Ministry for Primary Industries
Manatū Ahu Matua

# Survey of Dried and Edible Nuts, Seeds and Nut and Seed Products Available in New Zealand

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Prepared for the Ministry for Primary Industries under project MFS/11/05 (MFS/10/14 ctd) – Microbiological – Food Safety, as part of an overall contract for scientific services by
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New Zealand Government

*Growing and Protecting New Zealand*

# Scientific Interpretive Summary

Ministry for Primary Industries
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## Survey of dried and edible nuts, seeds and nut and seed products available in New Zealand

Dried seeds and nuts are becoming increasingly popular as snack foods because of their perceived health benefits and convenience as a ready-to-eat food. Nuts and seeds are often eaten without further preparation and may also be formed into products such as nut bars, seed bars, peanut butter, tahini and halva.

Unfortunately, in recent years there have been a number of outbreaks of foodborne illness associated with the consumption of nuts, seeds and nut and seed products, albeit just two in New Zealand, both associated with *Salmonella* and tahini (sunflower seed) products. The survival of *Salmonella* on these products for extended periods of time has been well established, and combined with the low number of these bacteria required to cause illness, gives concern for the safety of these food products.

However, little is known about the microbiological quality of these products in New Zealand. The Ministry for Primary Industries (MPI) commissioned a survey of nuts, seeds and products manufactured from them, e.g. nut butter products, tahini and halva. The products were purchased pre-packaged or directly from bulk bins from retail stores, or from on-line suppliers. A total of 805 products (domestic and imported) were tested for the presence of *Salmonella* and generic *E. coli*; the latter an indicator of hygienic production and processing of the nuts and seeds.

*Salmonella* was not detected in any of the products sampled. Generic *E. coli* was detected in just two samples, one of Brazil nuts and one of poppy seeds, at acceptable levels albeit described as marginal in the FSANZ *Guidelines for the Microbiological Examination of Ready-to-Eat Foods.* This encouraging profile reflects that of similar products in Australia that are likely sourced from the same international markets, and indicates that current measures taken by nut growers and processors to manage microbial pathogens, and New Zealand's Food (Prescribed Foods) Standard 2007, are sufficient to assure the safety of these products in New Zealand.

In addition to the microbiological survey, the nuts and seeds were also tested for the fumigant propylene oxide (PPO) which became widely used in the United States (FDA approved), for example, to control *Salmonella* on almonds and pistachios following large country-wide outbreaks of foodborne illness. New Zealand does not have a specific provision under the Food Standards Code (FSC) or a New Zealand Maximum Residue Limit (MRL) Food Standard for residues of PPO.

PPO was detected in 18/261 (6.9%) of the nuts sampled; 15/21 pistachio nuts (71.4%), 2/22 almond samples and a single sample of 23 walnut batches tested. These results are consistent with the known use of PPO overseas and the levels detected were well below the limits of 300ppm approved by the US-FDA.

Notwithstanding the above results, MPI is unable to assign any significance to the absence of *Salmonella* on the nuts and seeds with regard to PPO use as the sample numbers were small and country-of-origin PPO use data was sparse. Similarly, while the data on the levels of PPO residues is useful to inform a preliminary human exposure assessment, and does not in itself indicate a health concern to consumers, a more formal assessment is required to ascertain whether or not limits are required under the FSC or MPI standards. The need for CODEX MRLs for PPO is similarly being considered by the Joint FAO/WHO Meeting on Pesticide Residues (JMPR).

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## 1 SUMMARY

Between December 2011 and August 2012 a total of 805 dried and edible nut, seed and nut and seed products available in New Zealand were collected and analysed for the presence of *Salmonella* species, *Escherichia coli* and residues of the fumigant, propylene oxide (PPO).

The first goal of this project was to determine the prevalence of *Salmonella* and *Escherichia coli* in domestic and imported dried nuts and seeds, and in nut and seed products available at retail and wholesale in New Zealand. *Salmonella* was not detected in any of the samples and *E. coli* was detected in only two samples. The results of this survey are similar to those reported in a recent Australian survey.

The second goal was to determine the concentration of PPO residues in imported raw whole nuts. PPO residues were detected in 18/261 (6.9%) of the imported nut samples tested (15 pistachio, 2 blanched almond and 1 walnut sample). There is currently no specific maximum residue limit (MRL) under the Australia New Zealand Food Standards Code or the New Zealand (Maximum Residue Limit of Agricultural Compounds) Food Standards 2002 (NZ MRL Standard) for the presence of PPO residues. The maximum levels of PPO detected (1.3 mg/kg) were less than 0.5% of the present USA tolerance, specified in Part 180, Title 40 of the Code of Federal Regulation (300 mg/kg in pistachios). The NZ MRL Standard does have a default MRL of 0.1 mg/kg for residues of agricultural compounds not specified in the Standard. Eight samples of pistachios contained PPO residues at concentrations greater than 0.1 mg/kg.

## 2 INTRODUCTION

One of the strategic requirements of the New Zealand Ministry for Primary Industries (MPI) is to reduce the level of foodborne illness in New Zealand. This requires a robust understanding of the proportionality of exposure to various hazards from different food groups and demonstration that controls are effective.

Dried seeds and nuts are perceived as healthy snack foods. They are popular, particularly due to reports of their health benefits and convenience as a ready-to-eat food. Nuts and seeds are often eaten without further preparation and may also be formed into products such as nut bars, seed bars, peanut butter, tahini and halva.

There have been a number of outbreaks of foodborne disease associated with nuts and seeds overseas and in New Zealand. Peanuts, almonds, pine nuts, pistachio nuts, hazelnuts and sesame seeds are the nuts and seeds most commonly implicated in incidents of food poisoning associated with *Salmonella*. Examples include a worldwide 2001 outbreak of *Salmonella* Typhimurium associated with halva (PHLS, 2001), *S.* Montevideo in tahini in Australia and New Zealand in 2003 (Unicomb *et al.*, 2005), *S.* Agona in aniseed in Germany (Koch *et al.*, 2005), a multistate outbreak of *S.* Enteritidis in the USA linked to pine nuts from Turkey (CDC, 2011a), and *S.* Montevideo, *S.* Mbandaka and *S.* Maastricht illness associated with Turkish tahini in New Zealand and USA in 2012 – 2013 (ESR, 2013; CDC, 2013). Foodborne illness associated with peanut butter include *S.* Typhimurium outbreaks in the USA in 2008 - 2009, which later spread globally through products where the peanut butter was used as an ingredient (CDC, 2009), and a 2012 multistate outbreak of *S.* Bredeney (CDC, 2012).

Most outbreaks attributed to whole nuts have been associated with 'raw' dried shelled nuts but episodes associated with roasted and in shell nuts have also occurred. An international outbreak of *S.* Stanley and *S.* Newport in flavoured or roasted in shell nuts was reported in Australia, Canada and the UK (Kirk *et al.*, 2004) and recalls in the USA of honey roasted peanuts and chipotle peanuts contaminated with *Salmonella* have also occurred (FDA, 2009). In shell hazelnuts and mixed nuts in shell were the subject of a recent public health alert in Canada. Product was recalled as part of an ongoing food safety investigation associated with bulk hazelnuts from the USA suspected to contain *Salmonella* (CFIA, 2013).

Other pathogens have also been associated with nut and seed related outbreaks. In 2011 food poisoning incidents associated with the detection of *E. coli* O157:H7 in walnuts in Canada (CFIA, 2011) and in hazelnuts in shell in the USA were reported (CDC, 2011b).

A table of recent foodborne illness outbreaks associated with nut and seed products is given in Appendix 1.

The New Zealand Food (Prescribed Foods) Standard 2007 lists certain foods where conditions must be met during importation and whilst on the market. The Imported Food Requirements (IFR) provide specific food/hazard requirements for the prescribed foods at the border. The IFRs and stated hazards applicable to nut and seed products include:

- Desiccated coconut – pathogenic organisms, specifically *Salmonella*
- Peanuts and Pistachio Nuts – mycotoxin contamination
- Peanut butter – mycotoxic contamination and pathogenic bacteria, specifically *Salmonella*
- Tahini or crushed sesame seeds or any products containing these – pathogenic organisms, specifically *Salmonella*.

Only a small proportion of the nuts, seeds and nut and seed products available in New Zealand are locally grown. Large volumes of the foods are imported from Australia, India, Argentina, Vietnam, China, the USA and South Africa. Product from other areas may also enter the country as third country imports.

In addition to the potential microbiological and mycotoxin hazards in nuts, chemical sanitising or pasteurisation during production may leave undesirable residues. In the USA sanitising of raw almonds and some pistachios with propylene oxide (PPO) is mandatory. This was introduced in response to incidents of *Salmonella* food poisoning from raw almonds. This sanitiser may also be used in other countries exporting nuts to New Zealand.

There is currently no specific maximum residue limit (MRL) under the Australia New Zealand Food Standards Code or the New Zealand (Maximum Residue Limit of Agricultural Compounds) Food Standards 2002 (NZ MRL Standard) for the presence of PPO residues and its two degradation products (propylene chlorohydrin and propylene bromohydrin) in imported nuts. The NZ MRL Standard does have a default MRL of 0.1 mg/kg for residues of agricultural compounds not specified in the Standard. Nuts that may have been treated with PPO, which is known to leave a significant residue, may be unsuitable for sale in New Zealand. Any form of future standard allowing the use of PPO will depend on assessing the efficacy of microbiological control, as well as human exposure from residues for the New Zealand population.

This survey was commissioned to determine the prevalence of *Salmonella* and *E. coli* in selected nuts, seeds and products containing nuts and seeds, and to determine the level of exposure of New Zealand consumers to PPO through imported products.

## 3 SAMPLING

A total of 805 samples were collected and analysed over the nine month period of December 2011 to August 2012.

Nuts collected for the survey included whole raw nuts in shell, whole raw shelled nuts, whole raw blanched nuts, and nut butter products where nuts represented more than 80% of the ingredient content. Excluded from the scope were chestnuts, whole coconut, breakfast cereals, muesli bars, chocolate or yoghurt covered nuts, and fruit and nut mix.

Seed products included raw whole in-hull seeds, raw whole hulled seeds and seed products such as tahini and halva where seeds represented more than 80% of the ingredient content. Excluded from the scope were alfalfa seed, coffee beans, seed oils, seed supplements, teas, seed coated with chocolate, yoghurt or other coatings, and seed and fruit mixes.

Samples (>80g) were purchased, either pre-packaged or direct from bulk bins, from the main domestic suppliers such as retailers (supermarkets and specialty shops), on-line suppliers throughout New Zealand or directly from producers. Samples were transported and held at room temperature until analysis. Details were recorded of the product type, brand, weight, place of purchase and, where given, best before date, batch numbers and country of origin.

Purchase of each product type was spread evenly over the entire 9 month sampling period in order to collect as many different brands and batches as possible.

Target sample numbers for each product type were: 20 each of 16 nut varieties; 20 each of 7 seed varieties; 100 peanut butter; 100 other nut butters; and 50 each of tahini and halva. Difficulty was experienced sourcing different brands of unshelled hazelnuts and macadamia nuts and target numbers for these two products were not reached. Additional samples of other products were taken to achieve the total project target. Actual sample numbers and sample types are listed in Appendix 2.

## 4 SAMPLE EXAMINATION

Nuts in shell were opened as aseptically as possible and the meat removed for testing. The outer packaging of other samples was sterilised using 70% ethanol solution and opened aseptically.

For microbiological tests, the majority of sample homogenates were prepared by stomaching with a paddle blender. Linseed samples, however, were found to require a more vigorous procedure to dislodge the outer hull and homogenates were prepared in a rotary blender.

Samples for chemical analysis were not homogenised.

### 4.1 *Salmonella* species

Twenty-five gram samples were analysed qualitatively for *Salmonella* species using an enzyme linked visual immunoassay (3M™ TECRA™ Salmonella VIA). The AOAC Official Method 998.14 protocol was followed using 225mL of the appropriate pre-enrichment medium specified in FDA BAM (lactose broth for nuts and nut products and tryptic soy broth for seeds and seed products). A nonionic surfactant (Imbentin™) was added to the pre-enrichments of high fat samples (tahini, halva, peanut butter and other nut spreads) to aid emulsification during suspension.

### 4.2 Generic *Escherichia coli*

The samples were analysed quantitatively for generic *Escherichia coli* using Petrifilm *E. coli*/Coliform plates (3M™). In brief, 50g of sample was added to 100mL of 0.1% peptone water and homogenised. Further 1:10 and 1:100 dilutions were prepared from the initial homogenate. A direct 1:10 preparation (25g sample to 225mL diluent) was used for mucilaginous product (chia seed and linseed). One mL of each dilution was plated in duplicate following the protocol specified in AOAC Official Method 991.14. Blue colonies with gas were considered to be confirmed *E. coli*. Blue colonies without gas were picked for further testing. The lower limit of detection of the test was 10 CFU/g.

### 4.3 Propylene Oxide (PPO)

Imported whole nut samples were also tested to determine levels of PPO.

A known weight (between 2 and 5 grams) of sample was placed in a headspace vial containing 4 grams of sodium chloride. Distilled water (5 mL) was added and the vials sealed airtight and stored frozen until analysis.

Prior to analysis a known quantity of deuterated[1] internal standard ($d_6$–PPO) was injected into each vial. Samples were analysed by headspace gas chromatography-mass spectrometry (HS-GCMS) (Cao, 2009). The analysis was performed on a Shimadzu 2010 Gas chromatograph-Mass Spectrometer (GC-MS) fitted with a Combi-Pal autosampler. Chromatographic separation was carried out on an Agilent HP-PLOT/Q column (15 metres long, 0.32 mm internal diameter, 20 um film thickness), operated at $100^0$C isothermal, run time 15 minutes. The carrier gas was helium at 2.5 mL/min flow rate. The headspace injector and the GC to MS transfer were operated at $250^0$C.

PPO was monitored at m/z = 58, 43 and $d_6$-PPO at m/z = 64, 46. Working standards of PPO at levels of 0.5, 0.1, 0.05, and 0.002 mg/kg were prepared fresh for each run. Each working

[1] Deuterated PPO has the six hydrogen atoms replaced by its isotopic form, deuterium. This results in a molecule with the same chemical characteristics as the un-deuterated form, but with a greater mass.

standard comprised of the appropriate quantity of PPO solution and $d_6$-PPO internal standard added to 4 grams of sodium chloride and 10 mL of water, sealed in a 20 mL headspace vial. Quantification was performed by comparing the PPO/$d_6$-PPO ratios of the samples with that of the calibration standards.

Calibration standards were run at the beginning and the end of each sample batch analysis. In each case, the 0.002 mg/kg standard could be reliably detected.

Samples of nuts ($n$ = 18), covering a range of nut types, were spiked with either 0.1 mg/kg or 1.0 mg/kg of PPO and analysed as above. Mean recovery of PPO at 0.1 mg/kg was 115% (range 105-123%, relative standard deviation 7.5%) and at 1.0 mg/kg was 99% (range 86-103%, relative standard deviation 5.6%). Recoveries in the range 70-130% are usually considered acceptable for trace organic analysis.

The analytical limit of detection (LoD) was calculated as a concentration relating to a signal to noise (s/n) ratio of 3. The limit of quantification (LoQ) was calculated from a s/n ratio of 10. Due to differences in sample weights used for analysis LoDs were in the range 0.0005-0.0008 mg/kg and LoQs were in the range 0.0017-0.0026 mg/kg. Analytical results falling between the LoD and LoQ were reported as 'trace'.

## 5 RESULTS AND DISCUSSION

The sample types and numbers, as well as survey results, are listed in Appendix 2.

### 5.1 Microbiology

*Salmonella* species were not detected in any of the 805 samples of dried and edible nut, seed and nut and seed products tested.

*E. coli* was detected in only two samples:–

| | | | |
|---|---|---|---|
| Brazil nut | prepackaged | (origin unstated) | 10 cfu/g |
| Poppy seed | bulk bin | (origin unstated) | 40 cfu/g |

These counts are lower than the "unsatisfactory quality" level of >100 CFU/g given in the FSANZ *Guidelines for the microbiological examination of ready-to-eat foods* (FSANZ, 2011). This guideline states: "Ideally *E. coli* should not be detected and as such a level of <3 per gram (the limit of the Most Probable Number test) has been given as the satisfactory criteria for this organism". Consequently these samples would be considered marginally acceptable.

Comparison between the samples where *E. coli* was not detected is hampered by the fact that the *E. coli* method used in this survey had a limit of detection (10 CFU/g) which is slightly higher than the FSANZ "satisfactory" level.

The microbiological results of the survey are similar to those reported in a 2011 survey of 915 ready-to-eat nuts and nut products sold in Australia (NSWFA, 2012). *Salmonella* was found in only one sample (unpackaged macadamia nuts) and one sample of packaged hazel nuts was classified as marginal when assessed against the FSANZ guidelines due to the presence of *E. coli* at a concentration of 3.6 MPN/g.

Two recent surveys in the United Kingdom involving greater sample numbers showed a slightly higher prevalence of *Salmonella* and *E. coli* in nut and seed products. The presence of *Salmonella* is regarded as unsatisfactory in a ready-to-eat food. The first of these studies was a retail survey of 3,735 edible dried seed samples which was undertaken in 2007 (Willis *et al.*, 2009). *Salmonella* was detected in 23 samples (0.6%), of which over half (57%) were sesame seeds. Other seeds contaminated with *Salmonella* were linseed (1 sample), sunflower (1 sample), alfalfa (1 sample), melon (4 samples) and mixed seeds (3 samples). *E. coli* was detected in 9% of samples, with 1.5% containing ≥100/g - levels considered unsatisfactory when compared with the UK HPA (PHLS) guidelines for ready-to-eat food current at the time.[2] These included melon, pumpkin, sesame, hemp, poppy, linseed, sunflower and mixed seeds. In the second survey (2008-2009) *Salmonella* species and *E. coli* were detected in 3 (0.1%) and 23 (0.8%) of 2886 edible nut kernels, respectively (Little *et al.*, 2010). The levels of *Salmonella* ranged from <0.01 to 0.23/g. *E. coli* was found at unsatisfactory levels (150/g) in 1 sample and at lower levels (range: 3.6 – 43/g) in the other 22 positive samples. Levels of *E. coli* did not correlate with the presence of *Salmonella*.

In December 2012, subsequent to the New Zealand survey, *Salmonella* was detected in a batch of imported Turkish tahini. The product was initially tested as part of an investigation into a cluster of *S.* Montevideo cases associated with the consumption of Middle Eastern food. *S.* Montevideo, *S.* Maastricht and *S.* Mbandaka were isolated from unopened tubs of tahini (origin Turkey) sourced from the warehouse of the distributor. The pulsed field gel electrophoresis (PFGE) profile of the *S.* Montevideo strain isolated from the tahini was indistinguishable from the outbreak strain. The *S.* Mbandaka and *S.* Maastricht isolates also matched strains from recent human cases. Tahini imported into the USA from the same company in Turkey was also linked to a multistate outbreak of *S.* Montevideo and *S.* Mbandaka infections in February 2013. The *S.* Montevideo and *S.* Mbandaka strains isolated in the New Zealand investigation matched the outbreak strains found in the USA and additionally the New Zealand *S.* Maastricht isolate matched a strain isolated from opened jars of tahini in the USA investigation.

[2] The UK PHLS guidelines current at the time of this survey (*Guidelines for the microbiological quality of some ready-to-eat foods sampled at the point of sale*. Commun. Dis. Public Health 2000: 3 (3), 163–167) were updated in 2009 (Health Protection Agency. *Guidelines for Assessing the Microbiological Safety of Ready-to-Eat Foods*. London: Health Protection Agency, November 2009).

## 5.2 Propylene Oxide (PPO)

Overall, PPO was detected in 18/261 (6.9%) samples of imported nuts. PPO was detected in 15 of the 21 pistachio samples (range Trace – 1.31 mg/kg). Two of the positive pistachio samples were identified as imported from the USA. The origin of the others was either "not stated" or described as "packed in (Australia or New Zealand) from imported ingredients".

Very low concentrations of PPO were also detected in 2 blanched almond samples (0.0055 and 0.0079 mg/kg, origin not stated) and one shelled walnut sample from the USA (0.0021 mg/kg).

Treatment of Californian almonds to reduce the "potential for *Salmonella* bacteria" has been mandatory since September 2007 (Federal Register 72(61), 2007) and the use of PPO has been approved by the FDA for this purpose. PPO fumigation is also approved for use on pistachio and other nuts. Of the 261 samples analysed for PPO, 16 (6.1%) were clearly identified as originating from USA: 5 samples of walnuts, 4 of almonds, 3 of pistachios and 2 each of pecans and hazelnuts. Residues of PPO were detected in 3 of these samples (2 pistachios, 1 walnut), but levels found (0.0021, 0.155 and 0.283 mg/kg) were much lower than the USA tolerance levels of 300 mg/kg (Code of Federal Regulations, Title 40, Part 180.49).

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## 7 APPENDIX 1: OUTBREAKS – NUT AND SEED PRODUCTS

### Table 1 Outbreaks associated with nut and seed products

| Year | Country | Product | Pathogens | Cases | Comment | Reference |
|---|---|---|---|---|---|---|
| 2001 | Sweden, Norway, Germany and Australia | Halva | *S.* Typhimurium DT104 | >40 | Two brands (Turkey) | PHLS, 2001 |
| 2001 | Australia, Canada and UK | Peanuts (flavoured and roasted in shell). | *S.* Stanley and *S.* Newport | 109 | *S.* Kottbus, *S.* Lexington, *S.* Newport and *S.* unnamed also isolated from product. | Kirk *et al.*, 2004 |
| 2002-2003 | Australia and New Zealand | Tahini | *S.* Montevideo | 68 | Sesame-based products in other jurisdictions (Canada and United Kingdom) also positive for *Salmonella* spp. | Unicomb *et al.*, 2005 |
| 2002-2003 | Germany | Aniseed | *S.* Agona | 42 | Cases predominantly among infants. *S.* Agona isolated from pure aniseed and herbal teas containing aniseed. | Koch *et al.*, 2005 |
| 2006-2007 | USA (47 states) | Peanut butter | *S.* Tennessee | 628 | Associated with two brands produced at the same plant. | CDC, 2007 |
| 2008-2009 | USA (43 states) | Peanut butter | *S.* Typhimurium | 530 | Associated with peanut butter and pre-packaged peanut butter crackers. | CDC, 2009 |
| 2011 | USA (5 states) | Pine nuts | *S.* Enteritidis | 43 | Product from Turkey sold from bulk-bins. | CDC, 2011a |
| 2011 | Canada | Walnuts (raw shelled) | *E. coli* O157 | 13 | 9 cases hospitalised - 2 developed HUS. | CFIA, 2011 |
| 2011 | USA (3 states) | Hazelnuts (in shell) | *E. coli* O157 | 8 | Outbreak strain isolated from in shell hazelnuts and mixed nuts containing hazelnuts. | CDC, 2011b |
| 2012 | USA (20 states) | Peanut Butter | *S.* Bredeney | 42 | Outbreak strain isolated from peanut butter, shelled raw peanuts and environmental samples collected from the manufacturing plant. | CDC, 2012 |
| 2012<br>2013 | New Zealand and<br>USA (9 states) | Tahini | *S.* Montevideo<br>*S.* Mbandaka<br>*S.* Maastricht | 17 (NZ)<br>16 (USA) | Turkish product. Different brands implicated in USA and NZ but both were from same supplier. | ESR, 2013<br>CDC, 2013 |

## 8 APPENDIX 2: SUMMARY OF SURVEY RESULTS

### Table 2 Survey results – nut samples

| Product | Target sample numbers | Actual sample numbers | Origin | Microbiology<br>*Salmonella (P/A per 25g)*<br>*Escherichia coli (CFU/g)* | Chemistry (imported nuts only)<br>*Propylene Oxide (mg/kg)* |
|---|---|---|---|---|---|
| Almond (whole/shelled) | 20 | 25 | Imported (15)<br>Not stated (10) | *Salmonella* (25) Not isolated<br>*E. coli* (25) <10 | (25) Not detected |
| Almond (blanched) | 20 | 22 | Imported (7)<br>Not stated (15) | *Salmonella* (22) Not isolated<br>*E. coli* (22) <10 | (20) Not detected<br>(2) Range 0.0055 – 0.0079 |
| Brazil nut (whole/shelled) | 20 | 21 | Imported (9)<br>Not stated (12) | *Salmonella* (21) Not isolated<br>*E. coli* (1) 10<br>*E. coli* (20) <10 | (21) Not detected |
| Cashew nut (whole/shelled) | 20 | 23 | Imported (11)<br>Not stated (12) | *Salmonella* (23) Not isolated<br>*E. coli* (23) <10 | (23) Not detected |
| Hazel nut (whole/shelled) | 20 | 23 | New Zealand (11)<br>Imported (7)<br>Not stated (5) | *Salmonella* (23) Not isolated<br>*E. coli* (23) <10 | (12) Not detected |
| Hazel nut (in shell) | 20 | 18 | New Zealand (18) | *Salmonella* (18) Not isolated<br>*E. coli* (18) <10 | N/A |
| Macadamia (whole/shelled) | 20 | 21 | New Zealand (9)<br>Imported (5)<br>Not stated (7) | *Salmonella* (21 Not isolated<br>*E. coli* (21) <10 | (12) Not detected |
| Macadamia (in shell) | 20 | 14 | New Zealand (14) | *Salmonella* (14) Not isolated<br>*E. coli* (14) <10 | N/A |
| Mixed nuts (whole/shelled) | 20 | 23 | New Zealand (1)<br>NZ/Imported mixed (2)<br>Imported (8)<br>Not stated (12) | *Salmonella* (23) Not isolated<br>*E. coli* (23) <10 | (22) Not detected |
| Peanut (whole/shelled) | 20 | 21 | Imported (5)<br>Not stated (16) | *Salmonella* (21) Not isolated<br>*E. coli* (21) <10 | (21) Not detected |

| Product | Target sample numbers | Actual sample numbers | Origin | Microbiology<br>*Salmonella (P/A per 25g)*<br>*Escherichia coli (CFU/g)* | | | Chemistry<br>(imported nuts only)<br>*Propylene Oxide (mg/kg)* | |
|---|---|---|---|---|---|---|---|---|
| Peanut (blanched) | 20 | 22 | Imported (9)<br>Not stated (13) | *Salmonella*<br>*E. coli* | (22)<br>(22) | Not isolated<br><10 | (22) | Not detected |
| Pecan | 20 | 22 | Imported (12)<br>Not stated (10) | *Salmonella*<br>*E. coli* | (22)<br>(22) | Not isolated<br><10 | (22) | Not detected |
| Pine nut | 20 | 24 | New Zealand (2)<br>Imported (10)<br>Not stated (12) | *Salmonella*<br>*E. coli* | (24)<br>(24) | Not isolated<br><10 | (22) | Not detected |
| Pistachio | 20 | 21 | Imported (9)<br>Not stated (12) | *Salmonella*<br>*E. coli* | (21)<br>(21) | Not isolated<br><10 | (6)<br>(15) | Not detected<br>Range Trace – 1.31 |
| Walnut (whole/shelled) | 20 | 23 | New Zealand (8)<br>Imported (13)<br>Not stated (2) | *Salmonella*<br>*E. coli* | (23)<br>(23) | Not isolated<br><10 | (14)<br>(1) | Not detected<br>0.0021 |
| Walnut (in shell) | 20 | 20 | New Zealand (19)<br>Imported (1) | *Salmonella*<br>*E. coli* | (20)<br>(20) | Not isolated<br><10 | (1) | Not detected |
| **TOTAL NUTS** | **320** | **343** | | | | | | |

**Table 3 Survey results – seed samples**

| Product | Target sample numbers | Actual sample numbers | Origin | Microbiology<br>*Salmonella (P/A per 25g)*<br>*Escherichia coli (CFU/g)* | | |
|---|---|---|---|---|---|---|
| Chia seed | 20 | 23 | Imported (15)<br>Not stated (8) | *Salmonella*<br>*E. coli* | (23)<br>(23) | Not isolated<br><10 |
| Linseed | 20 | 20 | New Zealand (5)<br>Imported (3)<br>Not stated (12) | *Salmonella*<br>*E. coli* | (20)<br>(20) | Not isolated<br><10 |
| Pumpkin seed | 20 | 22 | New Zealand (3)<br>Imported (9)<br>Not stated (10) | *Salmonella*<br>*E. coli* | (22)<br>(22) | Not isolated<br><10 |
| Poppy seed | 20 | 21 | Imported (9)<br>Not stated (12) | *Salmonella*<br>*E. coli*<br>*E. coli* | (21)<br>(1)<br>(20) | Not isolated<br>40<br><10 |
| Sesame seed (unhulled) | 20 | 24 | Imported (20)<br>Not stated (6) | *Salmonella*<br>*E. coli* | (24)<br>(24) | Not isolated<br><10 |
| Sesame seed (hulled) | 20 | 26 | Imported (16)<br>Not stated (9) | *Salmonella*<br>*E. coli* | (26)<br>(26) | Not isolated<br><10 |
| Sunflower seed | 20 | 20 | Imported (11)<br>Not stated (9) | *Salmonella*<br>*E. coli* | (20)<br>(20) | Not isolated<br><10 |
| **TOTAL SEEDS** | **140** | **156** | | | | |

**Table 4 Survey results – nut and seed product samples**

| Product | Target sample numbers | Actual sample numbers | Origin | Microbiology *Salmonella (P/A per 25g)* *Escherichia coli (CFU/g)* | | |
|---|---|---|---|---|---|---|
| Peanut butter | 100 | 102 | Imported (102) | *Salmonella*<br>*E. coli* | (102)<br>(102) | Not isolated<br><10 |
| Nut butter | 100 | 101 | New Zealand (41)<br>NZ/Imported (mixed) (13)<br>Imported (47) | *Salmonella*<br>*E. coli* | (101)<br>(101) | Not isolated<br><10 |
| Tahini | 50 | 56 | Imported (47)<br>Not stated (9) | *Salmonella*<br>*E. coli* | (56)<br>(56) | Not isolated<br><10 |
| Halva | 50 | 47 | Imported (46)<br>Not stated (1) | *Salmonella*<br>*E. coli* | (47)<br>(47) | Not isolated<br><10 |
| **TOTAL NUT/SEED PRODUCTS** | **300** | **306** | | | | |

"Imported" includes product packed or manufactured in New Zealand from imported components