a 1997 survey conducted in the ACT, while a follow-up survey the next year found *E. coli* in 4/65 samples (6.2%) taken from retail premises, with levels ranging from 4 to 210 cfu/g (Christen & Millard, 1998).

In an extensive survey of catering and retail premises in the UK, Elson, Burgess, Little, & Mitchell (2004) found *E. coli* in 81/2894 samples (2.8%) of cooked sliced meats, with levels ranging from 20 cfu/g to greater than 10<sup>7</sup> cfu/g. Another large survey conducted in the UK on retail packaged cooked RTE meats found *E. coli* in 10/2981 samples (0.2%), at levels ranging from 20 to 10<sup>6</sup> cfu/g (Sagoo, Little, Allen, Williamson, & Grant, 2007).

### **Coagulase positive staphylococci**

Coagulase positive staphylococci (CPS) was not detected in any of the 44 UCFM products analysed in this survey — the limit of detection was 100 cfu/g.

For comparison, the 1997 and 1998 surveys conducted in the ACT found CPS in 1/44 (2.3%) and 12/65 samples (3.1%) respectively. Levels found in these surveys ranged from 100 cfu/g to more than 1000 cfu/g (Wojtas & Christen, 1997; Christen & Millard, 1998). The UK study conducted in 2003 found 9/2960 samples (0.3%) contained *S. aureus* at the level between 20 and 100 cfu/g (Sagoo *et al*, 2007).

### ***Salmonella***

No samples tested in this survey were found to contain *Salmonella* spp. This result is consistent with the low prevalence observed in other surveys conducted in Australia (ACT) and the UK. Of the more than 6000 samples analysed collectively by these surveys, not one sample was found to contain *Salmonella* spp. (see Appendix 4). A survey of cured meats sold in Cyprus did find *Salmonella* spp. in 2/1567 samples (0.1%).

Despite the apparent low prevalence of *Salmonella* in RTE meats, there was a recall in 2007 in Australia due to the presence of *Salmonella* in UCFM products. In addition, there have been a number of outbreaks recorded in Australia and overseas since 1984 involving *Salmonella* in RTE meats (Appendix 3). A total of twelve outbreaks caused by a variety of *Salmonella* serovars have been reported in the literature, affecting approximately 560 people, with two deaths. The cause of most outbreaks was unknown, however post-processing contamination and temperature abuse were frequently implicated (Lester *et al*, 1997). Investigation into a 1991 outbreak caused by consumption of salami in NSW uncovered inadequate fermentation process, inadequate cooking and temperature abuse (Westbrook *et al*, 1993).



### ***Listeria monocytogenes***

*L. monocytogenes* was detected in this survey in 6/154 samples (3.9%), including two samples of ham, two samples of salami, one sample of roast beef and one sample of silverside.

The prevalence of *L. monocytogenes* found in this survey is well within the range found in other surveys previously conducted in Australia and overseas, where the prevalence ranged from not detected to 50%, with the Australian prevalence averaging at 15.6% (Appendix 4). This survey also shows an improvement when compared to previous surveys undertaken in NSW, where a 1993 survey found *L. monocytogenes* in 7/53 samples (13.2%) (Arnold & Coble, 1995).

Enumeration of samples positive for *L. monocytogenes* found that the organism was present at very low levels. In four of the six samples, the organism was present at a level of less than 10 cfu/g (ie one ham, one roast beef, one silverside and one salami sample), and at a level of 10 cfu/g in the remaining two samples (ie one ham and one salami sample). For comparison, studies conducted in the UK have found RTE meat samples with levels of *L. monocytogenes* as high as  $10^4$  to  $10^5$  cfu/g (Elson *et al*, 2004) and Sagoo *et al* (2007) found 47 samples to contain *L. monocytogenes* at levels ranging from 20 to  $10^7$  cfu/g.

Contamination with *L. monocytogenes* has caused the majority of recalls 25/30 (83.3%) of RTE meats in Australia since 2004. *Standard 1.6.1* of the Food Standards Code has a 'not detected in 25g' limit for *L. monocytogenes* in packaged cooked cured/salted meats such as ham. However, the FSANZ *Recall guidelines for packaged ready-to-eat foods found to contain Listeria monocytogenes at point of sale* allow a level of 100 cfu/g if the product does not support the growth of *L. monocytogenes* (FSANZ, 2001). It is considered that this level is unlikely to cause illness in most consumers. Two of the products where *L. monocytogenes* was detected in this survey were salami (UCFM), where the combination of pH and  $a_w$  in the final product are such that they will not normally support the growth of *L. monocytogenes*. The limit for growth of *L. monocytogenes* is a pH of less than 4.5 or  $a_w$  of 0.92 or a combination of pH 5.0 and  $a_w$  0.94 (ICMSF, 1996).

A number of studies have found *L. monocytogenes* in UCFM products, with prevalence ranging from 7.5 to 8.2% (de Fatima Borges *et al*, 1999; Angelidis & Koutsomanis, 2006). Presence of *L. monocytogenes* in RTE meat products may be a concern even if the conditions for growth are not favourable as they may serve as a means of transmission of the pathogen during handling (ie slicing) and allow cross contamination of products that do support growth (Vorst, Todd & Ryser, 2006).

*L. monocytogenes* has been implicated in several outbreaks attributable to RTE meat and poultry products in Australia, New Zealand, Canada and the USA. While the initial level of contamination was unknown in a New Zealand outbreak attributed to corned silverside and ham, the long shelf life of these products was considered to be the main contributing factor in allowing the population of *L. monocytogenes* to reach levels that caused illness (Sim *et al*, 2002).

The most recent outbreaks include an outbreak of listeriosis from Conroy's Smallgoods in South Australia in 2005, resulting in three deaths of hospital patients. *Listeria* was isolated from the slicing machines in the factory used to slice the deli meats. The cost of the subsequent recall by Conroy's was in the order of \$2 million. A Canadian outbreak in 2008 from Maple Leaf Foods Inc. resulted in 20 deaths, and the resultant recall of more than 220 product lines and settlements from class action lawsuits was in the order of \$27 million Canadian dollars (AUD\$33 million). *L. monocytogenes* was isolated from the equipment used to slice the deli meats (Doolittle, 2008).

### **Verotoxigenic *E. coli* (VTEC) in uncooked comminuted fermented meats (UCFM)**

Fifteen UCFM products were randomly selected and tested for the presence of verotoxigenic *E. coli* (VTEC). None of the samples were found to contain VTEC.

Two outbreaks have been linked to these organisms. In 1994, a total of twenty laboratory-confirmed cases of diarrhoea caused by *E. coli* O157:H7 were reported in the western states of the United States. Epidemiological investigations linked the outbreaks to dry-cured salami and later uncovered inadequate fermentation process and cross-contamination as the contributing factors (Alexander *et al*, 1995).

One of the biggest outbreaks in Australia was caused by the consumption of mettwurst contaminated with *E. coli* O111. A total of 173 people were affected, and a young child died (Cameron *et al*, 1995). This outbreak resulted in new food safety standards for the production of UCFM products being incorporated into the Food Standards Code and the implementation of food safety programs by UCFM producers.

Well controlled fermentation and maturation of UCFM products should achieve a low pH and  $a_w$  to eliminate pathogens such as VTEC that may be present in the raw meat ingredient, however poorly controlled fermentation, as was the case with the Garibaldi product, can lead to survival of pathogens.

## Conclusion

The safety of RTE meat products relies largely on adequate processing (cooking, curing or fermentation) and/or the use of preservatives. This survey specifically targeted high risk RTE meat products which were sliced and packaged. Packaging of these products may involve modified atmosphere packaging or vacuum packaging, with the resultant extended shelf life potentially allowing the psychrotrophic pathogen *L. monocytogenes* the time and conditions to grow to levels that may cause infection in susceptible individuals. Sliced meats pose a higher risk as slicing is normally undertaken after cooking, therefore posing a microbiological risk because of the potential for recontamination via the slicing blade and subsequent handling.

This survey found that 95.5% of samples complied with the current microbiological standard and requirements.

The presence of *Listeria monocytogenes* in six samples supports the current risk management strategy of communicating to at-risk groups, particularly pregnant woman, that sliced packaged RTE meats should be avoided.

## References

- Alexander, E.R., Boase, J., Davis, M., Kirchner, L., Osaki, C., Tanino, T., *et al* (1995). Escherichia coli O157:H7 outbreak linked to commercially distributed dry-cured salami – Washington and California, 1994. *Morbidity and Mortality Weekly Report* 44(9), 157-160. Retrieved 14 April 2008, from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00036467.htm>
- Anonymous. (2002). Public health dispatch: outbreak of Listeriosis – Northeastern United States, 2002. *Morbidity and Mortality Weekly Report* 51(42), 950-951. Retrieved 14 April 2008 from <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5142a3.htm>
- Angelidis, A.S., & Koutsoumanis, K. (2006). Prevalence and concentration of *Listeria monocytogenes* in sliced ready-to-eat meat products in the Hellenic retail market. *Journal of Food Protection* 69(4), 938-942.
- Arnold, G.J. & Coble, J. (1995). Incidence of *Listeria* species in foods in NSW. *Food Australia* 47(2), 71-75.
- Baek, S.Y., Lim, S.Y., Lee, D.H., Min, K.H., & Kim, C.M. (2000). Incidence and characterization of *Listeria monocytogenes* from domestic and imported foods in Korea. *Journal of Food Protection* 63(2), 186-189.
- Beumer, R.R., te Giffel, M.C., de Boer, E., & Rombouts, F.M. (1996). Growth of *Listeria monocytogenes* on sliced cooked meat products. *Food Microbiology* 13, 333-340.
- Burnett, S.L., Mertz, E. L., Bennie, B., Ford, T., & Starobin, A. (2005). Growth or survival of *Listeria monocytogenes* in ready-to-eat meat products and combination deli salads during refrigerated storage. *Journal of Food Science* 70(6), 301-304.
- Cameron, A.S., Beer, M.Y., Walker, C.C., Rose, N., Aneer, E., Manatakis, Z., *et al* (1995). Community outbreak of Hemolytic Uremic Syndrome attributable to Escherichia coli O111:NM – South Australia, 1995. *Morbidity and Mortality Weekly Report* 44(29), 550-551, 557-558. Retrieved 14 April 2008, from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00038232.htm>
- Christen, S. & Millard, G. (1998). *Microbiological and chemical quality of cured and salted meats*. Retrieved 21 April 2008, from <http://health.act.gov.au/c/health?a=da&did=10017576&pid=1053858104>
- Cordano, A.M., & Rocourt, J. (2001). Occurrence of *Listeria monocytogenes* in food in Chile. *International Journal of Food Microbiology*, 70, 175-178.
- D'Aoust, J.Y. (1989). *Salmonella*. In M.P. Doyle (ed.), *Foodborne bacterial pathogens*. Marcel Dekker, Inc., New York.
- De Fatima Borges, M., de Siqueira, R.S., Bittencourt, A.M., Vanetti, M.C.D., & Gomide, L.A.M. (1999). Occurrence of *Listeria monocytogenes* in salami. *Revista de Microbiologia* 30, 362–364.
- Doolittle, R. (2008, December 18). Maple Leaf settles listeria suits for \$27M. The Toronto Star Retrieved 19 January 2009, from <http://www.thestar.com/business/article/555873>
- Eleftheriadou, M., Varnava-Tello, A., Metta-Loizidou, M., Nikolaou, A.S., & Akkelidou, D. (2002). The microbiological profile of foods in the Republic of Cyprus: 1991-2000. *Food Microbiology* 19, 463-471.
- Elson, R., Burgess, F., Little, C.L., & Mitchell, R.T. (2004). Microbiological examination of ready-to-eat cold sliced meats and pâté from catering and retail premises in the UK. *Journal of Applied Microbiology* 96, 499-509.
- Emberland, K.E., Nygård, K., Heier, B.T., Aavitsland, P., Lassen, J., Stavnes, T.L., *et al* (2006). Outbreak of Salmonella Kedougou in Norway associated with salami, April-June 2006. *Eurosurveillance* 11(7-9), 188. Retrieved from [http://www.eurosurveillance.org/eq/2006/03-06/pdf/eq\\_7\\_2006\\_188-188.pdf](http://www.eurosurveillance.org/eq/2006/03-06/pdf/eq_7_2006_188-188.pdf)
- FDA/USDA [Food and Drug Administration/ United States Department of Agriculture] (2003). *Quantitative assessment of relative risk to public health from foodborne Listeria monocytogenes among selected categories of ready to eat foods*. Retrieved 11 April 2008, from <http://www.foodsafety.gov/~dms/lmr2-toc.html>

- Food Safety Authority of Ireland (2003). *1<sup>st</sup> quarter national microbiological survey 2003 (NS1): microbiological quality/safety of pre-packed cooked sliced ham*. Retrieved 21 April 2008, from [http://www.fsai.ie/surveillance/food\\_safety/microbiological/prepacked\\_cooked\\_sliced\\_ham.pdf](http://www.fsai.ie/surveillance/food_safety/microbiological/prepacked_cooked_sliced_ham.pdf)
- Food Safety and Inspection Service. (2005). *A risk assessment for Clostridium perfringens in ready-to-eat and partially cooked meat and poultry products. Executive summary*. Retrieved 11 April 2008 from [http://www.fsis.usda.gov/PDF/CPerfringens\\_Risk\\_Assess\\_ExecSumm\\_Sep2005.pdf](http://www.fsis.usda.gov/PDF/CPerfringens_Risk_Assess_ExecSumm_Sep2005.pdf)
- Food Science Australia & Minter Ellison Consulting (2002). *National risk validation project. Final Report*.
- FSANZ [Food Standards Australia New Zealand] (2001). *Recall guidelines for packaged ready-to-eat foods found to contain Listeria monocytogenes at point of sale*. Retrieved 15 April 2008, from <http://www.foodstandards.gov.au/srcfiles/Listeria%20Recall%20Guidelines.pdf>
- FSANZ [Food Standards Australia New Zealand] (2004). *Initial assessment report – Proposal P289 – Food safety programs for the producers of manufactured & fermented meats*. Retrieved 8 April 2008, from [http://www.foodstandards.gov.au/srcfiles/P289\\_IAR\\_FSS\\_Manufactured\\_Meats\\_Final.pdf](http://www.foodstandards.gov.au/srcfiles/P289_IAR_FSS_Manufactured_Meats_Final.pdf)
- Gianfranceschi, M., Gattuso, A., Fiore, A., D'Ottavio, M.C., Casale, M., Palumbo, A., & Aureli, P. (2006). Survival of *Listeria monocytogenes* in uncooked Italian dry sausage (salami). *Journal of Food Protection* 69(7), 1533-1538.
- Gillespie, I., Little, C., & Mitchell, R. (2000). Microbiological examination of cold ready-to-eat sliced meats from catering establishments in the United Kingdom. *Journal of Applied Microbiology* 88, 467-474.
- Gombas, D.E., Chen, Y., Clavero, R.S., & Scott, V.N. (2003). Survey of *Listeria monocytogenes* in ready-to-eat foods. *Journal of Food Protection* 66(4), 559-569.
- Grau, F.H. & Vanderlinde, P.B. (1992). Occurrence, number, and growth of *Listeria monocytogenes* on some vacuum-packaged processed meats. *Journal of Food Protection* 55(1), 4-7.
- Gudbjörnsdóttir, B., Suihko, M.L., Gustavsson, P., Thorkelsson, G., Salo, S., Sjöberg, A.M. *et al* (2004). The incidence of *Listeria monocytogenes* in meat, poultry and seafood plants in the Nordic countries. *Food Microbiology* 21(2), 217-225.
- Guerra, M.M., McLauchlin, J., & Bernardo, F.A. (2001). *Listeria* in ready-to-eat and unprocessed foods produced in Portugal. *Food Microbiology* 18, 423-429.
- ICMSF [International Commission on Microbiological Specifications for Foods] (1996). *Microorganisms in Foods 5, Characteristics of Microbial Pathogens*. Roberts, T.A., Baird-Parker, A.C. & Tompkin, R.B. (Eds.). Blackie Academic & Professional.
- Jay, J.M. (1996). Prevalence of *Listeria* spp. In meat and poultry products. *Food Control* 7(4/5), 209-214.
- Lake, R., Hudson, A., Cressey, P. & Nortje, G. (2002). *Risk profile: Listeria monocytogenes in processed ready-to-eat meats*. Retrieved 22 April 2008, from <http://www.nzfsa.govt.nz/science/risk-profiles/listeria-in-rte-meat.pdf>
- Latorre, L., Parisi, A., Fraccalvieri, R., Normanno, G., Nardella La Porta, M.C., Goffredo, E., *et al* (2007). Low prevalence of *Listeria monocytogenes* in foods from Italy. *Journal of Food Protection* 70(6), 1507-1512.
- Lester, R., Carnie, J., McLennan, L., Lambert, S., Kelsall, H., Ferreira, C. *et al* (1997). *Salmonella in Victoria, 1997: the story so far*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdi2109-pdf-cnt.htm/\\$FILE/cdi2109b.pdf](http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdi2109-pdf-cnt.htm/$FILE/cdi2109b.pdf)

- Levine, P., Rose, B., Green, S., Ransom, G., & Hill, W. (2001). Pathogen testing of ready-to-eat meat and poultry products collected at federally inspected establishments in the United States, 1990 to 1999. *Journal of Food Protection* 64(8), 1188-1193.
- Lianou, A., & Sofos, J.N. (2007). A review of the incidence and transmission of *Listeria monocytogenes* in ready-to-eat products in retail and food service environments. *Journal of Food Protection* 70(9), 2172-2198.
- Lin, C.M., Takeuchi, K., Zhang, L., Dohm, C.B., Meyer, J.D., Hall, P.A. *et al* (2006). Cross-contamination between processing equipment and deli meats by *Listeria monocytogenes*. *Journal of Food Protection* 69(1), 71-79.
- Little, C.L. & de Louvois, J. (1998). The microbiological examination of butchery products and butchers' premises in the United Kingdom. *Journal of Applied Microbiology* 85(1), 177 – 186.
- MLA [Meat & Livestock Australia] (2003). Through chain risk profile for the Australian red meat industry, PRMS.038c, part 1: risk profile. North Sydney: Meat and Livestock Australia.
- MLA [Meat & Livestock Australia] (2006). *Listeria monocytogenes* in smallgoods: Risks and controls. North Sydney: Meat and Livestock Australia.
- Millard, G. & Rockliff, S. (2003). Microbiological quality of long life refrigerated products. Retrieved 21 April 2008, from <http://health.act.gov.au/c/health?a=da&did=10060511&pid=1146804970>
- Nesbakken, T., Kapperud, G., & Caugant, D.A. (1996). Pathways of *Listeria monocytogenes* contamination in the meat processing industry. *International Journal of Food Microbiology* 31, 161-171.
- New Jersey Department of Health and Senior Services (2002). *Commissioner warns of listeria risk from consuming sliced turkey deli meat*. Retrieved 21 January 2008 from <http://www.nj.gov/health/news/p21007b.htm>
- Ng, D.L.K., & Seah, H.L. (1995). Isolation and identification of *Listeria monocytogenes* from a range of foods in Singapore. *Food Control* 6(3), 171-173.
- NSW Food Authority (2007). General Circular 06/2003 (updated April 2007). Microbiological and Chemical Testing of Cooked Ready-to-Eat Meat and Poultry Products. Retrieved 3 February 2009, from [http://www.foodauthority.nsw.gov.au/Documents/industry\\_circulars/GenCirc62003+2007+update .pdf](http://www.foodauthority.nsw.gov.au/Documents/industry_circulars/GenCirc62003+2007+update.pdf)
- OzFoodNet Working Group (2002). *Foodborne disease in Australia: incidence, notifications and outbreaks, annual report of the OzFoodNet network, 2002*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi2702-pdf-cnt.htm/\\$FILE/cdi2702g.pdf](http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi2702-pdf-cnt.htm/$FILE/cdi2702g.pdf)
- OzFoodNet Working Group (2003). *Foodborne disease investigation across Australia: annual report of the OzFoodNet network, 2003*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-pubs-2004-cdi2803-pdf-cnt.htm/\\$FILE/cdi2803h.pdf](http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-pubs-2004-cdi2803-pdf-cnt.htm/$FILE/cdi2803h.pdf)
- OzFoodNet Working Group (2004). *Reported foodborne illness and gastroenteritis in Australia: annual report of the OzFoodNet network, 2004*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi2902-pdf-cnt.htm/\\$FILE/cdi2902f.pdf](http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi2902-pdf-cnt.htm/$FILE/cdi2902f.pdf)
- OzFoodNet Working Group (2005). *Burden and causes of foodborne disease in Australia: annual report of the OzFoodNet network, 2005*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3003-pdf-cnt.htm/\\$FILE/cdi3003b.pdf](http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3003-pdf-cnt.htm/$FILE/cdi3003b.pdf)
- OzFoodNet (2006a). *OzFoodNet: quarterly report, 1 January to 31 March 2006*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3002-pdf-cnt.htm/\\$FILE/cdi3002f.pdf](http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3002-pdf-cnt.htm/$FILE/cdi3002f.pdf)

- OzFoodNet (2006b). *OzFoodNet: quarterly report, 1 April to 30 June 2006*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3003-pdf-cnt.htm/\\$FILE/cdi3003m.pdf](http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3003-pdf-cnt.htm/$FILE/cdi3003m.pdf)
- OzFoodNet (2007). *OzFoodNet: quarterly report, 1 January to 31 March 2006*. Retrieved 14 April 2008, from [http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3102-pdf-cnt.htm/\\$FILE/cdi3102l.pdf](http://www.health.gov.au/internet/wcms/Publishing.nsf/Content/cda-cdi3102-pdf-cnt.htm/$FILE/cdi3102l.pdf)
- Ryu, C.H., Igimi, S., Inoue, S., & Kumagai, S. (1992). The incidence of *Listeria* species in retail foods in Japan. *International Journal of Food Microbiology* 16, 157-160.
- Sagoo, S.K., Little, C.L., Allen, G., Williamson, K., & Grant, K.A. (2007). Microbiological safety of retail vacuum-packed and modified-atmosphere-packed cooked meats and end of shelf life. *Journal of Food Protection* 70(4), 943-951.
- Samelis, J., Kakouri, A., Georgiadou, K.G., & Metaxopoulos, J. (1998). Evaluation of the extent and type of bacterial contamination at different stages of processing of cooked ham. *Journal of Applied Microbiology* 84, 649-660.
- Sim, J., Hood, D., Finnie, L., Wilson, M., Graham, C., Brett, M., & Hudson, J.A. (2002). Series of incidents of *Listeria monocytogenes* non-invasive febrile gastroenteritis involving ready-to-eat meats. *Letters in Applied Microbiology* 35, 409-413.
- Sofos, J.N. (2008). Challenges to meat safety in the 21<sup>st</sup> century. *Meat Science*, 78(1-2), 3-13.
- Uyttendaele, M., De Troy, P. & Debevere, J. (1999). Incidence of *Listeria monocytogenes* in different types of meat products on the Belgian retail market. *International Journal of Food Microbiology* 53, 75-80.
- Vitas, A.I., Aguado, V., & Garcia-Jalon, I. (2004). Occurrence of *Listeria monocytogenes* in fresh and processed foods in Navarra (Spain). *International Journal of Food Microbiology* 90, 349-356.
- Vorst, K.L., Todd, E.C.D., & Ryser, E.T. (2006). Transfer of *Listeria monocytogenes* during mechanical slicing of turkey breast, bologna, and salami. *Journal of Food protection* 69(3), 619-626.
- Ward, K., Hammond, R., Katz, D., & Hallman, D. (1997). Outbreak of staphylococcal food poisoning associated with precooked ham – Florida, 1997. *Morbidity and Mortality Weekly Report* 46(50), 1189-1191. Retrieved 11 April 2008, from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00050415.htm>
- Westbrook, J., Kraa, E., & Levy, M. (1993). *Investigating a suspected outbreak*. Retrieved 14 April 2008, from <http://www.health.nsw.gov.au/public-health/phb/phbjan93.pdf>
- Western Australian Food Monitoring Program (1999). *How safe are delicatessen meats?* Retrieved 22 April 2008, from [http://www.health.wa.gov.au/envirohealth/food/docs/How\\_Safe\\_are\\_Delicatessen\\_Meats.pdf](http://www.health.wa.gov.au/envirohealth/food/docs/How_Safe_are_Delicatessen_Meats.pdf)
- Wojtas, F. & Christen, S. (1997). *Preservative levels and microbiological quality of manufactured meat*. Retrieved 21 April 2008, from <http://health.act.gov.au/c/health?a=da&did=10017576&pid=1053857549>
- Wong, T.L., Carey-Smith, G.V., Hollis, L., & Hudson, J.A. (2005). Microbiological survey of prepackaged pâté and ham in New Zealand. *Letters in Applied Microbiology* 41, 106-111.
- Zimomra, J., Wenderoth, T., Snyder, A., Russ, R., Peterson, E.D., French, R., *et al* (1994). *Clostridium perfringens* gastroenteritis associated with corned beef served at St. Patrick's day meals – Ohio and Virginia, 1993. *Morbidity and Mortality Weekly Report* 43(8), 137-138, 143-144. Retrieved 14 April 2008, from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00025191.htm>

## **Appendices**

Appendix 1: Survey results

Appendix 2: Food recalls in Australia for RTE meat and poultry products

Appendix 3: Foodborne illness outbreaks due to RTE meat and poultry products

Appendix 4: Previous microbiological surveys of RTE meats



## Appendix 1: Survey results

Product name	CPS (cfu/g)	Thermotolerant coliforms (cfu/g)	<i>E. coli</i> (cfu/g)	<i>Salmonella</i> (/25g)	<i>Listeria</i> (/25g)	<i>L. monocytogenes</i> (/25g)	<i>L. monocytogenes</i> count (cfu/g)	VTEC (/g)	a <sub>w</sub>	pH
Shaved chicken breast	<sup>2</sup>	<3	<3	ND <sup>3</sup>	ND	ND	<10	–	–	–
Aust. turkey	–	<3	<3	ND	ND	ND	<10	–	–	–
Aust. pancetta mild	–	<3	<3	ND	Detected	ND	<10	–	0.95	5.2
Aust. coppa mild	–	<3	<3	ND	ND	ND	<10	–	0.94	5.5
Double-smoked ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Aust. pastrami	–	<3	<3	ND	ND	ND	<10	–	–	–
Pancetta	–	<3	<3	ND	ND	ND	<10	–	0.94	5.5
Prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.94	5.8
Mortadella	–	<3	<3	ND	ND	ND	<10	–	–	–
Ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Oven roasted turkey breast	–	<3	<3	ND	Detected	ND	<10	–	–	–
Coppa	–	<3	<3	ND	ND	ND	<10	–	0.93	6.1
Lachs schinken	–	<3	<3	ND	ND	ND	<10	–	0.93	5.4
Continential pepperham	–	<3	<3	ND	ND	ND	<10	–	0.91	5.6
Black Forest ham	–	<3	<3	ND	ND	ND	<10	–	0.91	5.4
Smoked pancetta	–	<3	<3	ND	ND	ND	<10	–	–	–
Premium leg ham 97% fat free shaved	–	<3	<3	ND	Detected	Detected	<10	–	–	–
Kangaroo prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.92	4.9
Pancetta	–	<3	<3	ND	ND	ND	<10	–	–	–
Lonza (pork loin)	–	<3	<3	ND	ND	ND	<10	–	–	–
Honey leg ham	–	<3	<3	ND	ND	ND	<10	–	–	–

<sup>2</sup> - sample was not tested for this organism

<sup>3</sup> ND - Not detected

Product name	CPS (cfu/g)	Thermotolerant coliforms (cfu/g)	<i>E. coli</i> (cfu/g)	<i>Salmonella</i> (/25g)	<i>Listeria</i> (/25g)	<i>L. monocytogenes</i> (/25g)	<i>L. monocytogenes</i> count (cfu/g)	VTEC (/g)	a <sub>w</sub>	pH
Prosciutto boneless whole	–	<3	<3	ND	ND	ND	<10	–	0.9	5.9
Corned beef	–	<3	<3	ND	ND	ND	<10	–	–	–
Sliced leg ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Chicken breast Portuguese style	–	<3	<3	ND	ND	ND	<10	–	–	–
Shaved turkey breast	–	<3	<3	ND	ND	ND	<10	–	–	–
Bresaola	–	<3	<3	ND	ND	ND	<10	–	0.88	5.3
Premium sliced pastrami	–	<3	<3	ND	ND	ND	<10	–	–	–
Premium sliced leg ham	–	<3	<3	ND	Detected	ND	<10	–	–	–
Sliced pancetta	–	<3	<3	ND	ND	ND	<10	–	0.95	5.2
Smoked prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.95	5.1
Prosciutto di parma	–	<3	<3	ND	ND	ND	<10	–	0.91	5.7
Prosciutto di parma	–	<3	<3	ND	ND	ND	<10	–	0.91	6
Jamon iberilo prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.87	5.7
Thinly sliced prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.91	6
Ham nitrate & sugar free	–	<3	<3	ND	ND	ND	<10	–	0.95	5.2
Bastorma	–	<3	<3	ND	ND	ND	<10	–	–	–
Shaved ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.92	5.6
Sliced devon	–	<3	<3	ND	ND	ND	<10	–	–	–
Pancetta	–	<3	<3	ND	Detected	ND	<10	–	0.9	5.1
Turkey breast - sliced	–	<3	<3	ND	ND	ND	<10	–	–	–
Premium leg ham - shaved	–	<3	<3	ND	ND	ND	<10	–	–	–
Prosciutto, Spanish style (sweet serrano)	–	<3	<3	ND	ND	ND	<10	–	0.94	6.4
Lamb prosciutto	<100	<3	<3	ND	ND	ND	<10	–	0.89	5.3
Prosciutto di parma	<100	<3	<3	ND	ND	ND	<10	–	0.92	5.9

Product name	CPS (cfu/g)	Thermotolerant coliforms (cfu/g)	<i>E. coli</i> (cfu/g)	<i>Salmonella</i> (/25g)	<i>Listeria</i> (/25g)	<i>L. monocytogenes</i> (/25g)	<i>L. monocytogenes</i> count (cfu/g)	VTEC (/g)	a <sub>w</sub>	pH
Continental pepper ham	<100	<3	<3	ND	ND	ND	<10	–	0.92	5.5
Prosciutto	<100	<3	<3	ND	ND	ND	<10	–	0.9	6.3
Prosciutto crudo	<100	<3	<3	ND	ND	ND	<10	–	0.93	6
Smoked turkey free range	<100	<3	<3	ND	ND	ND	<10	–	–	–
Oven roasted turkey breast	<100	<3	<3	ND	Detected	ND	<10	–	–	–
Smoked beef	<100	<3	<3	ND	ND	ND	<10	–	–	–
Sliced shoulder ham	<100	<3	<3	ND	ND	ND	<10	–	–	–
Ham free range	<100	<3	<3	ND	ND	ND	<10	–	–	–
Portuguese style chicken breast	<100	<3	<3	ND	ND	ND	<10	–	–	–
Prosciutto	<100	<3	<3	ND	ND	ND	<10	–	0.92	5.9
Pancetta	<100	<3	<3	ND	ND	ND	<10	–	0.73	6.1
Smoked roast beef	<100	<3	<3	ND	Detected	Detected	<10	–	–	–
Silverside		<3	<3	ND	ND	ND	<10	–	–	–
Thin sliced Hungarian salami	<100	<3	<3	ND	ND	ND	<10	ND	–	–
Sliced salami	<100	<3	<3	ND	ND	ND	<10	ND	–	–
Aust. Danish salami	<100	<3	<3	ND	ND	ND	<10	ND	0.96	4.7
Sliced Danish salami	<100	<3	<3	ND	ND	ND	<10	ND	0.92	4.8
Salami sopresso	<100	<3	<3	ND	Detected	Detected	10	ND	0.92	5.7
Leg ham		<3	<3	ND	ND	ND	<10	–	–	–
Hot Hungarian salami	<100	<3	<3	ND	ND	ND	<10	–	0.9	4.7
Prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.96	5.4
Double-smoked ham	–	<3	<3	ND	Detected	Detected	10	–	–	–
Coppa	–	<3	<3	ND	ND	ND	<10	–	–	–
Lite ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Turkey roll	–	<3	<3	ND	ND	ND	<10	–	–	–
Leg ham	–	<3	<3	ND	ND	ND	<10	–	–	–

Product name	CPS (cfu/g)	Thermotolerant coliforms (cfu/g)	<i>E. coli</i> (cfu/g)	<i>Salmonella</i> (/25g)	<i>Listeria</i> (/25g)	<i>L. monocytogenes</i> (/25g)	<i>L. monocytogenes</i> count (cfu/g)	VTEC (/g)	a <sub>w</sub>	pH
Spanish prosciutto jamon serrano	–	<3	<3	ND	ND	ND	<10	–	0.91	5.9
Danish salami	<100	<3	<3	ND	ND	ND	<10	ND	–	–
Casalingo salame	<100	<3	<3	ND	detected	ND	<10	ND	0.94	6
Prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.92	5.4
Pastrami	–	<3	<3	ND	ND	ND	<10	–	–	–
Double-smoked pancetta	–	<3	<3	ND	ND	ND	<10	–	0.98	5.9
Turkey breast	–	<3	<3	ND	ND	ND	<10	–	–	–
Devon	–	<3	<3	ND	ND	ND	<10	–	–	–
Chicken breast	–	<3	<3	ND	ND	ND	<10	–	–	–
Venison prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.91	6.3
Pancetta	–	<3	<3	ND	ND	ND	<10	–	0.94	5.8
Coppa	–	<3	<3	ND	ND	ND	<10	–	0.93	6.1
Prosciutto	–	<3	<3	ND	ND	ND	<10	–	0.97	5.6
Prosciutto	–	<3	<3	ND	ND	ND	<10	–	–	–
Mortadella	–	<3	<3	ND	ND	ND	<10	–	–	–
Salami	<100	<3	<3	ND	ND	ND	<10	ND	–	–
Soccer ball leg ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Bertocchi serrano ham	–	<3	<3	ND	ND	ND	<10	–	0.9	5.9
Sliced prosciutto	–	<3	<3	ND	ND	ND	<10	ND	0.91	5.6
Mild sopressa	<100	<3	<3	ND	ND	ND	<10	–	0.92	4.8
Sliced Polish salami	<100	<3	<3	ND	ND	ND	<10	ND	–	–
Sliced sandwich ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Sliced corned silverside	–	<3	<3	ND	ND	ND	<10	–	0.98	6.1
Sliced leg ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Pancetta	–	<3	<3	ND	ND	ND	<10	–	0.87	5.8
Coppa	–	<3	<3	ND	ND	ND	<10	–	0.86	6.2
Honey ham	–	<3	<3	ND	ND	ND	<10	–	–	–

Product name	CPS (cfu/g)	Thermotolerant coliforms (cfu/g)	<i>E. coli</i> (cfu/g)	<i>Salmonella</i> (/25g)	<i>Listeria</i> (/25g)	<i>L. monocytogenes</i> (/25g)	<i>L. monocytogenes</i> count (cfu/g)	VTEC (/g)	a <sub>w</sub>	pH
Gypsy ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Smoked pork fillet	–	<3	<3	ND	ND	ND	<10	–	0.97	6.2
Prosciutto sliced	–	<3	<3	ND	ND	ND	<10	–	–	–
Gourmet salami hot	<100	<3	<3	ND	ND	ND	<10	ND	0.93	4.9
San daniele prosciutto	<100	<3	<3	ND	ND	ND	<10	ND	0.91	5.9
Salami sopressa	<100	<3	<3	ND	ND	ND	<10	ND	0.89	4.7
Berliner	–	<3	<3	ND	ND	ND	<10	–	–	–
Roast beef	–	<3	<3	ND	ND	ND	<10	–	–	–
Chicken supreme	–	<3	<3	ND	ND	ND	<10	–	–	–
Prosciutto	<100	<3	<3	ND	ND	ND	<10	ND	0.91	6.1
Gypsy ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Porchetta	<100	<3	<3	ND	ND	ND	<10	ND	0.96	5.7
Oven roasted turkey breast	–	<3	<3	ND	ND	ND	<10	–	–	–
Chilli chicken breast smoked	–	<3	<3	ND	ND	ND	<10	–	–	–
Ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Cooked silverside	–	<3	<3	ND	ND	ND	<10	–	–	–
Cooked beef	–	<3	<3	ND	ND	ND	<10	–	–	–
Leg ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Coppa	<100	<3	<3	ND	ND	ND	<10	–	–	–
Prosciutto	<100	<3	<3	ND	ND	ND	<10	–	–	–
Ham deluxe	–	<3	<3	ND	ND	ND	<10	–	–	–
Roast beef	–	<3	<3	ND	ND	ND	<10	–	–	–
Sliced ham chardonnay	–	<3	<3	ND	ND	ND	<10	–	–	–
Smoked leg ham	–	4	4	ND	ND	ND	<10	–	–	–
Leg ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Devon	–	<3	<3	ND	ND	ND	<10	–	–	–
Cooked beef	–	<3	<3	ND	ND	ND	<10	–	–	–

Product name	CPS (cfu/g)	Thermotolerant coliforms (cfu/g)	<i>E. coli</i> (cfu/g)	<i>Salmonella</i> (/25g)	<i>Listeria</i> (/25g)	<i>L. monocytogenes</i> (/25g)	<i>L. monocytogenes</i> count (cfu/g)	VTEC (/g)	a <sub>w</sub>	pH
Silverside	–	<3	<3	ND	Detected	ND	<10	–	–	–
Soccerball ham	–	<3	<3	ND	ND	ND	<10	–	–	–
Pastrami	–	<3	<3	ND	ND	ND	<10	–	–	–
Cooked silverside	–	<3	<3	ND	Detected	Detected	<10	–	–	–
Ham deluxe	–	<3	<3	ND	ND	ND	<10	–	–	–
Devon	–	<3	<3	ND	ND	ND	<10	–	–	–
Devon	–	<3	<3	ND	ND	ND	<10	–	–	–
Chicken	–	<3	<3	ND	ND	ND	<10	–	–	–
Sopressa salami mild	<100	<3	<3	ND	ND	ND	<10	–	–	–
Bresaola	<100	<3	<3	ND	ND	ND	<10	–	0.91	6.1
Tartufo	<100	<3	<3	ND	Detected	Detected	<10	–	0.93	5.4
Sliced serrano jamon	<100	<3	<3	ND	ND	ND	<10	–	–	–
Casalingo	<100	<3	<3	ND	ND	ND	<10	–	–	–
Sliced prosciutto	–	<3	<3	ND	Detected	ND	<10	–	0.91	5.6
Pancetta	<100	<3	<3	ND	ND	ND	<10	–	–	–
Hot Spanish salami	<100	<3	<3	ND	ND	ND	<10	–	0.97	4.6
Polish kielbasa	<100	<3	<3	ND	ND	ND	<10	–	0.97	4.6
Prosciutto sliced	<100	<3	<3	ND	ND	ND	<10	–	–	–
Sliced emu prosciutto	<100	<3	<3	ND	ND	ND	<10	–	–	–
Smoked bresola	<100	<3	<3	ND	ND	ND	<10	–	–	–
Kangaroo prosciutto	<100	<3	<3	ND	ND	ND	<10	–	–	–
Classic prosciutto	<100	<3	<3	ND	ND	ND	<10	–	–	–
Lamb prosciutto	<100	<3	<3	ND	ND	ND	<10	–	–	–
Smoked boneless leg of lamb	–	<3	<3	ND	ND	ND	<10	–	–	–
Smoked kangaroo	–	<3	<3	ND	ND	ND	<10	–	–	–
Smoked turkey breast	–	4	<3	ND	ND	ND	<10	–	–	–
Smoked leg ham one out	–	<3	<3	ND	ND	ND	<10	–	–	–

Product name	CPS (cfu/g)	Thermotolerant coliforms (cfu/g)	<i>E. coli</i> (cfu/g)	<i>Salmonella</i> (/25g)	<i>Listeria</i> (/25g)	<i>L. monocytogenes</i> (/25g)	<i>L. monocytogenes</i> count (cfu/g)	VTEC (/g)	a <sub>w</sub>	pH
Prosciutto	–	<3	<3	ND	ND	ND	<10	–	–	–

**Appendix 2: Food recalls in Australia for RTE meat and poultry products (2004–2009)**

Year	Month	Products	Reason for recall
2004	August	Hungarian salami	Insufficient salt during processing
2004	December	Cooked roast meat	<i>L. monocytogenes</i> contamination
2004	January	Shaved BBQ chicken	<i>L. monocytogenes</i> contamination
2004	January	Sliced leg ham	<i>L. monocytogenes</i> contamination
2004	January	Sliced roast beef	<i>L. monocytogenes</i> contamination
2004	February	Brawn	<i>L. monocytogenes</i> contamination
2004	February	Sliced ham	<i>L. monocytogenes</i> contamination
2005	September	A range of deli goods sliced packaged meats	<i>L. monocytogenes</i> contamination
2005	September	Devon knob	Insufficient cooking
2005	December	A range of smallgoods	<i>L. monocytogenes</i> (environmental)
2006	January	Silverside	<i>L. monocytogenes</i> contamination
2006	May	Smoked chicken	<i>L. monocytogenes</i> contamination
2006	June	Luncheon ham & chicken meat	Plastic fragment
2006	July	A range of smallgoods	Precautionary health measure due to infected employee (virus)
2006	September	Sliced Moroccan lamb	<i>L. monocytogenes</i> contamination
2007	March	Cacciatori	<i>L. monocytogenes</i> contamination
2007	April	Chicken breast shaved	<i>L. monocytogenes</i> contamination
2007	April	Prosciutto & sliced ham	<i>L. monocytogenes</i> contamination
2007	May	Cacciatori, Veneto, & Sopressa	<i>Salmonella</i> contamination
2007	September	Corned silverside	<i>L. monocytogenes</i> contamination
2007	September	Sliced cooked beef (deli)	<i>L. monocytogenes</i> contamination
2007	October	Sliced ham & silverside	<i>L. monocytogenes</i> contamination
2007	November	Pastrami	<i>L. monocytogenes</i> contamination
2008	February	Cabanossi	<i>L. monocytogenes</i> contamination
2008	March	Smoked chicken, sliced	<i>L. monocytogenes</i> contamination
2008	March	Smoked ham, sliced	<i>L. monocytogenes</i> contamination
2008	July	Ham	<i>L. monocytogenes</i> contamination
2008	August	Roast beef, pastrami sliced	<i>L. monocytogenes</i> contamination
2008	September	Chicken breast sliced	<i>L. monocytogenes</i> contamination
2009	March	Mortadella, pancetta, salami	<i>L. monocytogenes</i> contamination



### Appendix 3: Foodborne illness outbreaks attributed to RTE meat and poultry products (1984–2008)

Year	Country	Food implicated	Pathogen	Cases (deaths)	Reference
1984	England & Wales	Ham	<i>S. Virchow</i>	274	D'Aoust (1989)
1991	Australia (SA)	Casalingo salami	<i>S. Anatum</i>	100	Baldwin <i>et al</i> (1992) as cited in FSA & Minter Ellison Consulting (2002)
1991	Australia (NSW)	Salami	<i>S. Typhimurium</i> PT9	20	Westbrook <i>et al</i> (1993)
1992	Australia (WA)	Felino salami	<i>S. Typhimurium</i>	30	Anonymous (1992) as cited in FSA & Minter Ellison Consulting, 2002
1993	USA (Ohio)	Corned beef	<i>C. perfringens</i>	156	Zimomra <i>et al</i> (1994)
1993	USA (Virginia)	Corned beef	<i>C. perfringens</i>	85	Zimomra <i>et al</i> (1994)
1994	USA	Dry-cured salami	<i>E. coli</i> O157:H7	20	Alexander <i>et al</i> (1995)
1995	Australia (SA)	Mettwurst (uncooked)	<i>E. coli</i> O111	173 (1)	Cameron <i>et al</i> (1995)
1997	Australia (Vic, SA)	Sliced corned beef or ham	<i>S. Muenchen</i>	32 (2)	Lester <i>et al</i> (1997)
1997	USA	Precooked ham	staphylococcal enterotoxin type A	18	Ward <i>et al</i> (1997)
1999	Australia (Vic)	Ham & corned beef	<i>S. Anatum</i>	25	Queensland Health as cited in FSA & Minter Ellison Consulting (2002)
2000	New Zealand	Corned silverside & ham	<i>L. monocytogenes</i>	26	Sim <i>et al</i> (2002)
2000	Australia (Vic)	Sucuk (uncooked fermented meat)	<i>S. Typhimurium</i> PT170	8	Anonymous (2000) as cited in FSA & Minter Ellison Consulting (2002)
2002	USA	Sliced turkey deli meat	<i>L. monocytogenes</i>	21 (7)	Anonymous (2002)
2002	Australia (SA)	Sliced ham	<i>S. Typhimurium</i> 43	unknown	OzFoodNet (2002)
2004	Australia (NSW)	Ham & bacon (suspected)	unknown	12	OzFoodNet Working Group (2004)
2005	Australia (SA)	Cold meats	<i>Listeria</i>	3	OzFoodNet Working Group (2005)
2006	Australia (Vic)	Capocollo (cured pork shoulder)	<i>S. Bovismorbificans</i> 11	13	OzFoodNet (2006b)
2006	Norway	Salami	<i>S. Kedougou</i>	54	Emberland <i>et al</i> (2006)
2006	Australia (Vic)	Salami (non-commercial)	<i>S. London</i>	5	OzFoodNet (2006a)
2007	Australia (Qld)	Ham (with salad & bread)	Norovirus	45	OzFoodNet (2007)
2008	Canada	Deli meats	<i>L. monocytogenes</i>	50 (20)	Doolittle (2008)

#### Appendix 4. Summary of selected microbiological surveys of RTE meats

Year	Country	Samples	No of samples	Organisms tested	Positive samples	Reference
1988-93	Australia (NSW)	Smallgoods	103	<i>Listeria</i> spp <i>L. monocytogenes</i>	34 (33%) 18 (17.5%)	Arnold & Coble (1995)
1990	Japan	Roast beef & ham	10	<i>L. monocytogenes</i>	0	Ryu <i>et al</i> (1992)
1990-97	Chile	RTE processed meats	521	<i>L. monocytogenes</i>	11 (2.1%)	Cordano & Rocourt (2001)
1991-2000	Cyprus	Cured meats	1567	<i>Salmonella</i>	2 (0.1%)	Eleftheriadou, Varnava-Tello, Metta-Loizidou, Nikolaou, & Akkelidou (2002)
1992	Australia	Sliced corned beef, ham, luncheon meat (all vacuum packed)	156	<i>L. monocytogenes</i>	78 (50%)	Grau & Vanderlinde (1992)
1992-93	Singapore	Ham, salami, bacon, luncheon meat	17	<i>L. monocytogenes</i>	3 (17.6%)	Ng & Seah (1995)
1993-2004	Italy	RTE cooked/salted treated meats	151	<i>L. monocytogenes</i>	4 (2.6%)	Latorre <i>et al</i> (2007)
1993-97	Korea	Ham	50	<i>L. monocytogenes</i>	0	Baek, Lim, Lee, Min & Kim (2000)
1997	Australia (ACT)	Manufactured meat	44	<i>E. coli</i> <i>L. monocytogenes</i> <i>C. perfringens</i> CPS <i>Salmonella</i>	3 (6.8%) 2 (4.5%) 0 1 (2.3%) 0	Wojtas & Christen (1997)
1997-98	Belgium	Sliced ham, loin, poultry	1038	<i>L. monocytogenes</i>	69 (6.6%)	Uyttendaele, De Troy, & Debevere (1999)
1997-99	Spain	Sliced cooked meats, cured meats	741	<i>Listeria</i> spp <i>L. monocytogenes</i>	117(15.8%) 58 (7.8%)	Vitas, Aguado, & Garcia-Jalon (2004)
1998	Australia (ACT)	Cured & salted meat	65 61	CPS <i>E. coli</i> <i>L. monocytogenes</i>	2 (3.1%) 4 (6.2%) 9 (14.8%)	Christen & Millard (1998)
1998-2000	Portugal	RTE cooked/cured meats	47	<i>Listeria</i> spp <i>L. monocytogenes</i>	21 (45%) 10 (21%)	Guerra, McLauchlin, & Bernardo (2001)

Year	Country	Samples	No of samples	Organisms tested	Positive samples	Reference
1998-99	Nordic countries	RTE meat	43	<i>L. monocytogenes</i>	1 (2.3%)	Gudbjörnsdóttir <i>et al</i> (2004)
1999	Brazil	Salami	81	<i>L. monocytogenes</i>	6 (7.5%)	De Fatima Borges, de Siqueira, Bittencourt, Vanetti & Gomide (1999)
1999	Australia (WA)	RTE delicatessen meats	276	<i>L. monocytogenes</i>	6 (2%)	Western Australia Food Monitoring Program (1999)
2000-01	USA	Sliced luncheon meats	9199	<i>L. monocytogenes</i>	82 (0.9%)	Gombas, Chen, Clavero & Scott (2003)
2002	UK	RTE cold sliced meat	2890 2890 2886 2874 2874 2874 2824 2887	SPC <i>Enterobacteriaceae</i> <i>E. coli</i> <i>Listeria</i> spp <i>L. monocytogenes</i> (qualitative) <i>L. monocytogenes</i> (quantitative) <i>Campylobacter</i> <i>Salmonella</i>	2798 (96.8%) 1143 (39.6%) 81 (2.8%) 180 (62.6%) 61 (2.1%) 60 <20 cfu/g 1 (0.03%) 0	Elson, Burgess, Little, & Mitchell (2004)
2003	Australia (ACT)	Packaged, RTE long shelf life refrigerated product	86	<i>Salmonella</i> <i>L. monocytogenes</i>	0 0	Millard & Rockliff (2003)
2003	Ireland	Packaged cooked sliced ham	619	SPC <i>Enterobacteriaceae</i> <i>L. monocytogenes</i> (qualitative) <i>L. monocytogenes</i> (quantitative)	13% unsatisfactory 4% unsatisfactory 1 (0.2%) all <20 cfu/g	Food Safety Authority of Ireland (2003)

Year	Country	Samples	No of samples	Organisms tested	Positive samples	Reference
2003	UK	Packaged RTE meat	2968 2968 2962 2960 2952 2970 2976 2976 2954 2971	SPC <i>Enterobacteriaceae</i> <i>E. coli</i> <i>S. aureus</i> <i>C. perfringens</i> <i>Listeria</i> spp <i>L. monocytogenes</i> (qualitative) <i>L. monocytogenes</i> (quantitative) <i>Campylobacter</i> <i>Salmonella</i>	2858 (96.3%) 974 (32.8%) 10 (0.3%) 9 (0.3%) 4 (0.1%) 263 (8.8%) 190 (6.3%) 143 <20 cfu/g 1 (0.03%) 0	Sagoo, Little, Allen, Williamson, & Grant (2007)
2003-04	New Zealand	Packaged RTE ham	104	<i>Listeria</i> <i>L. monocytogenes</i>	7 (6.7%) 1 (1%)	Wong, Carey-Smith, Hollis, & Hudson (2005)
2004	Greece	Packaged RTE meat products	209	<i>L. monocytogenes</i>	17 (8.1%)	Angelidis & Koutsoumanis (2006)

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