

# **Report on the prevalence of *Salmonella* and *E. coli* in ready to eat nuts and nut products sold in Australia**

A survey conducted under the Coordinated Food Survey Plan with participation from food regulatory jurisdictions in NSW, ACT, QLD, TAS, and WA.

Report prepared by the NSW Food Authority

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## Executive Summary

Nuts have traditionally been considered a microbiologically safe product because of their low water activity (generally less than 0.7) (Danyluk et al., 2007). However, there have been a number of documented foodborne illness outbreaks recently caused by *Salmonella* in nut and nut products. This has raised awareness of nuts as a potential vehicle for foodborne illness. Most notably, *Salmonella* in peanut butter in the USA caused food borne illness in over 600 people in 2006 and over 500 people in 2007, including over 100 hospitalisations and contributing to 8 deaths (CDC, 2007). In addition there has also been numerous international recalls of nuts due to microbiological contamination, including a large recall of pistachio nuts in the United States due to *Salmonella* (CDC, 2009b).

A number of studies have been conducted to determine the prevalence of *Salmonella* in nuts and nut products. Prevalence of *Salmonella* detected in these surveys ranged from 0 to 2.8%. *E. coli* has also been isolated from nuts with prevalence from 0 to 2.1%.

Given the number of outbreaks and recalls related to these products and the lack of recent data in Australia on nuts and nut products available at retail level, this survey was conducted with the objective to gather information on the prevalence of *Salmonella* and *E. coli* in ready to eat (RTE) nuts and their products (both imported and domestically produced products). Results of this survey will be used to inform consumers, manufacturers and regulatory authorities of the microbiological quality of nut and nut products in Australia.

Between January and June 2011, a total of 915 samples were collected across Australia and analysed for *Salmonella* and *E. coli*. Results were assessed against Food Standards Australia New Zealand's (FSANZ) guidelines for the microbiological examination of ready to eat foods (FSANZ, 2001).

The survey found that the microbiological quality of nuts and nut products in Australia is generally very good. Only one sample of unpackaged macadamia nut was categorised as potentially dangerous due to the presence of *Salmonella* Aberdeen. A follow up sampling of another unpackaged macadamias sample from the same retailer was negative for *Salmonella*.

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## 1. Introduction

### Nut Cultivation in Australia and New Zealand

The nut industry in Australia and New Zealand is a mixture of large 'corporate' farms and small to medium sized family farms. The Australian Nut Industry Council (ANIC) estimated that current Australian nut production has a commercial value of about \$350 million. Despite an expanding Australian domestic market, the majority of Australian production is exported to Japan, Europe and the United States (ANIC, 2009).

The main nuts produced in Australia are macadamias, almonds, chestnuts, hazelnuts, pecans, pistachios and walnuts

The nut cultivation industry in New Zealand is relatively small. The main crops are chestnuts, macadamias and walnuts. NZ imports nuts largely from Australia and the US (Horticulture & Food Research Institute of New Zealand Ltd, 2007).

The Apparent Consumption of Foodstuffs (ABS, 2000) states that in Australia, the apparent per capita consumption of peanuts rose by 16.2% to 2.3kg in 1998 – 99, but the consumption of tree nuts fell by 5.8% to 4.8kg per capita.

### Microbiological issues

Nuts have traditionally been considered microbiologically safe products because of their low water activity (generally less than 0.7) (Danyluk et al., 2007). However, raw macadamia nuts are frequently contaminated with *Salmonella*, possibly due to harvesting techniques (C. Bright, personal communication, December 22, 2011).

To assist with the shelf life, finished products may contain permitted preservatives or heat processed and/or packed in hermetically sealed containers (Wareing, Nicolaides, & Twiddy, 2000).

Historically, the major microbiological issue with nuts has been the control of mycotoxins produced by fungi such as *Aspergillus flavus* and *Aspergillus parasiticus*. However, recently there have been a number of documented foodborne illness outbreaks caused by *Salmonella* in nut and nut products. This has raised awareness of nuts as a potential vehicle for foodborne illness.

*Salmonella* cannot multiply on nuts or in nut products, however the organism can survive on and in these products, for an extended period (greater than one year), especially when held in cold storage (Danyluk et al., 2007).

*E. coli* contamination in nut and nut products is also a concern as the presence of *E. coli* in nuts normally indicates that products have been handled poorly during processing. Manual de-shelling also increases the exposure to microbial contamination (Freire, & Offord, 2002).

### Outbreaks and recalls

There have been a number of large outbreaks associated with nut and nut products in Australia and overseas. For example, in 1996, fifteen people were infected by *Salmonella* Mbandaka due to consumption of peanut butter in Australia (Scheil et al., 1998). Also, in 2001, there was an international outbreak of *Salmonella* Stanley and *S. Newport* associated with consumption of a specific brand of imported peanuts (Kirk et al., 2004). Most notable outbreak was *Salmonella* in peanut butter in the USA that caused food borne illness in over 600 people in 2006 and over 500 people in 2007, including over 100 hospitalisations and contributing to 8 deaths (CDC, 2007). Recent outbreaks are listed in Appendix 1. All outbreaks noted in Appendix 1 resulted in significant product recalls.

In addition, there have also been many recalls of nuts due to microbiological contamination, including a large recall of pistachio nuts in the United States due to *Salmonella* (CDC, 2009b).

#### Previous studies

A number of studies have been conducted to determine the prevalence of *Salmonella* in nuts and nut products. Prevalence of *Salmonella* detected in these surveys ranged from 0 to 2.8%. *E. coli* has also been isolated from nuts with prevalence from 0 to 2.1%. The full details of these studies are in Appendix 2 and 3.

A study on the bacteriological quality of pre-roasted kernels of peanuts, almonds, cashews, hazelnuts and Brazil nuts received into three Australian nut processing facilities was conducted between 2003 and 2006 (Eglezos, Huang, & Studdard, 2008). A total of 921 samples were analysed for *Salmonella* and *E. coli*. No samples were positive for *E. coli* and one almond sample was positive for *Salmonella*. No roasted kernels were analysed in this survey.

## **2. Survey Objective**

There is the lack of recent data in Australia on nuts and nut products available at retail level, thus a survey was conducted under the Coordinated Survey Plan of the Implementation Sub Committee (ISC) of the Food Regulation Standing Committee (FRSC) with the objective to gather information on the prevalence of *Salmonella* and *E. coli* in ready to eat (RTE) nuts and their products (both imported and domestically produced products).

Samples were collected from retailers, manufacturers and growers in New South Wales (NSW), the Australian Capital Territory (ACT), Queensland (QLD), Tasmania (TAS), and Western Australia (WA).

Results of this survey will be used to inform consumers, manufacturers and regulatory authorities of the microbiological quality of nut and nut products in Australia.

## **3. ISC Coordinated Food Survey**

On 30 October 2003 the Food Regulation Standing Committee's Implementation Sub-Committee (ISC) agreed to the development of a 'Coordinated Food Survey Plan' (the Plan) for the Australian jurisdictions, food regulatory partners and New Zealand. This was in recognition that there were significant advantages in implementing agreed national survey priorities in a prospective and coordinated manner. A national coordinated survey of the microbiological quality of ready to eat nuts and nut products was proposed by the NSW Food Authority and endorsed by ISC for inclusion on the Plan for 2010/2011.

## **4. Sample collection**

Products sampled included pre-packaged plain or salted nuts, unpackaged plain or salted nuts and nut products such as flavoured nuts, bars, spreads and sauces. Domestically produced nuts as well as imported nuts were included in the survey.

Products excluded from this survey were items where nuts were not the major component such as breakfast cereals, dairy products, chocolate covered nuts, fruit and nut mix, and seeds and seed products (such as pine nuts).

A total of 915 nut and nut product samples were analysed during the course of the survey. The breakdown of the type of samples analysed is outlined Table 1. Samples collected by each participating jurisdiction are outlined in Appendix 5.

**Table 1: Number of products sampled per category\***

<b>nut type</b>	<b>packaged</b>	<b>unpackaged</b>	<b>nut product</b>	<b>total</b>
almonds	55	63	13	131
brazil nuts	33	27	2	62
cashews	47	46	24	117
hazelnuts	10	18	6	34
macadamias	31	28	17	76
mixed nuts	35	46	50	131
peanuts	18	71	107	196
pecans	2	10	0	12
pistachios	40	34	2	76
walnuts	49	29	2	80
<b>total</b>	<b>320</b>	<b>372</b>	<b>223</b>	<b>915</b>

\* A number of products were tested during the course of the survey but they have been excluded from this report since they were out of the scope of the survey.

## 5. Method of analysis

Samples were tested quantitatively for *E. coli* and qualitatively for *Salmonella* spp. The list of laboratories and methods used are listed in Appendix 4.

Analytical results were assessed against FSANZ's guidelines for the microbiological examination of ready to eat foods (FSANZ, 2001).

**Table 2. Guideline levels for determining the microbiological quality of nuts and their products**

<b>Test</b>	<b>Microbiological result (cfu/g)</b>			
	<b>Acceptable</b>		<b>Unsatisfactory</b>	<b>Potentially hazardous</b>
	<b>Satisfactory</b>	<b>Marginal</b>		
<i>E. coli</i>	<3	3-100	≥100	**
<i>Salmonella</i>	Not detected in 25g	-	-	Detected

\*\* Pathogenic strains of *E. coli* should be absent

## 6. Results and Discussion

When assessed against the FSANZ's 'Guidelines for the microbiological examination of ready to eat foods' (FSANZ, 2001), the survey found that 99.9% of samples were classified as microbiologically acceptable (Table 3). The full results can be found in Appendix 6.

**Table 3. Survey results**

nut type	Acceptable		Unsatisfactory	Potentially hazardous
	Satisfactory	Marginal		
almonds	131 (100%)	-	-	-
brazil nuts	62 (100%)	-	-	-
cashews	117 (100%)	-	-	-
hazelnuts	33 (97%)	1 (3%)	-	-
macadamias	75 (99%)	-	-	1 (1%)
mixed nuts	131 (100%)	-	-	-
peanuts	196 (100%)	-	-	-
pecans	12 (100%)	-	-	-
pistachios	76 (100%)	-	-	-
walnuts	80 (100%)	-	-	-
<b>total</b>	<b>914 (99.9%)</b>		-	<b>1 (0.1%)</b>

One sample (0.1%) was classified as marginal due to *E. coli* at a level of 3.6 MPN/g. This was a packaged hazelnut meal product listing the hazelnut as sourced from 'Australia and others'.

A further one unpackaged macadamia sample (0.1%) was classified as potentially hazardous due to the presence of *Salmonella*. The sample of loose macadamia nuts was positive for *Salmonella* Aberdeen. *Salmonella* Aberdeen has previously been isolated from macadamias and other nuts in Australia as well as from a wide range of animal and environmental sources (OzFoodNet, 2008). No documented outbreak has been linked to this strain of *Salmonella* in nuts. It has been responsible for outbreaks in cattle and sheep usually through sewage contaminated fields, isolated from pet chews manufactured in China (Wong, Thom, Nicol, Heffernan & MacDiarmid, 2007) and pork served in Vietnamese rolls in NSW (Kardamanidis, Munnoch, Heilbronn, Stephens, 2010).

Nuts and similar products sold unpackaged at retail have the potential to be inadvertently contaminated by consumers and the presence of *Salmonella* may not automatically be associated with the processing of the nut. As such, the participating jurisdiction, which found one sample to be positive with *Salmonella*, undertook further analysis of a follow up sample of another unpackaged macadamia sample from the same retailer and this sample was found to be negative for *Salmonella*. As there appeared to be no on going issues, no further action was undertaken.

## 7. Conclusion

The microbiological quality of nuts and nut products in Australia is generally very good. Only one sample of macadamia nuts was found to be contaminated with *Salmonella* Aberdeen. It is clear from these results and outbreaks overseas that contamination of nuts and nut products is not common, however when it does occur, an outbreak is a likely outcome.

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## **9. Appendices**

Appendix 1: Outbreaks involving nut and nut products

Appendix 2: Selected surveys conducted on the microbiological quality of nuts, seeds and their products

Appendix 3: Other studies

Appendix 4: Participating agencies, laboratories conducted the testing and analytical method used

Appendix 5: The number of samples collected by each participating agency

Appendix 6: Full survey results (on separate document)

## Appendix 1. Outbreaks involving nut and nut products

Year	Country	Product implicated	Comments	Pathogen	Cases (death)	Reference
2008 - 2009	USA & Canada	Peanut butter and peanut butter-containing products	The source was traced back to one peanut processing plant.	<i>S. Typhimurium</i>	530 (8)	CDC, 2009a
2006 - 2007	USA	Peanut butter	Organism was isolated from several unopened jars of peanut butter and from environmental samples from the peanut butter factory.	<i>S. Tennessee</i>	628	CDC, 2007
2005 - 2006	Sweden	Almonds	15 cases of <i>Salmonella</i> Enteritidis were epidemiologically linked to almonds. <i>Salmonella</i> was not isolated from almonds tested in the study.	<i>S. Enteritidis</i>	15	Müller et al., 2007
2003 - 2004	USA & Canada	Raw almonds	Organism was found at the processor and at 2 huller-shellers that supplied the processor	<i>S. Enteritidis</i>	29	CDC, 2004
2001	Australia, Canada & UK	Asian-style peanuts	<i>Salmonella</i> were traced to Chinese peanuts. Product testing also resulted in isolations of <i>S. Kottbus</i> , <i>S. Lexington</i> & <i>S. Unnamed</i> .	<i>S. Stanley</i> <i>S. Newport</i>	97 12	Kirk et al., 2004
2000 - 2001	USA & Canada	Raw almonds	The outbreak strain was recovered from product samples, environmental swabs of processing equipment and from associated orchards.	<i>S. Enteritidis</i> PT30	168	Isaacs et al., 2005
1996	Australia	Peanut butter	Investigation implicated the supplier of roasted peanuts.	<i>S. Mbandaka</i>	15	Scheil et al., 1998

All outbreaks noted above resulted in significant product recalls.

**Appendix 2. Selected surveys conducted on the microbiological quality of nuts, seeds and their products**

<b>Year</b>	<b>Country</b>	<b>Samples</b>	<b>No of samples tested</b>	<b>Organisms tested</b>	<b>No of positive samples</b>	<b>Reference</b>
2008 - 2009	UK	Edible nut kernels	2886	<i>Salmonella</i> <i>E. coli</i>	3 (0.1%) 23 (0.8%)	Little et al., 2009b
2008	UK	Roasted, RTE nut kernels	727	<i>Salmonella</i> <i>E. coli</i>	1 (0.1%) 3 (0.4%)	Little et al., 2009a
2003 - 2006	Australia	Pre-roasted peanut, almond, cashew, hazelnut & brazil nut (as received by processing facility)	836 921 921	SPC <sup>1</sup> <i>Salmonella</i> <i>E. coli</i>	80 (9.6%) 1 (0.1%) 0	Eglezos, Huang & Stuttard, 2008
2001 - 2005	USA	Raw almonds	9274	<i>Salmonella</i> <i>E. coli</i> (>0.3 MPN/g)	81 (0.9%) 130 (1.4%)	Danyluk et al., 2007
Unknown	Turkey	RTE edible seeds & nuts (unpackaged)	217	<i>E. coli</i> <i>C. perfringens</i> <i>Salmonella</i> <i>B. cereus</i>	6 (2.8%) 19 (8.8%) 6 (2.8%) 35 (16.1%)	Vural & Erkan, 2008

<sup>1</sup> SPC was included in the survey to assess the effect of harvesting and processing on the microbial contamination of these products.

### Appendix 3. Other studies

Year	Country	Samples tested	Details	Reference
Unknown	India	Walnut kernels	Samples were tested for <i>B. cereus</i> , <i>Salmonella</i> , <i>E. coli</i> & <i>E. coli</i> O157:H7 using PCR assays. The predominant contaminants found: <i>Bacillus</i> , <i>Klebsiella</i> , <i>Enterobacter</i> and <i>Staphylococcus</i> .	Riyaz-Ul-Hassan et al., 2003
Unknown	Brazil	Cashew & brazil nut kernels	Cashew samples were obtained directly from farmers and brazil nut kernels were purchased from two retail suppliers. The predominant contaminants found: <i>Bacillus</i> , <i>Enterobacter</i> and yeast	Freire & Offord, 2002
Unknown	UK	Nuts	<i>C. perfringens</i> , <i>S. aureus</i> and <i>B. cereus</i> were found in nuts. No <i>Salmonella</i> , <i>E. coli</i> O157:H7 or <i>Campylobacter</i> was detected.	Candlish et al., 2001

**Appendix 4. Participating agencies, laboratories conducted the testing and analytical method used**

<b>Agency Name</b>	<b>Laboratories used</b>	<b>Method of analysis</b>	
		<i>Salmonella</i>	<i>E. coli</i>
NSW Food Authority	Division of Analytical Laboratories, Lidcombe	AS1766.2.5	AS1766.2.3
ACT Health	ACT Government Analytical Laboratory	AS5013.10	ISO:16649-2
Queensland Health	Queensland Health Forensic and Scientific Services	AS 5013.10-2009 (modified)	AS 5013.15-2006
Department of Health & Human Services, Tasmania	Public Health Lab (Tasmania)	AS5013.10	AS5013.15
Department of Health, Western Australia	PathWest Food and Water Laboratory	AS5013.10	AS5013.15

**Appendix 5. The number of samples collected by each participating agency**

<b>Agency Name</b>	<b>packaged nuts</b>	<b>unpackaged nuts</b>	<b>nut product</b>	<b>total</b>
NSW Food Authority	122	88	81	291
ACT Health	91	105	68	264
Queensland Health	23	12	19	54
Department of Health & Human Services, Tasmania	25	18	9	52
Department of Health, Western Australia	111	97	46	254
<b>Total number</b>	<b>372</b>	<b>320</b>	<b>223</b>	<b>915</b>