2009 NEW ZEALAND TOTAL DIET STUDY

Agricultural compound residues, selected contaminant and nutrient elements

Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

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Fruit Cake
$2.50

EXECUTIVE SUMMARY

The 2009 New Zealand Total Diet Study (NZTDS) was undertaken by the then New Zealand Food Safety Authority (NZFSA[1]), with management and technical input provided by the Institute of Environmental Science & Research (ESR). The 2009 NZTDS is the seventh such study, with previous ones undertaken in 1974/75, 1982, 1987/88, 1990/91, 1997/98 and 2003/04.

The 2009 NZTDS is an important and invaluable tool for risk assessors and risk managers involved in food safety. It enables the New Zealand food safety regulators to:

- assess the actual concentrations of certain chemical compounds in the New Zealand food supply as "normally consumed";
- obtain realistic estimates of dietary exposure, by analysing the most common retail foods in our national diet after preparing them as "normally consumed";
- target any necessary risk management or risk communication because the NZTDS also helps:
  - identify any potential dietary exposure concerns and associated risks to the consumer;
  - identify age-gender cohorts most affected;
  - identify the main food groups and/or individual foods contributing to their dietary exposures; and
- demonstrate trends in dietary exposure, including assessing the effectiveness of past risk management strategies.

The 2009 NZTDS involved sampling 123 different foods which represent the most commonly consumed food items for the majority of New Zealanders and analysing these foods to determine the concentrations of agricultural chemical residues, selected contaminants (arsenic, cadmium, lead, mercury and methylmercury) and nutrient elements (iodine, selenium and sodium). Changes to the food list since the 2003/04 NZTDS include the addition of an Indian takeaway dish, and the separation of water into tap and bottled waters.

1 NZFSA was amalgamated into the Ministry of Agriculture and Forestry from 1 July 2010.

Foods were organised into 12 food groups – Alcohol; Beverages (non-alcoholic); Chicken, eggs, fish and meat; Dairy; Fruits; Grains; Infant foods; Nuts; Oils and fats; Spreads and sweets; Takeaways; and Vegetables. This was to enable comparison with previous NZTDSs and to identify food groups containing specific agricultural compound residues, and contaminant and nutrient elements.

In the absence of updated national food consumption survey information since the last NZTDS, the two-week simulated typical diets using the 123 NZTDS foods were developed using the same diets as in the 2003/04 NZTDS with adjustment for the two food list changes. The 2003/04 diets had been derived from food frequency and 24-hour diet recall data from the *1997 National Nutrition Study* (NNS) for adults 15+ years and the *2002 National Children's Nutrition Study* (CNS) for 5–14-year-olds (both commissioned by the New Zealand Ministry of Health). Data from studies in 2002 had also been used to simulate the typical diets for children younger than five years of age.

The two-week simulated typical diets in the 2009 NZTDS were for the following eight age-gender cohorts, the same cohorts as used in 2003/04:

- 25+ year males
- 25+ year females
- 19–24 year young males
- 11–14 year boys
- 11–14 year girls
- 5–6 year children
- 1–3 year toddlers
- 6–12 month infants

For each age-gender cohort, the weight of each individual food item consumed in the respective fortnightly diets was the same as in 2003/04, but with the addition of an Indian takeaway dish and separation of water into tap and bottled.

To enable effective and representative sampling, the 123 foods were split into two groups. One comprising 61 national foods and the other 62 foods sampled on a regional basis. National foods were defined as those that were either manufactured in one location and distributed throughout New Zealand (for example, chocolate biscuits), or they were imported and distributed nationally (for example, bananas, raisins/sultanas). All national foods were purchased in supermarkets in Christchurch. Regional foods may potentially vary in their agricultural compound residue, contaminant or nutrient element levels, and were sampled in four centres – Auckland and Napier in the North Island of New Zealand, and Christchurch and Dunedin in the South Island.

The foods sampled were selected as being typical of what was available at the point of sale to the New Zealand consumer. All foods were bought at two different times of the 2009 year to provide a measure of seasonal variation, including the import of some foods outside the New Zealand growing season. Regional foods were sampled in January/February and July/August 2009, and national foods in April/May and October/November/December 2009.

Approximately 4330 different food samples were purchased in the 2009 NZTDS. Most of these were composited to provide a total of 982 different food samples for elemental and agricultural compound residue analyses. As with the last four NZTDSs, all foods in the 2009 NZTDS were prepared ready for consumption, prior to analysis. The analysis of the prepared samples used internationally accepted methodologies and incorporated a number of quality control measures (including blanks, duplicates, spike recovery and/or certified reference materials, and control samples) to ensure confidence in the robustness of the analytical results. Analyses were undertaken in an accredited laboratory.

Deterministic exposure estimates were obtained by combining food consumption data from the simulated model diets with mean concentration data, and used for chronic dietary risk assessment of agricultural compound residues, and selected contaminant and nutrient elements for each of the eight age-gender cohorts.

Agricultural compound residues in the 2009 NZTDS

For the eight age-gender cohorts in the 2009 NZTDS, estimated dietary exposures to agricultural compound residues were all well below the relevant Acceptable Daily Intake (ADI). Ninety-three percent (93%)[2] of these dietary exposures were less than 0.1% of the ADI. Of these, 69% had zero exposure because there were no detectable residues, and 24% of the residue exposures were between 0% and 0.1% of ADI. For the remaining dietary exposures, 4.1% were between 0.1–1% of ADI, 0.4% between 1–1.7% of ADI, and 0.4% between 1.7–52% of the ADI, and 2.5% of exposures had no ADI to benchmark against.

The highest estimated dietary exposures were for dithiocarbamate (DTC) fungicides, due to residues on a range of fruits and vegetables, with main contributors being apples, potatoes with and without skin, and brassicas. For 19–24 year young males, and 25+ year males and females, exposures ranged from 1.7–19% of the ADI, for 11–14 year boys and girls (2.6–27%), and for 5–6 year children, 1–3 year toddlers and 6–12 month infants (3.7–52%). While DTCs are analysed as a group, the individual DTCs within the group vary in their ADIs, ranging from 3–30 µg/kg[3] bw/day. International analytical methods for DTC as used in this study do not differentiate which DTC was being detected. The upper bound of each exposure range as a percentage of the ADI thus represents a conservative worst case estimate as it is relative to the lowest available DTC ADI of 3 µg/kg bw/day for thiram and ziram. The degree of overestimation in dietary exposure as a percentage of ADI could be as much as a factor of ten if all DTCs actually present were from the group with the highest ADI (30 µg/kg bw/day, which includes mancozeb and metiram), and this is discussed further in section 3.3.4. Thiram, ziram, mancozeb and metiram are all registered for use in New Zealand. In addition, current DTC methodology is unable to differentiate DTCs from natural compounds in some vegetables (for

2 Percentage of dietary exposures based on total number of agricultural compounds screened (241) times number of age-gender cohorts (8).

3 Micrograms per kilogram.

example, brassicas). DTCs detected on brassicas, including those from natural compounds, contributed approximately 5–10% of the total estimated exposure to DTCs for 6–12 month infants, 5–6 year children, 11–14 year boys and girls; and 12–14% for 19–24 year young males, 25+ year males and females.

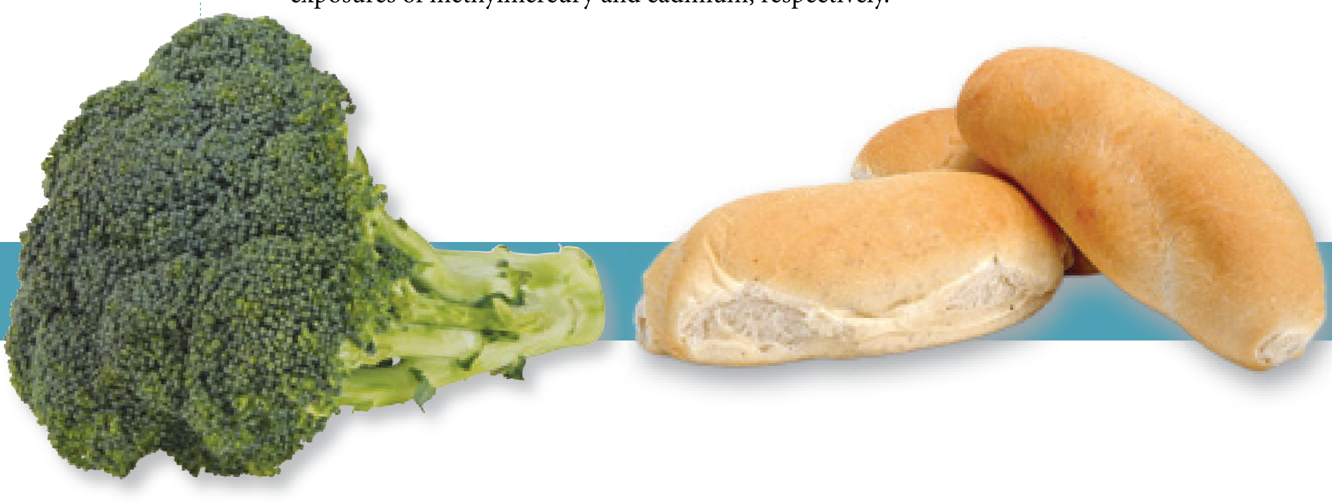
In the 2009 NZTDS, 982 food samples were screened for 241 agricultural compound residues, of which 437 samples (45 percent) were found to contain detectable residues. This is lower than the 50% found in the 2003/04 NZTDS and the 59% in the 1997/98 NZTDS. Residues of 75 different agricultural compounds were detected in the 2009 study, compared to 82 in 2003/04.

Of the 236,662 individual analytical agricultural compound residue results, 910 (0.4%) had detected residues, compared with 0.5% in 2003/04 and 1.4% in 1997/98, and despite an expanded list of compounds and lower limits of detection in this study.

While the frequency of residue detections is an interesting statistic, it has little bearing on the prime focus of the NZTDS and on food safety risk assessment, which is dietary exposures. The key factors in determining these exposures are both the amount of foods that are consumed (that is, the simulated diets) and the residue concentrations of the respective foods. In this regard, the 2009 NZTDS has shown that dietary exposures to agricultural compounds for all age-gender cohorts are all well below the respective ADIs, and are therefore unlikely to represent a risk to public health.

Contaminant elements in the 2009 NZTDS

The 2009 NZTDS estimated dietary exposures to total mercury and methylmercury were below the respective Provisional Tolerable Weekly Intakes (PTWIs) of 4 and 1.6 ug/kg bw/week set by the World Health Organization (WHO), and cadmium dietary exposures were below the Provisonal Tolerable Monthly Intake (PTMI) of 25 ug/kg bw/month, also set by WHO. In the absence of such health standards for total arsenic, inorganic arsenic or lead, and given consistency of 2009 findings with previous NZTDSs, international thinking is that our dietary exposures to these contaminant elements are unlikely to represent a significant risk to public health. Nonetheless, it remains important to keep such dietary exposures as low as reasonably achievable (ALARA). It should be noted that dietary exposures in the 2009 NZTDS were based on average energy diets for each of the age-gender cohorts. High percentile consumers of certain types of fish and Bluff dredge oysters have the potential to have significantly higher exposures of methylmercury and cadmium, respectively.



Arsenic

Most foods in the 2009 NZTDS analysed for total arsenic had mean concentrations less than 0.01 mg/kg. Fish products (fresh fish, battered fish, mussels and oysters, canned fish and fish fingers) contributed 92% of weekly total arsenic exposure for the young males' diet and 82% for the infants' diet, which excluded oysters and mussels. International studies have demonstrated that most (>90%) of the arsenic present in fish is in the relatively non-toxic organic form.

Using the United States Food and Drug Administration (US FDA) assumption, which it notes as conservative, that 10% of total arsenic in fish/seafood is inorganic, and that 100% of total arsenic in all other foods is inorganic, the 2009 NZTDS weekly dietary exposures of inorganic arsenic ranged from a low of 1.3 µg/kg bw/week for 11–14 year girls, to a high of 3.1 µg/kg bw/week for 6–12 month infants.

Estimated dietary exposures to total arsenic for 25+ year males in the 2009 NZTDS were similar to the United Kingdom (UK), higher than Australia, the United States of America (USA), France, the Czech Republic and China, and about one-third the Basque Country (Spain) who have more than double our fish consumption.

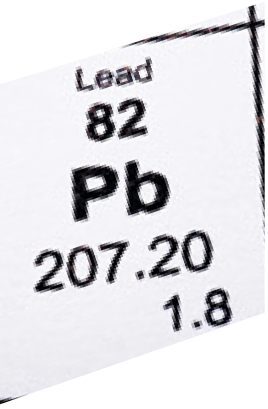
Cadmium

The major sources of dietary cadmium are oysters, potatoes and breads. Oysters are included only in the 19–24 year young males and 25+ year males and females simulated typical diets, not the 11–14 year boys and girls or younger, and 94% of New Zealanders never eat shellfish or rarely do so.

Estimated monthly dietary exposure to cadmium for the 19–24 year young males (diet including three–four oysters per fortnight) is 27% of the PTMI set by WHO, which is down from the 31% of the PTMI in 2003/04 and 40% in 1997/98. Given that cadmium in oysters is not free cadmium, but is protein bound and largely not biologically available, high levels in oysters are not of particular concern as it will contribute little to the actual body burden of cadmium. For this reason and the fact that oysters are consumed by very few New Zealanders, dietary exposures are also estimated in their absence. With oysters excluded from the simulated diet, the monthly dietary exposure to cadmium for the 19–24 year young males in the 2009 NZTDS is 23% of the PTMI, the same as in 2003/04.

Cadmium dietary exposures of the other age-gender cohorts of the 2009 NZTDS range from a low of 22% of the PTMI for the 25+ year females up to 46% for the 5–6 year children.

The 25+ year males in the 2009 NZTDS, with a diet including oysters, has a moderate cadmium dietary exposure by international Total Diet Study (TDS) comparisons, being below those of the Czech Republic and China, and above those of Australia, the USA, the UK, France, and the Basque Country. If oysters are excluded from the diet, the 2009 NZTDS exposures to cadmium for the 25+ year males decrease accordingly and are then very similar to most of the aforementioned countries, but remain well above France.



Lead

Foods in the 2009 NZTDS generally had concentrations of lead similar to those in 2003/04.

The 2009 NZTDS estimated weekly dietary exposures for lead are essentially the same as 2003/04 NZTDS levels for all age-gender cohorts, except the infant, which has reduced further from 2.9 µg/kg bw/week to 2.1 µg/kg bw/week. This is because a lead contamination was identified in the 2003/04 NZTDS in one out of eight samples of infant weaning food.

Dietary lead exposure for 19–24 year young males was 25 µg/kg bw/week in 1982 and is now down to levels of 1 µg/kg bw/week in the 2009 NZTDS. Similar reductions have been observed for the other age-gender cohorts, and exposure levels now appear to be stabilising to reflect residual environmental presence of lead. The NZTDS thus demonstrates that levels of lead in our diet are now ALARA.

Dietary exposure sources for lead are spread fairly evenly over the foods and food groups and reflect the ubiquitous environmental presence of residual lead in New Zealand.

The 2009 NZTDS lead exposure for 25+ year males (0.9 µg/kg bw/week) is low when compared to Australia (1.6), France (1.9), and the Czech Republic (2.4), and essentially the same as the USA (0.88). The UK (0.67) has a lower lead exposure, whereas in China (6.1) it is almost seven times higher than New Zealand.

Mercury

Mercury is present in fish and shellfish predominantly as methylmercury, while in all other foods it is considered to be present as inorganic mercury. For the eight age-gender cohorts in the 2009 NZTDS, the estimated weekly dietary exposures from all 2009 NZTDS foods excluding fish and shellfish were 13% or less of the PTWI for inorganic mercury, while from fish and shellfish they were 34% or less of the PTWI for methylmercury.

Fish and shellfish contributions ranged from 73% of the total mercury dietary exposure for young males, down to 55% for infants whose diet excluded shellfish.

In the 2009 NZTDS, 19–24 year young males had estimated weekly dietary exposures to total mercury for all foods of 0.73 µg/kg bw/week, essentially the same as in the 2003/04 NZTDS (0.74) and the 1997/98 NZTDS (0.73), despite a 40% increase in fish/shellfish consumption in 2009 and 2003/04 diets (245 g/week) compared to 1997/98 (175 g/week). This primarily reflects the lower mean mercury concentrations in battered fish in 2009 and 2003/04 (0.27 mg/kg and 0.25 mg/kg, respectively), compared to 0.36 mg/kg in 1997/98.

Methylmercury dietary exposures from fish and shellfish in the 2009 NZTDS were 0.27–0.37 µg/kg bw/week for 19–24 year young males and 25+ year males and females, 0.19–0.34 µg/kg bw/week for 11–14 year boys and girls, and 0.45–0.52 µg/kg bw/week for 5–6 year children, 1–3 year toddlers and 6–12 month infants.

Nutrient elements in the 2009 NZTDS

Iodine

Most foods in the 2009 NZTDS contained less than 0.05 mg/kg of iodine, consistent with previous studies.

Dairy foods, other animal sources (eggs, mussels, fresh fish and oysters) and takeaways provided the majority of the iodine in the diet of 25+ year males and females, 19–24 year young males, and 11–14 year boys and girls. Dairy foods make the most significant contribution (66% of total) to iodine intake for 1–3 year toddlers. Intake of iodine for 6–12 month infants is dominated by levels in infant and follow-on formula.

The mean daily intakes of iodine in New Zealand have steadily declined over the past 20 years, but appear to have levelled off in the 2009 NZTDS. The estimated mean iodine intake for each age-gender cohort in the 2009 NZTDS was below the Estimated Average Requirement (EAR), reflecting an inadequate iodine intake for more than 50% of each age-gender cohort. Intakes in New Zealand from 2009 NZTDS data remain low compared with intakes in Australia, Denmark, the Czech Republic and China.

It should be noted that dietary iodine intakes of this study (and any previous NZTDSs) are likely to be underestimated because discretionary iodised salt used during cooking or at the table for taste was not considered.

Selenium

The majority of selenium in the diets of all age-gender cohorts in the 2009 NZTDS came from breads and grain products, takeaways, seafood, chicken, and eggs, except for the 6–12 month infant, for whom infant weaning foods contribute 34% of intake.

The selenium content of South Island white breads (0.027 mg/kg) was approximately one-quarter that of North Island breads (0.112 mg/kg). This geographical difference reflects that North Island breads are likely to be made with higher selenium imported wheat, whereas South Island breads use predominantly domestically grown wheat.

The estimated daily dietary intakes of selenium for all age-gender cohorts in the 2009 NZTDS exceeded the EAR, or the adequate intake (AI) for the infant, and were all well below the upper levels of intake (UL). Across each population cohort selenium intakes have generally been relatively consistent over a 25-year period. Regional differences in intake may be expected due to differing selenium content of breads.

Mean intakes of selenium in the 2009 NZTDS are comparable to Australia, the UK, the Czech Republic and China, but are about half of the USA, and about double that of France.

Sodium

The 123 foods of the 2009 NZTDS had sodium concentrations that ranged from <10 mg/kg in many fruits and vegetables to 35,000 mg/kg in yeast extract. Much higher sodium concentrations are found in processed foods than unprocessed foods. For example, the mean concentration of sodium in tomato is 10 mg/kg, compared with 8332 mg/kg in tomato sauce.

Although the estimated mean daily sodium intakes of age-gender cohorts in the 2009 NZTDS are lower than those for the USA, the UK, Japan, China and the Czech Republic, New Zealand intakes are significantly above the AI for all age-gender cohorts. Mean sodium intakes in the 2009 NZTDS exceeded the ULs for the simulated diets of 25+ year males, 19–24 year young males, 11–14 year boys and girls, 5–6 year children, and 1–3 year toddlers cohorts by 116–148%. Only the diet of 25+ year females did not exceed the UL, but with mean sodium intake of 2049 mg/day, was still two to four times the AI.

Bread is the single greatest contributor (14–27%) to sodium intake, followed by processed meats (bacon, ham, corned beef and sausages), contributing 10–15% of total sodium intake. Processed grain products combined (including breads) account for 27–48% of sodium intake, with takeaways contributing 9–28% of sodium intake.

Sodium intake estimates in the 2009 NZTDS do not include the use of discretionary salt added at the time of cooking or at the table for taste, and it has been estimated that this could potentially add considerably more sodium to intake estimates, possibly as much as an extra 20%.

Sodium intakes have decreased for all age-gender cohorts by 14–28% since the 1987/88 NZTDS, but only 5–8% since the 2003/04 NZTDS.

BACKGROUND 1

1.1 Total Diet Studies

1.1.1 What are Total Diet Studies?

Total Diet Studies (TDSs) enable us to estimate and monitor dietary exposures to chemical residues, contaminant and nutrient elements.

A TDS involves purchasing (at retail level) foods commonly consumed by the population, preparing them as for normal consumption, homogenising and compositing them, before analysing the foods for the chemicals of interest (WHO, 2005).

TDSs differ from other surveillance programmes because:

» they assess exposure to chemicals across the total diet in the one study, in contrast to food commodity surveys where only a few individual foods are generally investigated;

» actual concentrations of chemicals are measured in foods after they have been prepared as for normal consumption. For this reason, TDSs provide, in general, the most accurate estimate of dietary exposures to chemical residues for a country as a whole, and thus the best means of assessing the potential risk to the population; and

» a TDS needs to measure down to very low concentrations of the chemicals in the foods in order to reduce the percentage of "not detected" results and make the exposure estimates more robust and meaningful. These concentrations are generally 10–1000 times lower than those needed for regulatory purposes. The extremely low limits of detection (LOD) needed and the procedure for assigning concentration data to "not detected" results are critical to exposure estimates in a TDS (see also section 2.4). When an Accepted Daily Intake (ADI) is low, accurate estimates require a low LOD, but when not, the imperative for a low LOD is less.

1.1.2 Why are TDSs important in risk assessment?

TDSs are considered important for monitoring dietary exposures to chemicals, and the associated risk to public health is characterised by comparing the estimated exposures to

international health guidance values such as the ADI, PTWI, EAR (see Appendix 13 for explanation of terms). This is the main reason why many developed countries conduct TDSs on a regular basis. Previous New Zealand Total Diet Studies (NZTDS) have been carried out in 1974/75, 1982, 1987/88, 1990/91, 1997/98 and 2003/04.

TDSs are a snap shot in time of the food supply and dietary exposure. They are promulgated by the World Health Organization (WHO) as the most cost effective means of assessing robust dietary exposures.

Unsafe exposures to chemicals from food also have the potential to pose threats to trade and the environment. It is estimated that the global economic and trade burden from contaminants in the food supply is many billions of dollars annually (FAO/WHO, 2003). A TDS is able to provide estimates of a population's dietary exposure to chemicals.

In addition, the results from a TDS can provide indicators of environmental contamination by chemicals and can be used to assess the effectiveness of specific risk management measures, so monitoring trends over TDSs is both useful and important.

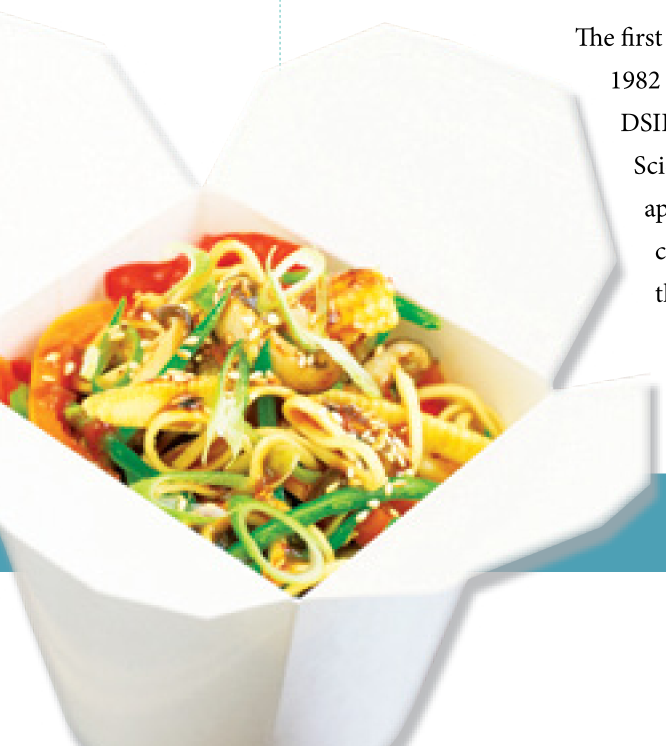
The 2009 NZTDS dietary exposures and concentration data for agricultural compounds, and selected contaminant and nutrient elements, provide important information for New Zealand and other international authorities as to the quality and safety of the New Zealand food supply.

1.2 The New Zealand Total Diet Study

1.2.1 History of New Zealand Total Diet Studies

The 2009 NZTDS is the seventh such study. In each of the TDSs, each type of food was sampled from four different geographic regions, so as to take into account different regional agricultural compound usage and the different levels of trace elements due to the varying soil conditions. Sampling of each food was also carried out on more than one occasion to take into account any seasonal variation.

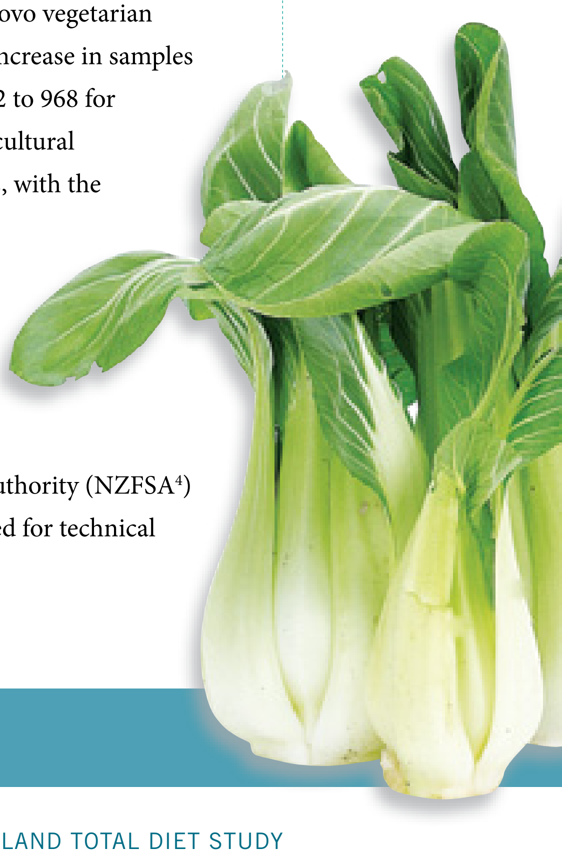
The first two TDSs, undertaken in 1974/75 (Dick *et al.,* 1978a, b) and 1982 (Pickston *et al.*, 1985) by the then Department of Health and DSIR Chemistry Division (later the Institute of Environmental Science & Research (ESR)), were based on a food group composites approach. Foods of a similar type, for example fruits, were combined in proportions relative to their level of consumption in the diet of an active 19–24 year young male. Individual food items were not analysed. A more detailed explanation of the sampling protocols can be found in the appropriate publications.



In the 1987/88 NZTDS (ESR/MoH, 1994), the design was changed to an individual foods approach. For each of the 105 foods involved, a total of 24 samples were obtained to provide a broad sampling base and yielded a total of 2520 samples. The 24 samples were composited (a subsample from each of the 24 samples was taken and combined) to give one analytical sample for each of the 105 foods. In addition, the diet for the 19–24 year young males were now based on a median (50th percentile) energy diet, and specific diets were developed for a wider range of age-gender cohorts (25+ year males, 25+ year females, 4–6 year children, 1–3 year toddlers). Foods were prepared table ready (for example, the meat was cooked).

The 1990/91 NZTDS (Vannoort *et al.,* 1995a, b; Hannah *et al.,* 1995; Pickston and Vannoort, 1995), 1997/98 NZTDS (Cressey *et al.,* 2000; Vannoort *et al.,* 2000), and 2003/04 NZTDS (Vannoort and Thomson, 2005a, b) continued the individual food approach. In 1990/91, the food list had increased to 107 foods, and included drinking water and in 1997/98 it had been extended to 114 foods, and a 19–40 year lacto-ovo vegetarian female diet added because vegetarians were identified by the Ministry of Health as a group becoming more significant amongst females. The 1990/91 NZTDS also saw the separation of the food list into "regional" and "national" foods, which has continued for all NZTDSs since. Regional foods continue to be sampled in four geographic locations, while national foods (including imported foods) are sampled in one city.

In the 2003/04 NZTDS, 121 foods were assessed, including *inter alia* the addition of infant weaning foods. The simulated fortnightly diets were revised to reflect a higher overall energy intake, consistent with National Nutrition Survey (NNS) data for relevant age-gender cohorts, compared to the diets used for the 1997/98 NZTDS. Simulated diets were added for 6–12 month infants, 11–14 year boys and girls, while deleting the lacto-ovo vegetarian female diet. A wider sampling base was undertaken, and also a significant increase in samples analysed from 460 to 990 for agricultural compound residues, and from 532 to 968 for elements. Improvements in analytical technology enabled the range of agricultural compounds included in the multi-residue screen to increase from 90 to 202, with the additional inclusion of an 18-compound acid herbicide screen. Additional emphasis was also given to the assessment of iodine intakes, and iron and sodium were added to the selected nutrients under investigation (Vannoort and Thomson, 2005a).



1.2.2 The 2009 NZTDS

The 2009 NZTDS was undertaken by the then New Zealand Food Safety Authority (NZFSA[4]) and the Institute of Environmental Science & Research (ESR) was contracted for technical input and operational management.

4 NZFSA was amalgamated into the Ministry of Agriculture and Forestry from 1 July 2010.

Goals

The agreed goals for the 2009 NZTDS were to:

» formulate in consultation with interested parties the design and content of the NZTDS;

» estimate dietary exposure for selected chemical residues, contaminants and nutrient elements in the New Zealand food supply, compare this with internationally recognised acceptable exposures or recommended levels, and identify trends in New Zealand over time;

» compare dietary exposure estimates with those in other countries, where comparable data is available;

» ensure that the outcomes of the NZTDS are complementary with data on chemical residues, contaminants and nutrient elements generated from other sources in New Zealand;

» where appropriate, provide data on selected chemical residues, contaminants and nutrient elements for incorporation into other databases including the WHO Global Environmental Monitoring System (GEMS) and the New Zealand Food Composition Database; and

» communicate findings to interested parties in a timely and transparent manner.

Comparison of the 2009 NZTDS with the 2003/04 NZTDS

The 2009 NZTDS was very similar to the 2003/04 NZTDS. Its main features were:

» the food list was further increased to a total of 123 foods in 2009, with the separation of water into tap and bottled water, and the addition of an Indian takeaway;

» in the absence of updated national nutrition survey information, the eight age-gender cohorts and associated body weights were the same as those used in the 2003/04 NZTDS;

» similarly, the simulated typical diets for the age-gender cohorts were the same as those in the 2003/04 NZTDS, except for the minor changes associated with the addition of Indian takeaway, and the split of water into tap and bottled waters;

» the multi-residue screen was extended from 202 to 240 agricultural compounds and metabolites, and most of the LODs improved. The 18-compound acid herbicide screen in the 2003/04 found no residues and was not included in 2009 NZTDS;

» the same heavy metals (arsenic, cadmium, lead, mercury) were assessed, with methylmercury also assessed for the first time on fish and seafood related foods in the 2009 NZTDS;

» iodine, selenium and sodium were again assessed amongst the nutrients, but iron was excluded from this study; and

» a total of 4330 samples were purchased, and these were composited on a seasonal/regional or seasonal/brand basis so that 982 samples were analysed for agricultural compound residues, and selected contaminant and nutrient elements.

Other reports of the 2009 NZTDS

All individual analytical data for each food/analyte combination associated with the 2009 NZTDS has been released previously in four quarterly reports (Vannoort, 2009b; NZFSA, 2009a, b, 2010b).

A procedures manual for the 2009 NZTDS was prepared, including purchasing instructions and sample preparation instructions (Vannoort, 2009a).

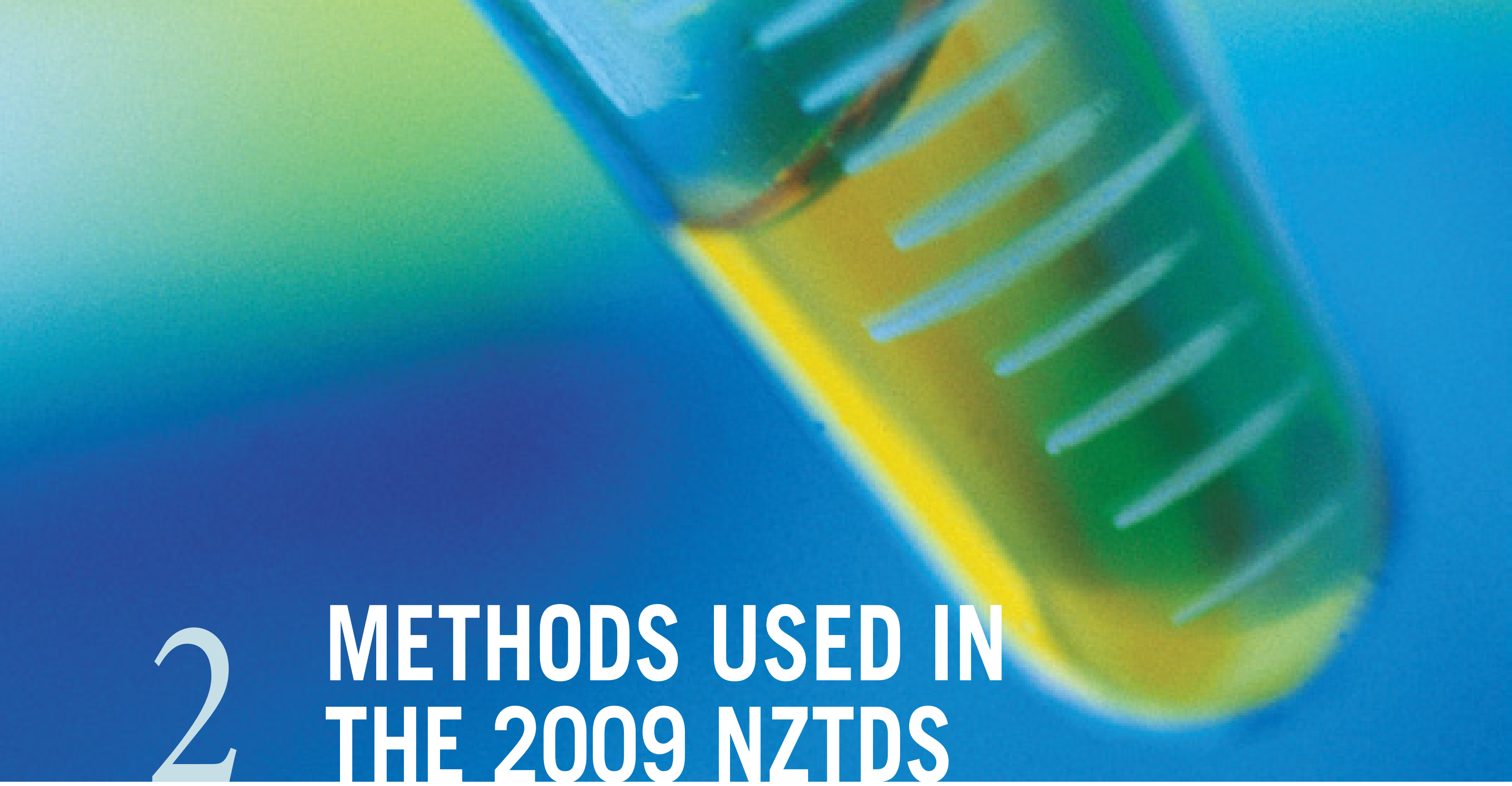
Separate reports have also been produced about the agreed outline and content of the 2009 NZTDS, including the food list (NZFSA, 2008), and the review of simulated typical diets for the 2009 NZTDS (NZFSA, 2010a).

Structure of this report

This is the main report for the 2009 NZTDS, and it summarises the key findings regarding estimated dietary exposures to agricultural compound residues, and selected contaminant and nutrient elements. It provides a general introduction to total diet studies and details the methodologies used in the 2009 NZTDS.

The results of the NZTDS for agricultural compound residues, and selected contaminant and nutrient elements are each considered in separate chapters, with each structured using a risk assessment framework, including hazard identification, hazard characterisation, exposure assessment and risk characterisation.

The appendices provide details of the NZTDS food list, food preparation instructions, simulated diets, the agricultural compounds screened for and their LODs, the elements analysed and their LODs in the 2009 NZTDS. The appendices also contain the summarised concentration data for all individual foods for all analyses in the 2009 NZTDS, and consolidated summaries of the estimated dietary exposures.



2 METHODS USED IN THE 2009 NZTDS

2.1 Food selection, sampling and preparation

The selection of foods for the 2009 NZTDS was based on those of the 2003/04 NZTDS, with the addition of an Indian takeaway, and the separation of water into tap and bottled waters. This 2009 NZTDS consisted, therefore, of 123 foods (Appendix 1) and represents those foods most commonly consumed in New Zealand. It should be noted that some foods in the food list are consumed only in very small amounts or by a limited number of age-gender cohorts, but they were included because they are significant sources of contaminants or agricultural compounds (for example, oysters and liver). Other foods are included because they are popular foods for specific sub-populations, especially children, such as infant foods and flavoured milk.

The following food groups and numbers of contributing foods were selected: Alcohol (3), Beverages, non-alcoholic (4), Chicken, eggs, fish and meat (17), Dairy (9), Fruit (17), Grains (18), Infant foods (4), Nuts (2), Oils and fats (3), Spreads and sweets (7), Takeaways (8) and Vegetables (26). A list of individual foods is given in Appendix 1.

Foods were classified as either:

NATIONAL FOODS (61), which were not expected to exhibit any regional variability and included processed foods, such as biscuits, breakfast cereals and beverages, which are uniformly available throughout New Zealand. National Foods were sampled in a single location (Christchurch) over five weeks on two separate occasions (January/February 2009 and July/August 2009). Multiple purchases of four leading brands, selected on the basis of market share, were collected on each sampling occasion. Foods were analysed on the basis of composites of individual brands per season to give a total of four analyses for each food for each of the two seasons.

REGIONAL FOODS (62) that may be expected to demonstrate variation in agricultural compound, contaminant and nutrient level depending on the location in which the food was produced. Regional foods include meat, milk, fruit and vegetables, and were mostly domestically produced, although some contained imports, depending on the season. Regional foods were

sampled in each of four locations (Auckland, Napier, Christchurch and Dunedin)[5] over six weeks on two separate occasions (April/May 2009 and October/November/December 2009). Multiple purchases of each food were made in each region, from at least two different outlets, such as supermarkets and specialty shops (for example, green grocer, butchery, bakery). Foods were prepared and analysed on the basis of composites of individual regions/season to give a total of four analyses for each food for each of the two seasons.

All foods in the 2009 NZTDS had eight different samples analysed, with the only exception being yeast extract, with six samples analysed[6].

Foods were prepared to a "table ready" state before analysis. For example, meats and potatoes were cooked, while fruits that are normally consumed without peel, such as oranges and bananas, were peeled. All water used in food preparation was distilled. (Details of food preparation are given in Appendix 2).

2.2 Food consumption data

Food consumption information was derived from 14-day simulated typical diets for different age-gender cohorts in the New Zealand population. A limited review of the simulated diets used in 2003/04 NZTDS was undertaken for the 2009 NZTDS (NZFSA, 2010a). In the absence of updated nationally representative food consumption data since the last NZTDS, the simulated typical diets in the 2009 NZTDS are the same as those of 2003/04, with the addition of an Indian takeaway in the 25+ year and 19–24 year diets, and separation of water into tap and bottled for all diets.

The simulated diets in the 2009 NZTDS are for the following age-gender cohorts::

- 25+ year males
- 25+ year females
- 19–24 year young males
- 11–14 year boys
- 11–14 year girls
- 5–6 year children
- 1–3 year toddlers
- 6–12 month infants

The main data sources for the 2003/04 and the 2009 NZTDS simulated diets were the *1997 National Nutrition Survey* (NNS) conducted for New Zealanders 15 years and older (Russell *et al.*, 1999) and the *2002 National Children's Nutrition Survey* (CNS) for children 5–14 years of age (MoH, 2003), and surveys of food consumption by young children (Soh *et al.*, 2002; Watson *et al.*, 2001; Weber, 1997).

The weights of each individual food estimated to be consumed by each age-gender cohort in the 2009 NZTDS are listed in Appendix 3. Diets resemble an average consumer in each of the selected cohorts and included all appropriate foods from the food list (for example, children's diets do not contain alcohol).

5 Four sampling locations provide geographical spread across the country, with Auckland being the main population centre in the North Island, and Napier a key growing area in the North Island. Christchurch is the main population centre in the South Island, and Dunedin another South Island city, with different soil and climatic conditions.

6 Only two national brands were available, additional batches for each brand were sampled in one season. However, this did not occur in the other season due to sampler error.

A summary of the body weights, total weight of diet and estimated energy intakes of the simulated diets for each age-gender cohort in the 2009 NZTDS is given in Table 1. In the absence of updated national nutrition survey information, body weights are the same as in 2003/04. Total weights of diets and energy content have increased since 2003/04 for all adult and teenager age-gender cohorts to reflect the addition of an Indian takeaway to their diets. Children's weights are the same as in 2003/04, which were based on measured national data, and children's diets based on regional studies compared with food and nutrition guideline values.

Table 1: Simulated diet parameters (2009 NZTDS)

Age-gender cohort	Body weight (kg)	Total weight of diet [d] (g/day)	Energy (MJ)
25+ year males	82 [a]	3474	13.3
25+ year females	70 [a]	2792	9.6
19–24 year young males	78 [a]	3187	15.4
11–14 year boys	54 [b]	2051	11.3
11–14 year girls	55 [b]	1797	9.3
5–6 year children	23 [b]	1633	7.2
1–3 year toddlers	13 [c]	1275	5.2
6–12 month infants	9 [c]	1044	3.8

Notes

a NNS, 1997 (Russell *et al.*, 1999).
b CNS, 2002 (MoH, 2003).
c NHMRC, 2006.
d Diet includes beverages.

2.3 Analytes

Foods in the 2009 NZTDS were analysed for a range of agricultural compound residues, and selected contaminant and nutrient elements. A number of quality assurance procedures, including blanks, duplicates, certified reference materials, spikes and blind duplicates, were included to ensure confidence in the methodology and robustness of the results. These have been previously reported in the four quarterly reports (Vannoort, 2009b; NZFSA, 2009a, b, 2010b).

2.3.1 Agricultural compounds

All foods in the 2009 NZTDS were screened for 240 agricultural compounds and metabolites using a multi-residue agricultural compound screen.

In addition, 46 fruit and vegetable products were analysed separately for dithiocarbamate (DTC) fungicides, with four different regional samples per food per season.

The multi-residue screen of 240 agricultural compounds was achieved via two methods: the first involved an ethyl acetate extraction followed by purification by gel permeation chromatography and detection and quantification by gas chromatography tandem mass spectrometry (GCMSMS) for Q1 and Q2, and by triple quadruple gas chromatography mass spectrometry for Q3 and Q4. The upgrading of the gas chromatography mass spectrometry (GCMS) for the

last two quarters (one sampling round for all foods) also improved the LOD for 200 of the 240 agricultural compounds, which resulted in an extra 121 detections out of 607 in total for Q3 and Q4. Internal standards were used to give an accurate determination of residue levels. The second method involved an acetonitrile extraction followed by purification by dispersive solid phase extraction and detection and quantification by liquid chromatography tandem mass spectrometry (LCMSMS).

Foods for analysis of DTC residues were decomposed in acid conditions to form carbon disulphide, which was then measured by GCMS.

The LODs for the multi-residue and DTC agricultural compounds in the 2009 NZTDS are detailed in Appendix 4.

2.3.2 Contaminant elements

The contaminant elements – arsenic, cadmium, and lead – were analysed in all foods in the 2009 NZTDS. For the other contaminant element – mercury – both total mercury and methylmercury were analysed. Total mercury was analysed in all foods except for 29 high-fat (for example, butter) or dry foods (for example, biscuits), and methylmercury only in the four fish and two shellfish foods. Foods not analysed for the aforementioned elements were because LODs were considered inadequate to yield a meaningful mean concentration value for use in subsequent dietary exposures.

Foods were acid digested to release the elements arsenic, cadmium, lead, and mercury. The diluted digests were analysed by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Methylmercury was determined by alkaline extraction followed by derivatisation with tetraphenylborate and detection and quantification by head-space solid phase micro extraction (SPME) GCMS.

The LODs for the contaminant elements in the 2009 NZTDS are detailed in Appendix 8.

2.3.3 Nutrient elements

Nutrient elements iodine and sodium were also analysed in all 2009 NZTDS foods, while selenium was analysed in all but a few high-fat foods. Foods not analysed for the aforementioned elements were because LODs were considered inadequate to yield a meaningful mean concentration value for use in subsequent dietary exposures.

Foods were acid digested to release the nutrient element sodium. The diluted digests were analysed by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Samples requiring selenium or iodine analyses were alkaline digested and analysed by ICP-MS.

The LODs for the nutrient elements in the 2009 NZTDS are detailed in Appendix 8.

2.4 Calculating mean concentration data in the 2009 NZTDS

The primary focus of the NZTDS is to estimate dietary exposure. Deterministic (point estimate) exposures are obtained by multiplying mean concentration data by the amount of food consumed (WHO, 2009). Mean concentration data would normally be rounded, but the mean is an intermediate in the calculation of the estimated dietary exposure, so rounding has been left to the final calculated exposure figure.

2.4.1 Agricultural compound mean concentration data

Mean concentrations of agricultural compounds in the 2009 NZTDS foods were calculated as simple arithmetic means. Agricultural compound residues may be present at a detectable level, may be present at a level below the LOD, or may not be present. Where no residue was detected in the sample, the true concentration of the agricultural compound in that sample was assumed to be zero. Unlike elements, agricultural compounds are intentionally applied to crops at specific times to achieve a specific purpose, so one cannot assume it has been used or would be present in "not detected" samples. This is the most commonly used international protocol for estimating dietary exposure to agricultural compounds (FSANZ, 2003; FAO/UNEP/WHO, 1985). Residues above the LOD have been reported and used for determining mean concentrations in the 2009 NZTDS.

The agricultural compound concentration data for the 2009 NZTDS foods are detailed in Appendices 5 and 6.

2.4.2 Contaminant and nutrient element mean concentration data

Contaminant and nutrient elements are naturally occurring and ubiquitous. For this reason, a "not detected" result means there is a high probability of contaminant and nutrient elements being present but at such a level that they cannot be measured. To assume that the "not detected" level implies a zero value for the contaminant or nutrient element would

underestimate the total level in the diet. Conversely, to assume that "not detected" values are all present at the LOD may overestimate the total level in the diet.

For contaminant and nutrient elements, when determining an arithmetic mean concentration, a "not detected" result was allocated the value of half the LOD (ND=LOD/2). This maintains consistency of approach with previous NZTDSs, and the approach recommended by the 1995 GEMS/Food Euro workshop (WHO GEMS/Food-Euro, 1995). For a concentration above the LOD, the actual concentration in the 2009 NZTDS has been used. Lower bound (ND=0) and upper bound (ND=LOD) mean concentrations were also determined for completeness of dietary exposure/intake estimates for contaminant and nutrient elements.

Similar "non-zero" protocols for "not detected" results are in use internationally. The Basque Country (Spain) (Jalón *et al.*, 1997) assigned a value equal to LOD to "not detects". The United Kingdom (UK) (Rose *et al.*, 2010) and the United States of America (USA) (Egan, 2011) use both lower and upper bound estimates. Australia used the lower and upper bound mean estimates for nutrients (FSANZ, 2008), and statistical middle value (median) for contaminant elements because it is not dependent on the treatment of results below the limit of quantitation (LOQ) (FSANZ, 2003).

Foods not analysed in the 2009 NZTDS for some elements (see section 2.3.2) were separately assigned a mean concentration value based on previous NZTDSs or other NZ data (Vannoort *et al.,* 2000, for total mercury or selenium).

The contaminant and nutrient element concentration data in the 2009 NZTDS foods are detailed in Appendices 9 and 11, respectively.

2.5 Estimating dietary exposures in the 2009 NZTDS

The estimates of dietary exposures were calculated by using the arithmetic mean concentration of the particular agricultural compound (Appendix 5), contaminant (Appendix 9) or nutrient elements (Appendix 11) in food multiplied by the daily weight for each food consumed (derived from two-week simulated diets) for each age-gender cohort (Appendix 3).

The estimated mean exposures include uncertainties associated with the respective "not detected" protocol used, but do not include sampling, analytical or food consumption errors associated with the simulated diets. Such uncertainties are not generally quantified or reported in TDSs internationally, being complex and also matrix/concentration dependent (Rose *et al.*, 2010; FSANZ, 2003, 2008; Egan, 2002, 2005, 2011; Li, 2011; Leblanc *et al.,* 2005).

For agricultural compounds, the estimated mean exposure is then divided by body weight (bw) to yield dietary exposures on a µg/kg[7] bw/day basis. For contaminant elements, dietary exposures are expressed on a µg/kg bw/week or month, which is derived by multiplying the daily per kilogram bodyweight exposure by seven or 365/12, respectively. For the nutrient elements, daily intakes are not divided by bodyweight, so are expressed on a µg or mg/person/day basis.

7 Micrograms per kilogram.

3 AGRICULTURAL COMPOUND RESIDUES: RESULTS AND DISCUSSION

3.1 Introduction

Agricultural compounds have been used widely. Their application has improved crop yields and has increased the quantity of fresh fruits, vegetables, cereals and nuts available to the consumer (NRC, 1993). Agricultural compounds may also cause harm. If the dose is sufficiently high, some agricultural compounds can cause a range of adverse effects on human health, including acute and chronic injury to the nervous system, lung damage, reproductive dysfunction, possibly cancer, and dysfunction of the endocrine and immune systems (NRC, 1993). However, foods produced in accordance with good agricultural practice (GAP) should not contain levels of agricultural compound residues from which adverse effects are likely to result.

Agricultural compound residues are usually present in foods as the result of intentional application to crops, or food production animals, or to stored food products for a defined purpose at a particular time. While levels of nutrients in foods are relatively well established in food composition databases (Lesperance, 2009), the agricultural compound content of foods can vary significantly over time and from place to place. The analyses included in NZTDSs allow temporal and geographical trends to be examined.

Agricultural compounds fall into a number of generic classes, and these are detailed below, along with their chemical structure, historical development, their stability in the environment and ability to accumulate up the food chain, their mode of action, and effects of acute and chronic toxicity.

The 2009 NZTDS analysed foods for residues of the following classes of agricultural compounds:

» organochlorine compounds;

» organophosphorus compounds;

» fungicides; and

» “other” agricultural compounds.

The other agricultural compounds class includes some insecticides including synthetic pyrethroids (analogues of the naturally-occurring pyrethrins) and carbamates, some herbicides, synergists (compounds which are applied in conjunction with other agricultural compounds to increase their effectiveness), plant growth regulators including post-harvest sprout inhibitors, some veterinary medicines such as those administered to food production animals for the control of ectoparasites, and any other agricultural compound which does not fit into the preceding three major categories.

3.2 Agricultural compound residue results

3.2.1 Concentration data and estimated dietary exposures of the 2009 NZTDS

Methodology for determining mean concentration data and dietary exposure estimates has been previously explained in section 2.4.1 and 2.5, respectively.

Details of the concentrations of agricultural compounds in the 123 individual foods assessed in the 2009 NZTDS are sorted either by agricultural compound (Appendix 5) or by the food (Appendix 6).

Appendix 7 provides a summary of the resultant estimated dietary exposures of agricultural compounds for the 2009 NZTDS. Where possible, these exposures are also shown as a percentage of the international health-based guidance value, the ADI.

3.2.2 Comparison of 2009 NZTDS results with previous NZTDSs

The 2009 NZTDS is the seventh carried out in New Zealand. While there were significant changes in the study design from food group approach in the 1982 NZTDS (Pickston *et al.*, 1985) to an individual food approach in the 1987/88 NZTDS (ESR/MoH, 1994), the procedures for performance of the NZTDS have been fairly consistent for the last five studies (1987/88, 1990/91, 1997/98, 2003/04 and 2009). Therefore, changes in estimated dietary exposure from one study to the next can be assumed to reflect:

- changes in usage patterns of agricultural compounds; or
- changes in food consumption patterns; or
- changes in analytical procedures allowing detection of a wider range of agricultural compounds, or the same agricultural compounds, but at previously undetectable levels.

Trends will be reported for the main agricultural compounds detected in the 2009 NZTDS compared to previous NZTDSs.

3.2.3 Comparison of 2009 NZTDS with overseas TDSs

The results of the 2009 NZTDS have been compared with the 20th (2000/01) Australian Total Diet Study (ATDS; FSANZ, 2003) and the 2000/01 United States Total Diet Study (USTDS; Egan, 2005). There are a limited number of TDSs available for comparison and these two studies were selected for the cultural similarities between these countries and New Zealand and because the methodologies for estimating exposure are comparable.

Comparison of estimated dietary exposure to agricultural compounds for the New Zealand population with estimates made in other countries can be challenging due to differences in:

» analytical procedures, including LODs;
» agricultural practices;
» analytical quality assurance/quality control;
» TDS design (individual foods or food group composites);
» definition of age-gender cohorts and body weights used;
» protocols for dealing with "not detected" analytical results;
» diets (different foods, levels of consumption);
» ethnic differences; and
» timing of the published results.

Comparisons with international TDSs have been made against estimated dietary exposures calculated for the New Zealand adult males (25+ years, 82 kg bw). The overseas studies and the relevant age-gender cohort for comparison are given in Table 2 below.

Table 2: Comparative overseas TDSs

Country	Name of study	Age-gender cohort	Body weight (kg)	Age (years)
New Zealand	2009 NZTDS	adult males	82	25+
Australia	2000/01 (20th) ATDS (FSANZ, 2003)	adult males	82	25–34
United States	2000/01 USTDS (Egan, 2005)	adult males	80	25–30

3.3 Agricultural compounds discussion

3.3.1 Overview and statistical summary

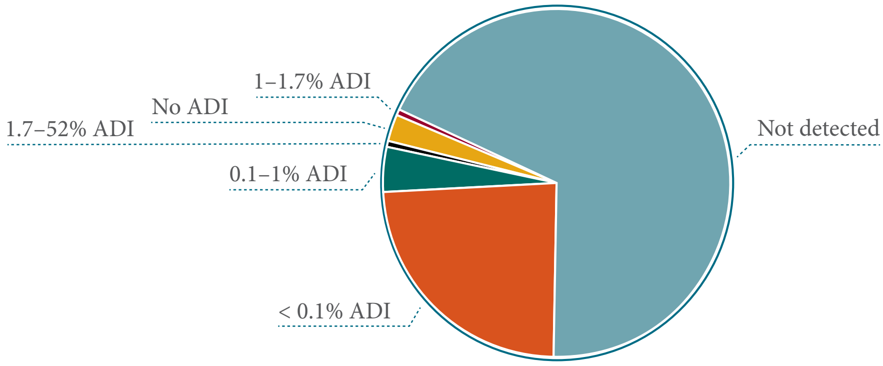
A consolidated summary of the estimated dietary exposures to the agricultural compound residues detected in the diets of the eight age-gender cohorts of the 2009 NZTDS is provided in Appendix 7.

Sixty-nine percent (69%)[8] of the estimated dietary exposures to agricultural compound residues for the eight age-gender cohorts in the 2009 NZTDS were zero (not detected), 24% were less than 0.1% of the ADI, 4.1% between 0.1 and 1% of the ADI, 0.4% between 1 and 5% of the ADI, and 0.4% between 5 and 52% of the ADI, and 2.5% of exposures had no ADI to benchmark against (Figure 1).

8 Percentage of dietary exposures based on total number of agricultural compounds screened (241) times number of age-gender cohorts (8).

The estimated dietary exposures in the 1.7–52% of ADI category were all for DTC fungicides. For 19–24 year young males and 25+ year males and females, these ranged from 1.7–19% of the ADI; for 11–14 year boys and girls (2.6–27%); and for 5–6 year children/1–3 year toddlers/6–12 month infants (3.7–52%) (see Appendix 7). The upper bound is considered to be an overestimate by as much as a factor of 10 because of assumptions about ADIs of DTCs contributing to the exposure estimates (see section 3.3.4 for explanation). In addition, interferences from naturally occurring constituents in brassicas are possible. Brassicas contributed 5–14% of DTC exposures in the 2009 NZTDS, depending on age-gender cohort.

Figure 1: Dietary exposures to agricultural compound residues (2009 NZTDS)



Figures 2–9 include the 18 agricultural compounds for each of the eight age-gender cohorts in the 2009 NZTDS with the highest estimated daily dietary exposures, and equating to those exceeding 0.02% of the ADI. Of these 18, three were organochlorine compounds (total DDT, dieldrin, and total endosulfan); seven were organophosphorus compounds (chlorpyrifos, chorpyrifos-methyl, dimethoate, fenitrothion, methamidiphos, pirimiphos-methyl, and prothiofos); four were fungicides (DTCs, imazalil, diphenylamine and iprodione) and four were "other" agricultural compounds (deltamethrin, carbaryl, chlorpropham and piperonyl butoxide). Of the eight age-gender cohorts, the higher exposures were observed for the 5–6 year children, 1–3 year toddlers or 6–12 month infants. This is not unexpected because these cohorts have higher consumptions of food and energy on a per kilogram body weight basis.

Figure 2: Dietary exposures to agricultural compound residues for 25+ year males

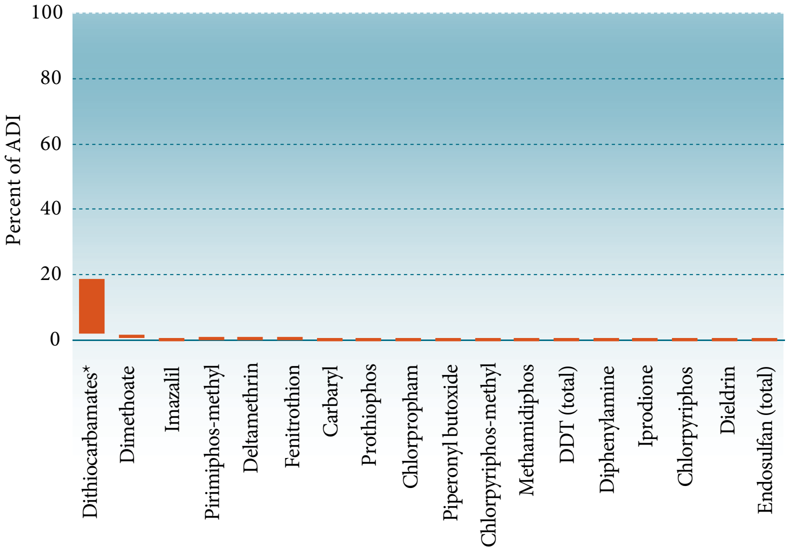


Figure 3: Dietary exposures to agricultural compound residues for 25+ year females

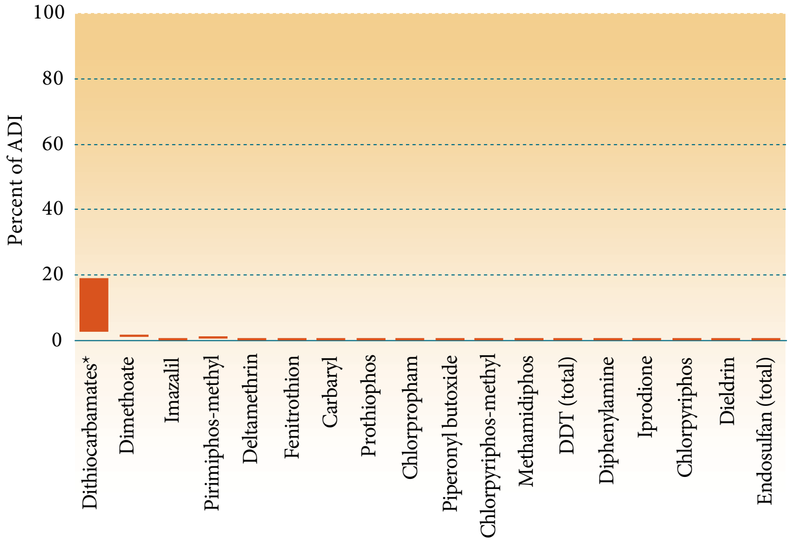
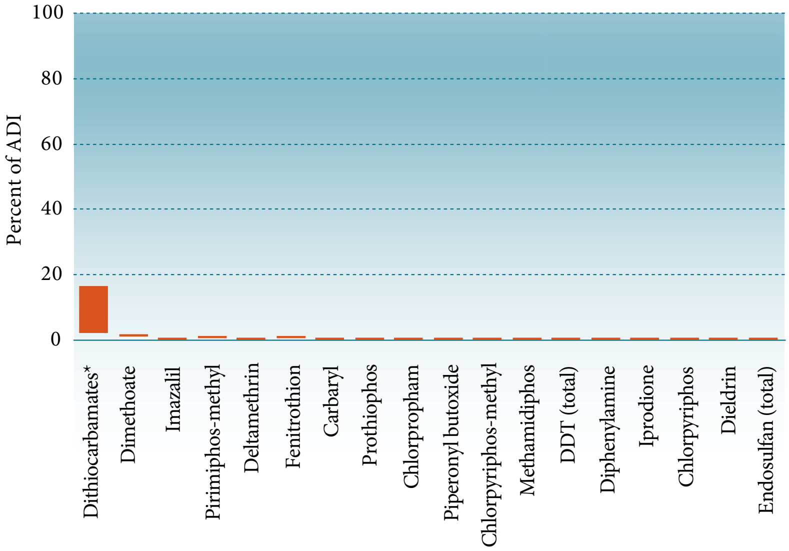


Figure 4: Dietary exposures to agricultural compound residues for 19–24 year young males



Note: Only those agricultural compounds with dietary exposures > 0.02% of ADI in the 2009 NZTDS have been graphed.
* Marker shows upper and lower bound estimates of exposure.

Figure 5: Dietary exposures to agricultural compound residues for 11–14 year boys

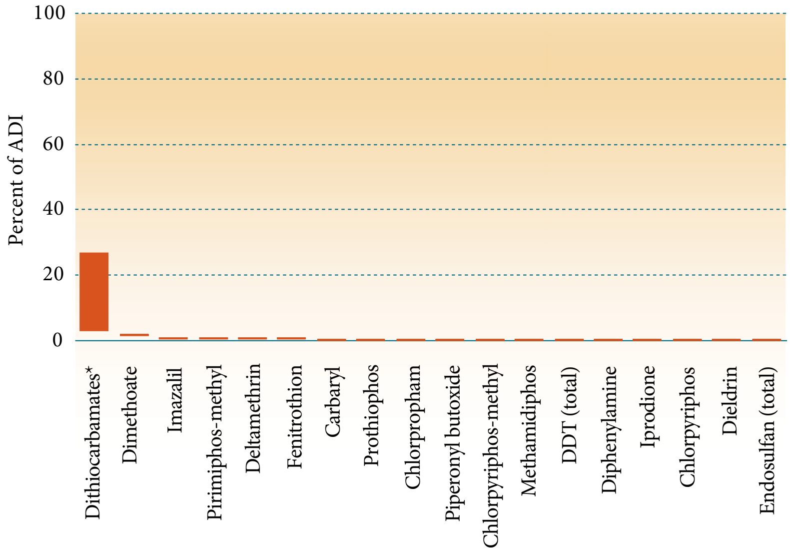


Figure 6: Dietary exposures to agricultural compound residues for 11–14 year girls

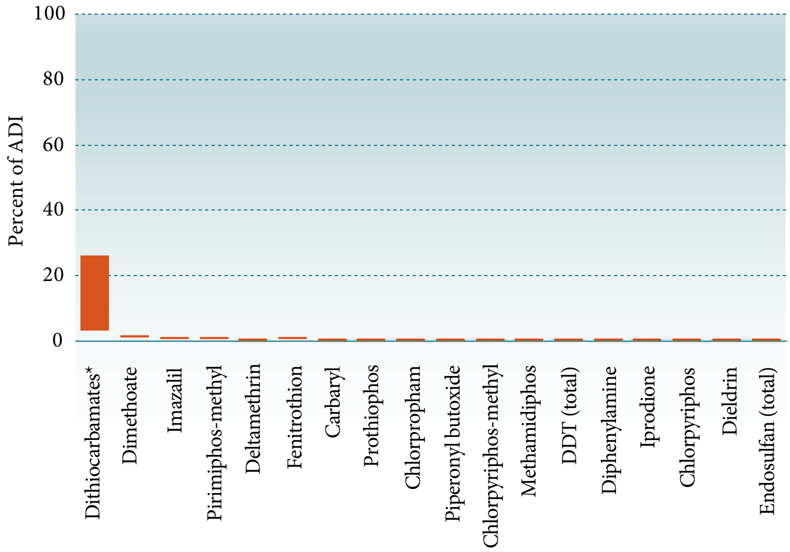
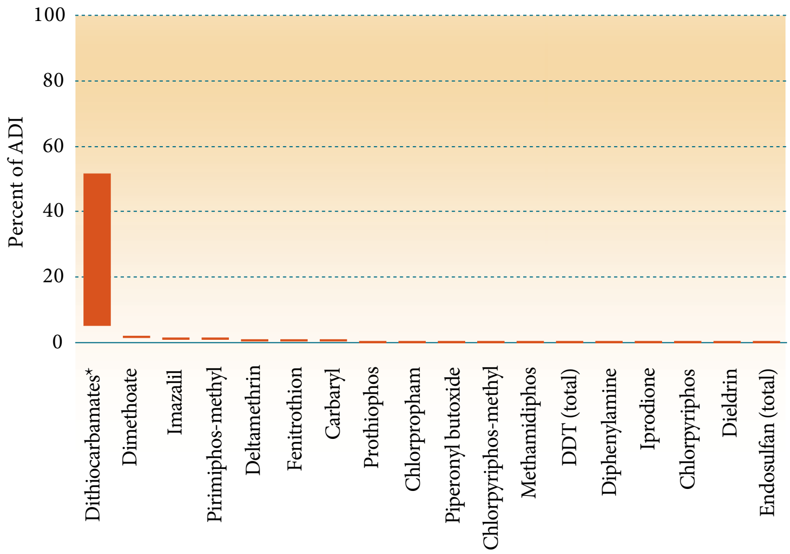


Figure 7: Estimated daily dietary exposures to agricultural compound residues for 5–6 year children



Note: Only those agricultural compounds with dietary exposures > 0.02% of ADI in the 2009 NZTDS have been graphed.
* Marker shows upper and lower bound estimates of exposure.

Figure 8: Dietary exposures to agricultural compound residues for 1–3 year toddlers

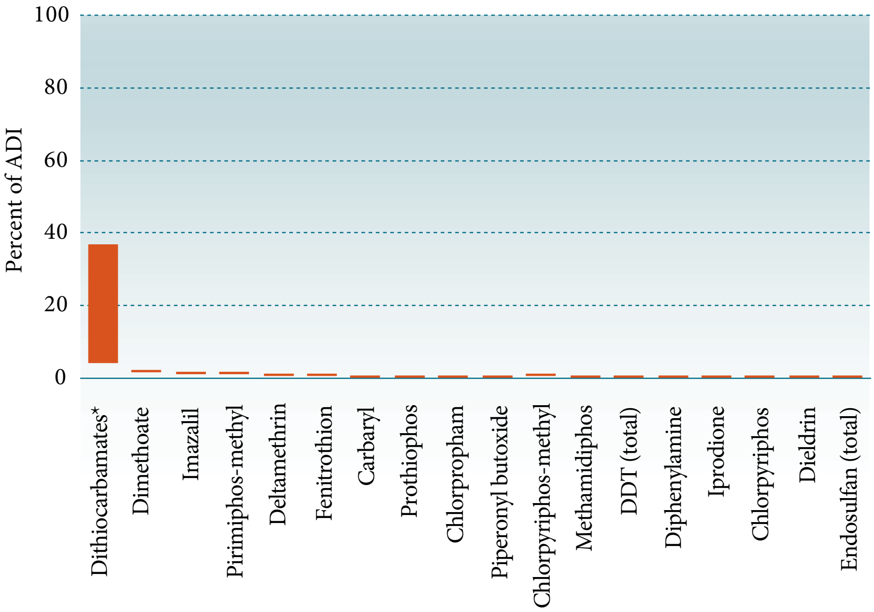
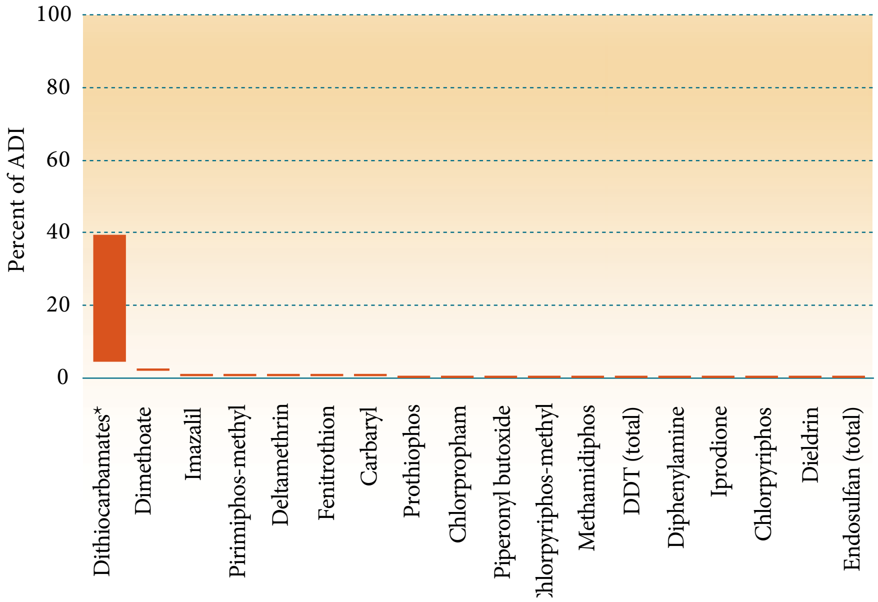


Figure 9: Dietary exposures to agricultural compound residues for 6–12 month infants



Note: Only those agricultural compounds with dietary exposures > 0.02% of ADI in the 2009 NZTDS have been graphed.
* Marker shows upper and lower bound estimates of exposure.

Of the 982 food samples screened for 241 agricultural compound residues, 437 samples (45%) were found to contain detectable residues. This is lower than the percentages found in the 2003/04 NZTDS (50%, Vannoort and Thomson, 2005a) and 1997/98 NZTDS (59%, Cressey *et al.*, 2000), respectively, despite the current study employing a broader agricultural compound screen (241 agricultural compounds versus 221 in 2003/04 and 90 in 1997/98), in addition to some of the same compounds being analysed down to lower detection limits in 2009.

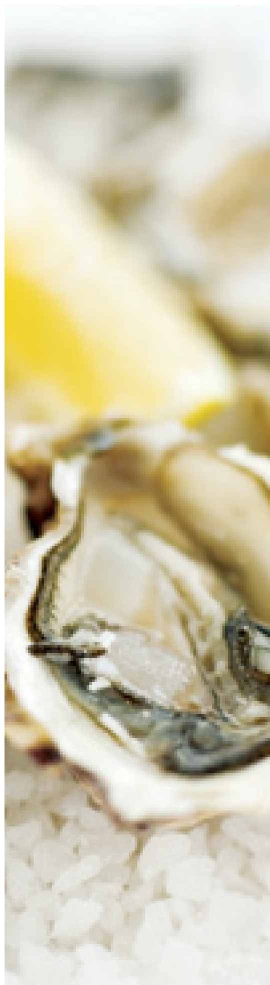
A total of 75 different agricultural compound residues were detected out of the 241 agricultural compounds screened for in the 2009 NZTDS. Appendix 5 details which agricultural compounds were detected or not detected in the 2009 NZTDS foods.

The different food types containing the highest number of agricultural compound residues were strawberries (15 different residues), cucumber (14), bran flake cereal, muesli and grapes (12), pears and chicken takeaway (10), celery, courgette, raisins/sultanas (9), plain sweet biscuits and nectarines (8); although for each food type, these were not all in the same sample. The maximum number of agricultural compound residues in any one food sample from the 2009 NZTDS was 13 and 11, on imported strawberries, but it should be noted that both these samples were composites of four purchases. By contrast, 35 foods had no agricultural compound residues detected in the 2009 NZTDS and these are listed in Appendix 6, along with the foods that had residue levels that were detected.

Of the 236,662 individual analytical agricultural compound residue results, 910 results (0.4%) represented detectable residues, compared to 0.5% in 2003/04 and 1.4% in 1997/98.

Only nine of the 241 agricultural compound residues screened for accounted for 580 (64%) of the 910 detectable residues. These were DTCs (138 detections), pirimiphos-methyl (120), piperonyl butoxide (108), 4,4’-DDE (56), pyrimethanil (42), cyprodonil (32), procymidone (31), iprodione (29), and fenitrothion (24).

While the frequency of residue detections are interesting statistics, they have little bearing on the prime focus of the NZTDS, which is dietary exposures. The key factors in determining these exposures are the simulated diet consumption amounts and the residue concentrations of the respective foods. In this regard, the 2009 NZTDS has shown that dietary exposures to agricultural compounds for all age-gender cohorts are all well below the respective ADIs, and are therefore unlikely to represent a risk to public health.



3.3.2 Organochlorine compound residues

Organochlorine compounds are organic compounds that contain at least one covalently bonded chlorine atom. They were amongst the first of the modern agricultural compounds, developed during the 1930s (NRC, 1993). Over time, it has been realised that they have two unfavourable characteristics. Firstly, they can be very stable compounds and persist in soils, and secondly, they are also fat-soluble and may be stored in the fat of humans and other animals, thus concentrating up the food chain. The majority of residues found in food are due to the

persistence of compounds such as DDT or its metabolites. DDT has a half-life of up to 30 years in soil.

While commonly used in the past, many organochlorines have been removed from the market due to their health and environmental effects, and their persistence (for example, DDT) (US EPA, 2011). DDT was earlier used in New Zealand for *inter alia* control of grass grub, but was banned in New Zealand in 1989, although its general use on pasture was voluntarily discontinued 10–20 years prior to that. Because they are no longer used in agriculture such organochlorine compounds are more accurately classified as environmental contaminants than as agricultural compounds.

Endosulfan is a later generation organochlorine, developed in the early 1950s. Its half-life is nine months to six years. Endosulfan is an insecticide previously permitted for use on some fruits and vegetables. New Zealand's Environmental Risk Management Authority (ERMA) announced a total ban on importation and use of endosulfan, effective 16 January 2009 (ERMA, 2008).

Hazard identification

Organochlorines were effective as agricultural compounds by disrupting pests' nerve function. In mammals, acute poisoning (usually occupational exposure or suicide) can produce death by respiratory or cardiac failure as a result of nerve dysfunction. Chronic poisoning results in behavioural changes, liver damage and reduced reproductive efficiency (Jones, 1993). These compounds are no longer in use in New Zealand, so occupational and safety health issues are not relevant. Similarly, given the very low residues encountered in the NZTDS, none of these signs of poisoning would occur.

Hazard characterisation

ADIs for organochlorine compounds range from 0.1 µg/kg bw/day for the more toxic compounds aldrin, dieldrin and heptachlor, to 2 µg/kg bw/day for dicofol, 6 µg/kg bw/day for endosulfan, and up to 10 µg/kg bw/day for total DDT (IPCS, 2009). The list of ADIs for organochlorine compounds detected in this study is included in Appendix 7.

Dietary exposure assessment

Prevalence/concentrations

The concentrations of organochlorine compounds in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in the appendices of this report, detailing the minimum, maximum and arithmetic mean concentrations of organochlorine compounds in 2009 NZTDS foods, sorted either by agricultural compound (Appendix 5) or by the 2009 NZTDS food (Appendix 6).

Residues of six organochlorine compounds, 4,4'-DDE (56 detections), dieldrin (1), dicofol (1), endosulfan I (1), endosulfan II (5) and endosulfan sulphate (8) were detected in foods analysed in the 2009 NZTDS. Residues of these organochlorine compounds account for 8% of all residues detected (72 out of a total of 910).

By far the most frequently detected organochlorine was 4,4'-DDE, the major metabolite of DDT. It was detected in a wide range of animal products, and processed foods containing animal products such as cheese, meat pie, pizza and sausages. The parent compound, 4,4'-DDT was not detected in any samples.

Table 3 presents comparative data from the 1990/91, 1997/98, 2003/04 and 2009 NZTDSs for the mean concentration of total DDT (DDT and its metabolites) in selected total diet foods. While the mean concentrations are based on relatively limited sample numbers (n=2–10), a general downward trend in the levels of total DDT in New Zealand foods is evident.

Fourteen residues of endosulfan were found in the 2009 NZTDS foods. Residues of endosulfan I were found on one sample of tomatoes, endosulfan II was found on two samples of tomatoes, courgettes (1), pear (1) and strawberries (1). Endosulfan sulphate was found in one sample of Chinese takeaway, courgette (4), cucumber (1) and tomatoes (2). Five of the residues were

Table 3: Mean concentration trends for total DDT

Food	Mean concentration of total DDT in selected NZTDS foods (mg/kg)			
	1990/91 NZTDS	1997/98 NZTDS	2003/04 NZTDS	2009 NZTDS
Bacon	0.0200	0.0055	0.0048	0.0012
Beef, mince	0.0075 [a]	0.0075	0.0048	0.0042
Butter	0.0414	0.0186	0.0231	0.0140
Cheese	0.0243	0.0075	0.0081	0.0012
Chicken	0.0050 [a]	0.0015 [a]	0.0033	not detected
Lamb/mutton, shoulder	0.0300	0.0095	0.0055	0.0027
Lamb's liver	0.0800	0.0050	not detected	0.0028
Sausages, beef	0.0300	0.0150	0.0097	0.0063
LOD	**0.01**	**0.003**	**0.002**	**0.0002**

Note

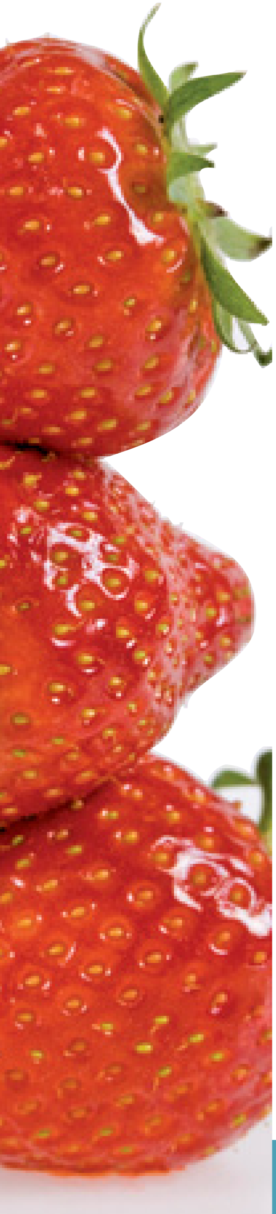
a Reported results which are below the limit of detection (LOD) are the result of averaging results above the LOD and results below the LOD (assigned a value of zero).

detected in the January sampling, and were all less than 0.054 mg/kg. The other nine detections occurred in the August 2009 sampling, seven months after ERMA's ban on its use came into effect in New Zealand. Of those nine detections, four were in courgette samples and one strawberry, all of Australian origin, where endosulfan use is permitted. The residues in Chinese takeaway, or domestic pear or tomato were all less than or equal to 0.0034 mg/kg. By way of comparison, a total of 35 detections of endosulfan were found in the 2003/04 NZTDS, ranging from 0.010–0.145 mg/kg.

Dieldrin residues were detected in only one imported courgette sample. This is consistent with previous NZTDSs, in which dieldrin has also been encountered in ground-grown cucurbits.

Dicofol is a miticide (to control mites) and was detected at 0.0007 mg/kg in one sample of bran flake cereal, which also contained imported sultanas. This is not unexpected as dicofol was found on imported grapes and raisins/sultanas in the last NZTDS. Dicofol is no longer registered in New Zealand, but dicofol is permitted on foods imported into New Zealand for which Codex has established a residue limit, grapes are one such food.

α-BHC and β-BHC (HCCH) were not detected in the 2009 NZTDS, although they were both detected in 2003/04.

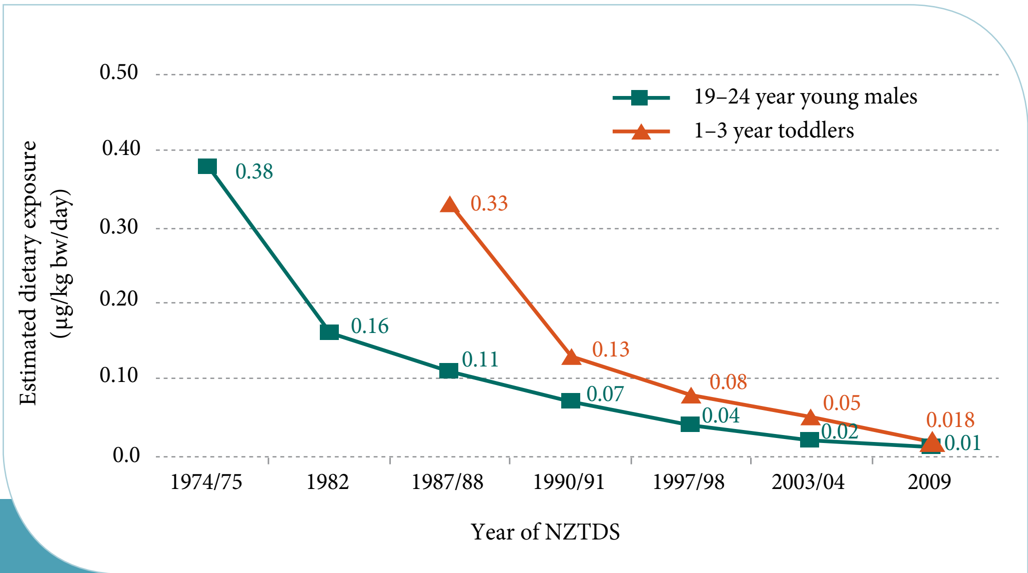


Estimated dietary exposures

Estimated daily dietary exposures to organochlorine compounds for each of the age-gender cohorts considered in the 2009 NZTDS are given in Appendix 7. Exposures are expressed as µg/kg bw/day, and as a percentage of the relevant ADI, as ADIs differ between organochlorine compounds.

In the 2009 NZTDS, the highest dietary exposures to organochlorine compounds were from total DDT, with exposures less than or equal to 0.024 µg/kg bw/day for each of the eight age-

Figure 10: Dietary exposure trends for total DDT



gender cohorts (Appendix 7). Exposure to total DDT residues was almost exclusively from three of the food groups: the chicken, eggs, fish and meat group, dairy products, and takeaway foods. This is consistent with the fat soluble nature of this persistent organochlorine compound. Dairy products and the chicken, eggs, fish and meat group each contributed approximately half of the total exposure for the eight age-gender cohorts, with takeaways about 2–3%. These foods are likely to be domestically sourced.

Figure 10 shows the estimates of daily dietary exposure for total DDT determined in each of the NZTDSs for 19–24 year young males, and for 1–3 year toddlers. DDT was deregistered for use in New Zealand in 1989, and its persistence is reflected by the dietary exposures to DDT, which are slowly but steadily decreasing as levels of this contaminant gradually reduce in the New Zealand environment.

Total endosulfan estimated dietary exposures in the 2009 NZTDS were all less than or equal to 0.0036 µg/kg bw/day for each of the eight age-gender cohorts (Appendix 7), and have decreased more than 10-fold since the last NZTDS. Exposure to total endosulfan is determined by summing of exposures from endosulfan I, II and sulphate, with 78–91% of total endosulfan exposures for all cohorts resulting from residues on tomatoes. This reduction is consistent with its effective banning from use in New Zealand during the sampling period of the 2009 NZTDS[9], yet still being permitted for use in some countries overseas.

Dieldrin dietary exposures have decreased about 50-fold since the last study, and are now less than or equal to 0.00009 µg/kg bw/day for all population cohorts. It has also been banned in New Zealand since 1989 and exposures are due to imported food.

Estimated dietary exposures to dicofol in the 2009 NZTDS are now less than or equal to 0.00014 µg/kg bw/day for all population cohorts, and have decreased more than five-fold since the last NZTDS.

Risk characterisation

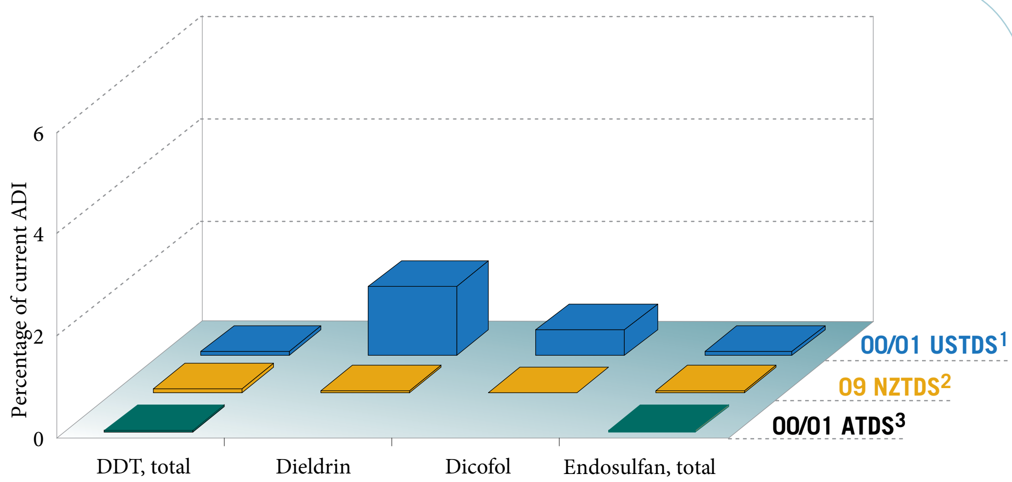
All dietary exposures to organochlorine compounds for each of the age-gender cohorts in the 2009 NZTDS were extremely low, being less than or equal to 0.21% of their respective ADI, the international health standard set by WHO.

Estimated daily dietary exposures to organochlorine compounds for 25+ year males in the 2009 NZTDS are generally comparable to overseas estimates (Figure 11). Details of reference studies and age-gender cohorts are given in Table 2. Total DDT estimates for all studies considered were at or less than 0.1% of the ADI, reflecting the fact that all three countries (New Zealand, Australia, and the United States) discontinued use of this agricultural compound over 30 years ago. The WHO GEMS food programme (GEMS/Food) reported estimated total DDT exposure from 12 countries ranging from 0.004 to 0.69% of the ADI (FAO/UNEP/WHO, 1992).

9 In December 2008 the Environmental Risk Management Authority (ERMA) decided to revoke the approvals for endosulfan or its formulations and to prohibit its use from early in 2009. Subsequently the registrations, under the Agricultural Compounds and Veterinary Medicines Act 1997, for several trade name products containing endosulfan were surrendered.

Estimated exposures to dieldrin for 25+ year males in the 2009 NZTDS (0.04% of ADI) and the 2000/01 USTDS (0.13% of ADI) are both very low, while in the ATDS dieldrin was not detected, probably because their reporting limits were three to five times higher than the 2009 NZTDS. Dietary exposures to total endosulfan are similar in the NZTDS and ATDS, and below the USTDS, with all less than 0.17% of ADI. Dicofol exposure (0.001% of ADI) in the 2009 NZTDS is two orders of magnitude lower than the USTDS (0.48% of ADI), while Australia did not detect dicofol, but its reporting limits were three to five times higher than those of the 2009 NZTDS.

Figure 11: Comparative dietary exposures to organochlorine compounds (25+ year males)



Notes
1 USTDS United States Total Diet Study (2000/01).
2 NZTDS New Zealand Total Diet Study (2009).
3 ATDS Australian Total Diet Study (2000/01).
NB: Vertical axis maximum greatly expanded to facilitate comparison of very low exposures between countries.

3.3.3 Organophosphorus compound residues

Organophosphorus compounds are esters of phosphoric and similar acids. The organophosphorus compounds were mainly developed during the 1970s to replace the organochlorine compounds, because most organophosphorus compounds degrade readily in biological systems. Organophosphorus compounds, such as pirimiphos-methyl and fenitrothion, are mostly insecticides for the protection of crops against aphids and soft-bodied insects, and fumigants for the control of weevil during shipping and storage of grain (Jones, 1993). Organophosphorus compounds are the most commonly used insecticides in New Zealand (Walker *et al.*, 2005)

Hazard identification

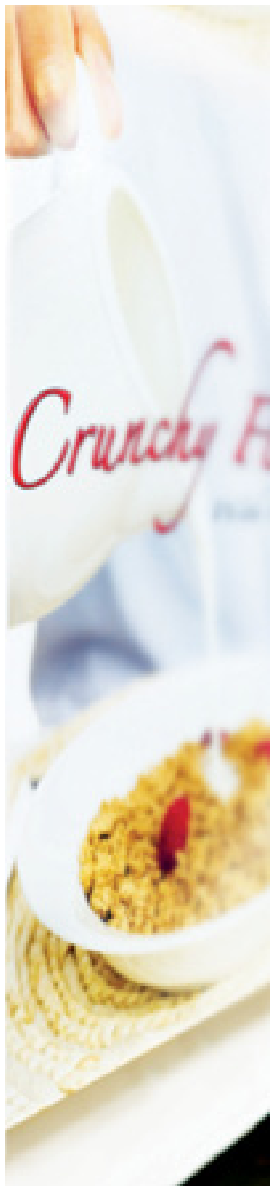
The organophosphorus compounds act on the pests' central nervous system. These compounds are acetylcholinesterase inhibitors, and by suppressing the activity of this enzyme, allow toxic

levels of the neurotransmitter acetylcholine to accumulate. As a class, the organophosphorus compounds are generally more acutely toxic than the organochlorine insecticides they replaced, but they have the advantage that they are less persistent in the environment (US EPA, 2011). In mammals, acute poisoning from high oral exposure can result in death due to respiratory failure, while chronic exposure results in delayed neuropathy, changed behaviour and reduced reproductive efficiency (Jones, 1993). Acute poisoning only occurs at much higher levels than normally found in food.

Hazard characterisation

Organophosphorus compounds have a wide range of toxicity, with ADIs ranging from 0.1 μg/kg bw/day for prothiofos to 300 μg/kg bw/day for malathion (IPCS, 2009). The list of ADIs for organophosphorus compounds detected in this study is included in Appendix 7.

As most organophosphorus compounds act via a common mode of toxicity, the potential for cumulative exposure has been increasingly recognised in recent years, and regulatory permissions, maximum residue limits (MRLs) and ADIs have been reviewed and revised accordingly in a number of countries. Methodology to assess risks from combined exposures to pesticide residues with a common mode of toxicity continues to be developed internationally (Boobis *et al.*, 2008; Boon *et al.*, 2008).



Dietary exposure assessment

Prevalence/concentrations

The concentrations of organophosphorus compounds in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in the appendices of this report, detailing the minimum, maximum and arithmetic mean concentrations of organophosphorus compounds in 2009 NZTDS foods, sorted either by agricultural compound (Appendix 5) or by the 2009 NZTDS food (Appendix 6).

Thirty organophosphorus compounds were detected in the 2009 NZTDS and accounted for 27% of all residues detected (245 out of a total of 910). The organophosphorus compounds most detected were pirimiphos-methyl (120 detections), fenitrothion (24), chlorpyrifos (21), chlorpyrifos-methyl (19), malathion (16), dimethoate (11), and methamidiphos (8).

Pirimiphos-methyl, fenitrothion, and chlorpyrifos-methyl were detected almost exclusively on cereal products (breads, biscuits, muffin, muesli, oats and pasta), and processed foods containing cereal products, such as hamburger, meat pie, battered fish or pizza. This is presumably a consequence of their use as fumigants of stored grain. Chlorpyrifos was detected on cereal products (breads, mixed bran cereal, muesli), fruit (grapes, raisins), and foods containing fruit (for example, snack bars), silverbeet and in an Indian takeaway. Dimethoate was detected on fruiting vegetables (capsicum, courgettes, melons and tomatoes) and beans. Malathion was detected only on cereal products (breads, biscuits, muesli, snacks and wheat biscuit cereals) and relate to stored product pest control uses. Methamidophos was detected on capsicum, cucumber, tomatoes in juice and silverbeet.

The organophosphorus compounds acephate, diazinon, dichlorvos, and prothiofos were also detected in the 2009 NZTDS. Improvements in analytical methodology meant other organophosphorus compounds were detected for the first time in this NZTDS and these were cyanophos, EPN, ethion, fenchlorphos, methidathion, phenthoate, propaphos and thiometon. Those detected for the first time are not registered for use in New Zealand, so imported foods were the most likely sources.

It should also be noted that azinphos-methyl, parathion-methyl, phorate, phosmet, pyrazophos, terbufos, and tetrachlorvinphos, which were detected in the 2003/04 NZTDS, were not detected in the 2009 NZTDS.

Estimated dietary exposures

The estimated daily dietary exposures to organophosphorus compounds for each of the eight age-gender cohorts considered in the 2009 NZTDS are given in Appendix 7. Results are presented as exposures expressed as µg/kg bw/day, and as a percentage of the relevant ADI, because ADIs differ between organophosphorus compounds.

In the 2009 NZTDS, the highest dietary exposure to organophosphorus compounds was for pirimiphos-methyl (0.286 µg/kg bw/day) for the 5–6 year children, of which 73% was contributed by breads. The highest exposure for dimethoate (0.045 µg/kg bw/day) was for the 6–12 month infants, of which 87% was due to residues on four out of eight courgettes samples; predominantly of imported origin. Fenitrothion's highest exposure (0.029 µg/kg bw/day) was for the 1–3 year toddlers, all of which was contributed by cereal products (breads, biscuits, muffin, muesli, bran flake cereal, rolled oats, pasta) or takeaways containing cereal products (hamburger, meat pie, or pizza).

Table 4: Dietary exposure trends for organophosphorus compounds (25+ year males)

		Estimated daily dietary exposure (µg/kg bw/day)			
Compounds	ADI	1990/91 NZTDS	1997/98 NZTDS	2003/04 NZTDS	2009 NZTDS
Chlorpyrifos	10	0.033 [b]	0.006 [c]	0.004 [c]	0.002 [d]
Chlorpyrifos-methyl	10	0.011 [b]	0.103 [c]	0.040 [d]	0.006 [e]
Diazinon	5	0.0008 [b]	0 [b]	0.0015 [c]	0.0005 [e]
Dichlorvos	4	0.0004 [b]	0 [b]	0.0001 [c]	0.0001 [e]
Dimethoate	2	0 [a]	0.013 [a]	0.031 [b]	0.020 [c]
Fenitrothion	6	0.151 [b]	0.004 [b]	0.087 [e]	0.013 [e]
Malathion	300	0.0100 [b]	0 [b]	0.0023 [c]	0.0025 [e]
Methamidophos	4	NA	NA	NA	0.0053 [a]
Pirimiphos-methyl	30	0.230 [b]	0.238 [b]	0.237 [d]	0.106 [e]

Notes

NA = not analysed.

0 = No exposures since no residues of this compound were detected, at defined LOD.

a LOD = 0.03 mg/kg.

b LOD = 0.01.

c LOD = 0.003.

d LOD = 0.002.

e LOD = 0.001.

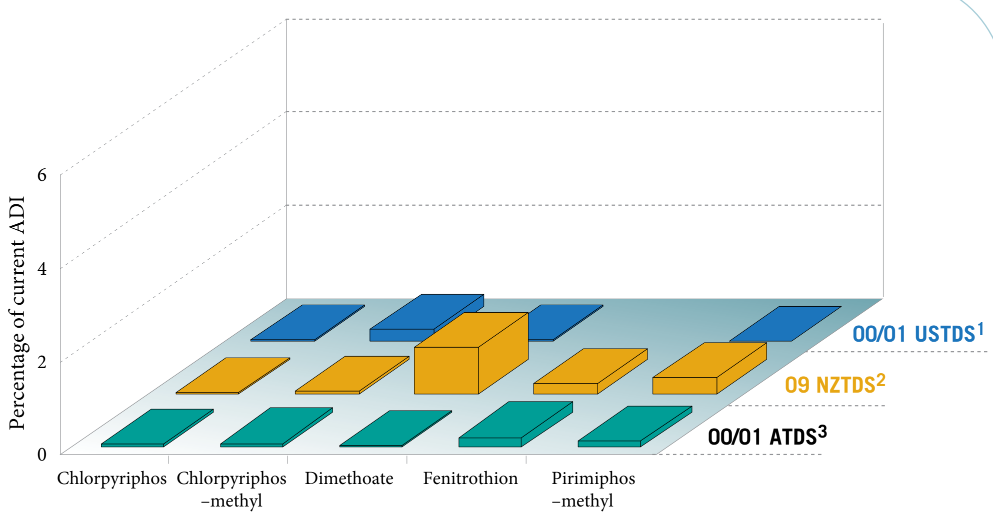
The estimated daily dietary exposures to some organophosphorus compounds for 25+ year males in the 2009 NZTDS are compared to previous NZTDSs in Table 4. Although a uniform trend is not evident across the NZTDSs, estimated daily dietary exposures to most of the organophosphorus compounds have decreased since the last NZTDS, with chlorpyrifos-methyl and fenitrothion decreasing by more than a factor of six, and pirimiphos-methyl approximately halved, even with LODs also decreasing.

Risk characterisation

All dietary exposures to organophosphorus compounds for each of the age-gender cohorts in the 2009 NZTDS were less than or equal to 2.2% of the ADI, the international health standard set by WHO.

The ATDS (FSANZ, 2003) generally had low exposure estimates for the five main organophosphorus compounds also detected in the NZTDS for 25+ year males (Figure 12). Details of reference studies and age-gender cohorts are given in Table 2. The results from the USTDS (Egan, 2005) were also low. Despite being a much more recent study, dietary exposures to dimethoate in the 2009 NZTDS are considerably higher than those in the 2000/01 ATDS or the 2000/01 USTDS, and also pirimiphos-methyl, albeit to a much lesser extent. More than 95% of the dimethoate exposures in the 2009 NZTDS were due to imported courgettes, capsicums and melons in the winter sampling. Other dietary exposures to organophosphorus compounds are directly comparable between the countries. The differing pattern of estimated exposure

Figure 12: Comparative dietary exposures to organophosphorus compounds (25+ year males)



Notes

1 USTDS United States Total Diet Study (2000/01).
2 NZTDS New Zealand Total Diet Study (2009).
3 ATDS Australian Total Diet Study (2000/01).

NB: Vertical axis maximum greatly expanded to facilitate comparison of very low exposures between countries.

to organophosphorus compounds between countries presumably reflects usage and climatic conditions.

3.3.4 Fungicide residues

Fungicides are agricultural compounds from different chemical families grouped by their mode of action. Fungicides are used to control fungal diseases on plants including blights, mildews, moulds and rusts that when unchecked can disrupt the regular supply of varied, quality food commodities to a much greater extent than insect pests (US EPA, 2011). The main benefit of their use is to stop food rotting, while a secondary benefit of use is to control mycotoxins. The mycotoxins produced by certain fungal species are typically associated with certain foods including nuts, grains and fruits. Mycotoxins have the potential to cause serious health problems in both humans and stock (WHO, 1990).

Hazard identification

Fungicides vary enormously in their potential for causing adverse effects in humans. Historical instances of pesticide poisoning from fungicides relates to mistaken consumption of seed grain treated with organic mercury or hexachlorobenzene fungicides. However, most fungicides currently in use are unlikely to cause frequent or severe systemic poisonings. Apart from systemic poisoning (for example, Iraq 1971/72 consumption of methylmercury-treated grain intended for planting), fungicides as a class are probably responsible for a disproportionate number of irritant injuries to eyes and mucous membranes, as well as dermal sensitisation (NPIC, 2010)

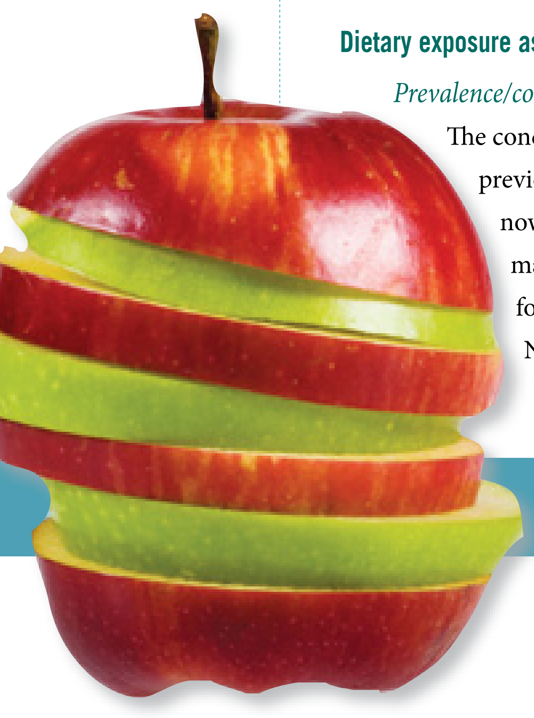
Hazard characterisation

Fungicides are generally less acutely toxic to humans than organochlorine or organophosphorus compounds. This is reflected in their ADIs, which range from 10 µg/kg bw/day (bitertanol, cyproconazole, dicloran, difenoconazole, fenarimol, and quintozene), to 30 µg/kg bw/day (imazalil), 60 µg/kg bw/day (iprodione), 100 µg/kg bw/day (procymidone), 200 µg/kg bw/day (azoxystrobin and pyrimethanil), up to 400 µg/kg bw/day (fludioxonil).

Dietary exposure assessment

Prevalence/concentrations

The concentrations of fungicides in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in the appendices of this report, detailing the minimum, maximum and arithmetic mean concentrations of fungicides in 2009 NZTDS foods, sorted either by agricultural compound (Appendix 5) or by the 2009 NZTDS food (Appendix 6).



In total 26 fungicides were detected in the 2009 NZTDS. Residues of all fungicides account for 43% of all residues detected in this study (389 out of a total of 910). DTCs account for approximately 35% (138/389) of the fungicide residues detected (cf 29% in 2003/04 NZTDS). This is consistent with DTCs being the predominant class of fungicides used in New Zealand (Walker *et al.*, 2005).

The fifteen most frequently detected fungicides in the 2009 NZTDS were: DTCs (detected in 138 samples), pyrimethanil (42), cyprodonil (32), procymidone (31), iprodione (29), fludioxonil (15), diphenylamine (13), captan (11), imazalil (10), myclobutanil (10), metalaxyl (9), chlorothalonil (8), dicloran (7), tolylfluanid (6), and trifloxystrobin (5).

Fungicide residues were primarily detected on fruits and vegetables, or foods containing fruit (muesli and snack bars), or foods made from fruits (wine, jam), and vegetables. The range of fungicides detected in the 2009 NZTDS was similar to the range detected in the 2003/04 NZTDS.

Bitertanol, fenarimol, imazalil and myclobutanil fungicides were detected in the 2009 NZTDS, but not in 2003/04. The latter two compounds were new additions to the agricultural compound screen in 2009.

Dichlofluanid, kresoxim-methyl, pencycuron, triademenol and vinclozolin were detected in 2003/04, but were not detected in the 2009 NZTDS.

Estimated dietary exposures

Estimated daily dietary exposures to fungicides for each of the eight age-gender cohorts considered in the 2009 NZTDS are given in Appendix 7. Results are presented as exposures expressed as µg/kg bw/day, and as a percentage of the relevant ADI, because ADIs differ between fungicides.

The highest dietary exposure to fungicides in the 2009 NZTDS were from DTCs, with all being less than or equal to 0.57 µg/kg bw/day for each of the age-gender cohorts. A wide range of fruits and vegetables contribute to the total exposure to DTC fungicides (Appendix 5).

Table 5 shows the estimates of daily dietary exposure for the 25+ year males age-gender cohort from the 1990/91, 1997/98, 2003/04 and 2009 NZTDSs to some of the more commonly observed fungicides. LODs are also included, demonstrating the general improvement in ability to detect lower residues across the NZTDSs. The 25+ year males cohort has been chosen because it reflects the general trend of the other age-gender cohorts, and maintains consistency with previous NZTDSs and international TDSs as a key reference group.

Estimated dietary fludioxonil exposures for 25+ year males exhibited the largest increase, associated with residues (0.22–0.56 mg/kg) on imported nectarines in the July/August sampling. The Codex MRL for fludioxonil on imported stone fruit is 5 mg/kg (Codex, 2009).

The estimated exposure to DTC fungicides has more than doubled since 2003/04. Major contributors to DTC exposures were apples (from 21% of dietary exposure for 19–24 year young males to 41% for 5–6 year children), peeled potatoes (from 9% for the 6 month infants up to 21% for the 25+ year males), potatoes with skin (8.5% for 6 month infants up to 23% for 11–14 year boys), and brassica vegetables (cabbage, broccoli/cauliflower; from 5% for the 1–3 year toddlers up to 14% of dietary exposure for 25+ year females) (see also risk characterisation of DTCs below).

Exposures to seven of these fungicides (captan, dicloran, diphenylamine, iprodione, procymidone, pyrimethanil, vinclozolin) have decreased since the last NZTDS. Tolylfluanid exposures demonstrated the biggest reduction, decreasing by a factor of eight.

Risk characterisation

Estimated dietary exposures to fungicides, with the exception of DTCs, were all less than 1.1% of the relevant ADI for all eight age-gender cohorts of the 2009 NZTDS.

Table 5: Dietary exposure trends for fungicides (25+ year males)

		Estimated daily dietary exposure (μg/kg bw/day)			
Fungicide	ADI	1990/91 NZTDS	1997/98 NZTDS	2003/04 NZTDS	2009 NZTDS
Captan	100	0.013 [e]	0	0.058 [h]	0.030 [f]
Chlorothalonil	20	0.020 [f]	0.002 [e]	0.002 [i]	0.002 [i]
Cyprodonil	30	NA	NA	0.002 [h]	0.007 [j]
Dicloran	10	NA	0.011 [f]	0.004 [h]	0.002 [i]
Diphenylamine	80	0	0.047 [f]	0.086 [i]	0.026 [j]
DTCs	3–30 [a]	0.23 [b]	0.30 [c]	0.20 [c]	0.55 [c]
Fludioxonil	400	NA	NA	0.0001 [f]	0.040 [j]
Imazalil	30	NA	NA	NA	0.043 [j]
Iprodione	60	0.184 [d]	0.483 [d]	0.175 [f]	0.067 [f]
Metalaxyl	80	0	0	0.001 [g]	0.004 [i]
Myclobutanil	30	NA	NA	NA	0.0005 [j]
Procymidone	100	0.052 [d]	0.008 [f]	0.018 [h]	0.008 [j]
Pyrimethanil	200	NA	NA	0.033 [i]	0.018 [j]
Tolylfluanid	80	NA	NA	0.031 [f]	0.004 [j]
Vinclozolin	10	0.1060 [e]	0.0030 [f]	0.0001 [g]	0 [j]

Notes

NA = Not analysed.

a DTCs are a group of 8 compounds, having differing ADIs (see "Risk characterisation for DTC fungicides" section below for more explanation).

b LOD for DTC is 0.10, based on LOD for CS2 0.05 mg/kg.

c LOD for DTC is 0.02, based on LOD for CS2 0.01 mg/kg.

d LOD 0.03 mg/kg.

e LOD 0.02 mg/kg.

f LOD 0.01 mg/kg.

g LOD 0.005 mg/kg.

h LOD 0.003 mg/kg.

i LOD 0.002 mg/kg.

j LOD 0.001 mg/kg.

The estimated dietary exposures in the 2009 NZTDS for the DTC fungicides ranged from 1.7–52% of ADI, with main contributors being apples, potatoes with and without skin, and brassicas. However, DTCs present a particular problem in risk characterisation (see subsection below for more details).

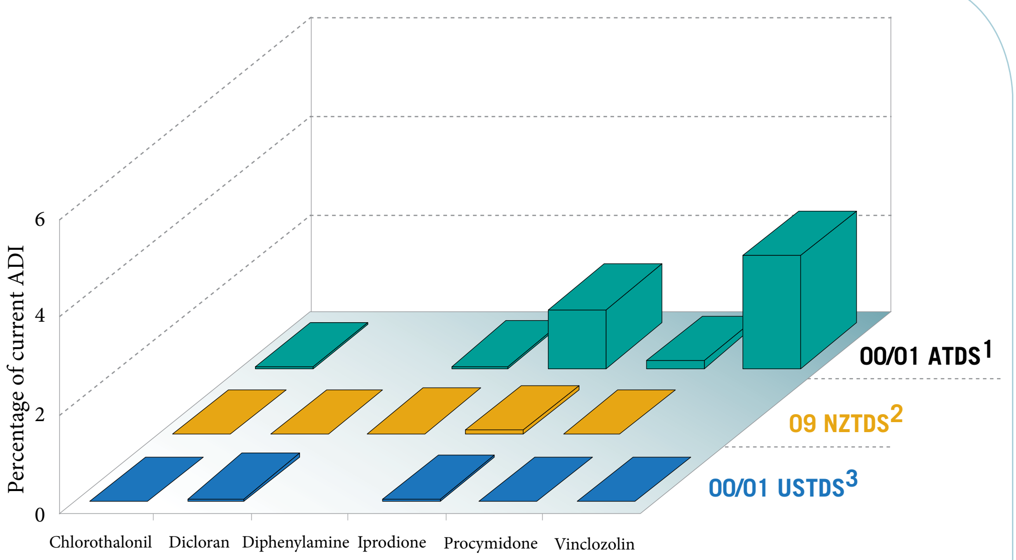
Figure 13 compares the estimated daily dietary exposure to selected fungicides for 25+ year males in the 2009 NZTDS with similar overseas estimates. Details of reference studies and description of age-gender cohorts is given in Table 2. DTCs were not included, as neither of the comparison studies included estimates of DTC exposure.

Estimated daily dietary exposure to fungicides in New Zealand generally compares favourably to estimates from other studies considered. Interestingly, dietary exposures to some fungicides appear to be higher in Australia than New Zealand or the United States, whereas earlier in this report, it was noted that New Zealand had the highest exposures for three of the five organophosphorus compounds. Whatever the country, all dietary exposures to fungicides are still at very low levels.

Risk characterisation for DTC fungicides

DTCs consist of a group of eight agricultural compounds (ferbam, mancozeb, maneb, metiram, propineb, thiram, ziram, and zineb) which are conventionally listed as a group on the basis of the common analytical method for their determination.

Figure 13: Comparative dietary exposures to fungicides (25+ year males)



Notes

1 ATDS Australian Total Diet Study (2000/01).
2 NZTDS New Zealand Total Diet Study (2009).
3 USTDS United States Total Diet Study (2000/01).

NB: Vertical axis maximum greatly expanded to facilitate comparison of very low exposures between countries.

International assessments have suggested that these compounds should be considered as two groups on the basis of their toxicological endpoints (FAO, 1998):

» mancozeb, maneb, metiram and zineb have been assigned a group ADI of 30 µg/kg bw/day based on their thyroid toxicity (WHO, 1994; FAO/WHO, 1996), propineb is also included in this group due to its thyroid toxicity, but has a lower ADI (7 µg/kg bw/day; WHO, 1994); and
» thiram, ziram and ferbam have been assigned a group ADI of 3 µg/kg bw/day, based on similar toxicities, but different to the above group because the toxicity endpoints are different (FAO, 1998).

In New Zealand, DTCs from both groups are registered for use on selected fruit and vegetables. These are thiram, ziram, propineb, metiram and mancozeb.

The analysis of DTCs in the 2009 NZTDS involves decomposition of the parent compounds in acid and analysis of the resultant carbon disulphide (CS_2), so does not differentiate which DTC is actually present. In converting CS_2 concentrations to DTC equivalent concentrations, factors of 1.78 to convert from CS_2 to mancozeb and two for thiram have been used internationally (EFSA, 2009; WHO, 1997a). In this study, erring on the side of toxicological caution, a factor of two has been used.

Given it is not possible to tell which individual DTC has caused the CS_2 detected, characterising DTC risk can be associated with either of the ADIs, which therefore creates lower and upper bound DTC exposures when expressed as a percentage of ADI. Comparing DTC exposure to the lower group ADI for thiram, ziram and ferbam (3 µg/kg bw/day) generates an upper bound DTC exposure as a percentage of ADI. If the other group of DTCs are in fact present, with their higher group ADI (30 µg/kg bw/day), then the estimated dietary exposure as a percentage of the ADI is 10-fold lower, and generates a lower bound exposure relative to ADI. The true dietary exposure will probably lie somewhere between the lower and upper bound estimates (Appendix 7).

Although quantities of the respective DTCs used in New Zealand can be ascertained, an existing registration does not provide information of the relative frequency of each DTC used and certainly does not account for any off-label or other misuse. It is also not possible for DTC usage data to be extrapolated to individual DTCs actually in the different NZTDS foods without sophisticated modelling. The majority (96%) of DTC used on apples is metiram, not thiram or ziram (Butcher, 2010). On this basis, it would move the best estimate of DTC exposures in 2009 NZTDS as a percentage of the ADI from the upper bound towards the lower bound, but would still be dependent on the DTCs used in all other contributing fruits and vegetables too. This also supports using a mid-point estimate, with associated uncertainties.

Compounding the situation even further, some commodities, such as brassicas (cabbage, broccoli, cauliflower) contain natural compounds that can produce carbon disulphide under the conditions used for DTC analysis. As carbon disulphide is the chemical species determined in the DTC analysis in the 2009 NZTDS (section 2.3.1), this can lead to an overestimation of the

DTC content of these products (MAFF, 1997). DTCs detected on brassicas range from 5–14% of the estimated exposure to DTC fungicides in the 2009 NZTDS for the 1–3 year old toddlers and the 25+ year females, respectively.

On the basis explained above, the DTC exposures for 19–24 year young males, 25+ year males and females in the 2009 NZTDS are 1.7–19% of the ADI, 2.6–27% of ADI for 11–14 year boys and girls, and 3.7–52% of ADI for 5–6 year children, 1–3 year toddlers and 6–12 month infants, respectively (Appendix 7). The upper bound is considered to be an overestimate because of assumptions about ADIs of DTCs contributing to the exposure estimates, and also probable interference from naturally occurring constituents of brassicas and possibly other crops.

3.3.5 "Other" agricultural compound residues

As the name suggests, the category of "other" agricultural compounds contains an assortment of generally unrelated agricultural compounds, including herbicides (for example, diuron, linuron), insecticides such as carbamates (for example, carbaryl) and synthetic pyrethroids (for example, permethrin), plant growth regulators including inhibitors (for example, chlorpropham, propham), veterinary medicines such as those for the control of ectoparasites (for example, deltamethrin), and synergists (for example, piperonyl butoxide). Herbicides are chemicals that inhibit or interrupt normal plant growth and development, and are widely used in agriculture and urban areas to control weeds. Carbamates were first developed in the 1950s for use as insecticides. Synthetic pyrethroids are man-made insecticides which have a chemical structure based on that of the natural pyrethrins present in chrysanthemum. Pyrethroid and carbamate insecticides are mostly biodegradable, so do not tend to persist in the environment or concentrate up the food chain as organochlorine compounds do. Plant growth regulators include inhibitors that prevent *inter alia* post-harvest sprouting in stored potatoes. Veterinary medicines such as those administered to animals for the control of ectoparasites help ensure that food production animals are healthy. Synergists are compounds which increase the effectiveness of other agricultural compounds, with which they are applied in conjunction.

Hazard identification

The variety of "other" agricultural compounds means they have varying modes of action and potential human health effects at high enough doses. A plant growth regulator such as chlorpropham is slightly toxic by the oral route, a mild eye and skin irritant, and practically non-toxic through dermal exposure.

Pyrethrins and pyrethroids are well known irritants and potential sensitisers of humans' respiratory systems as well as of the skin and eyes. Synthetic pyrethroids and carbamates act on the nervous system of insects and animals.

Hazard characterisation

ADIs range from 0.5 µg/kg bw/day for alachlor (ADHA, 2010), to carbaryl with 8 µg/kg bw/day, to chlropropham with 50 µg/kg bw/day, and up to 200 µg/kg bw/day for piperonyl butoxide (IPCS, 2009).

Dietary exposure assessment

Prevalence/concentrations

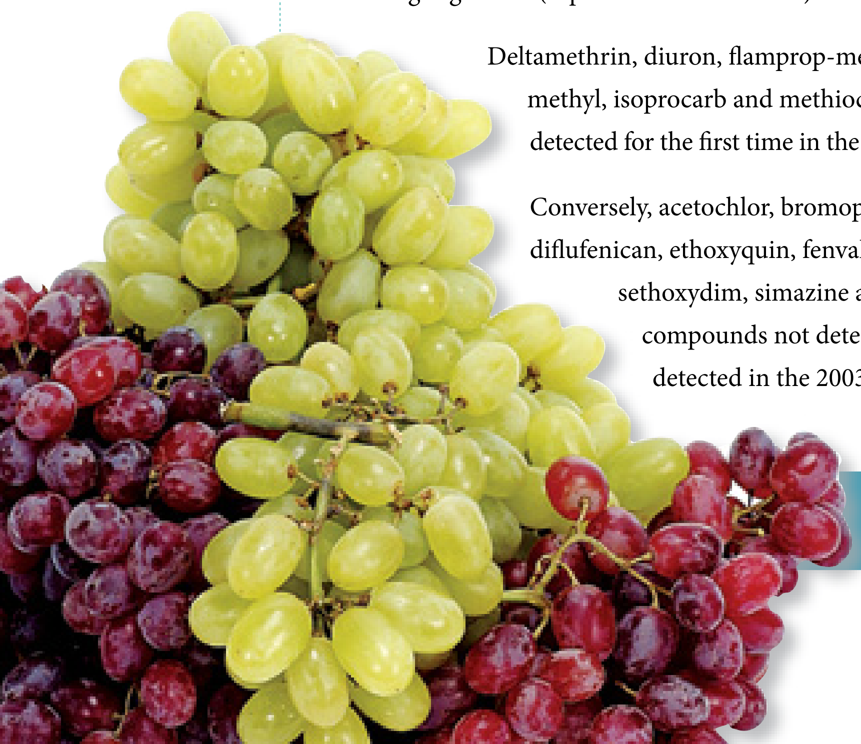
The concentrations of "other" agricultural compounds in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in the appendices of this report, detailing the minimum, maximum and arithmetic mean concentrations of "other" agricultural compounds in 2009 NZTDS foods, sorted either by agricultural compound (Appendix 5) or by the 2009 NZTDS food (Appendix 6).

In total, residues of 23 "other" agricultural compounds were detected in the 2009 NZTDS, and these accounted for 22% of all residues detected (204 out of a total of 910). These were dominated by piperonyl butoxide (108 residues detected), followed by propham (16), deltamethrin (13), diuron (9), carbaryl (9), buprofezin (8), bifenthrin (5), and chlorpropham (4).

Piperonyl butoxide is a synergist usually used in conjunction with pyrethroid agricultural compounds, such as deltamethrin, bifenthrin, permethrin and cypermethrin. Piperonyl butoxide was found in 35 different foods, almost all from the grains and takeaway food groups. Propham and chlorpropham are sprout inhibitors, consistent with finding them mainly on potato-related products. Diuron is a herbicide and was found on root vegetables and related foods such as carrots and potato (hot chips). Carbaryl is a carbamate insecticide and was detected on a range of fruit and related products. Buprofezin is an insect growth regulator and insecticide and was found on fruiting vegetables (capsicum and cucumber) and grapes.

Deltamethrin, diuron, flamprop-methyl, fluvalinate, furathiocarb, haloxyfop-methyl, isoprocarb and methiocarb were "other" agricultural compounds detected for the first time in the 2009 NZTDS.

Conversely, acetochlor, bromopropylate, cyhalothrin, dichlofluanid, diflufenican, ethoxyquin, fenvalerate, kresoxim-methyl, propazine, propoxur, sethoxydim, simazine and terbutylazine were all "other" agricultural compounds not detected in 2009, even though they were all detected in the 2003/04 NZTDS.



Estimated dietary exposures

Estimated daily dietary exposures to "other" agricultural compounds for each of the eight age-gender cohorts considered in the 2009 NZTDS are included in Appendix 7. Results are presented as exposures expressed as µg/kg bw/day, and as a percentage of the relevant ADI, because ADIs differ between agricultural compounds.

The highest estimated daily dietary exposures to the "other" agricultural compounds for each of the age-gender cohorts in the 2009 NZTDS were for deltamethrin (0.056 µg/kg bw/day) for 5–6 year children, carbaryl (0.024 µg/kg bw/day) for 6–12 month infants, chlorpropham (0.099 µg/kg bw/day) and piperonyl butoxide (0.353 µg/kg bw/day), both for 1–3 year toddlers (Appendix 7).

Table 6 compares the exposure estimates for nine of the "other" agricultural compounds for 25+ year males in the current study with those in the 1990/91, 1997/98 and 2003/04 NZTDSs. LODs are also included, demonstrating the general improvement in ability to detect lower residues across the NZTDSs.

Bifenthrin and carbaryl dietary exposures have both decreased since being included in the 2003/04 NZTDS for the first time. Dietary exposure estimates of bromopropylate and propham have decreased across the last four NZTDSs, while deltamethrin has been detected for the first time in the 2009 NZTDS. Estimated dietary exposures to indoxacarb and permethrin demonstrated the biggest reductions (88%) compared to 2003/04. Piperonyl butoxide exposures have oscillated up and down across past NZTDSs and exhibit the largest

Table 6: Dietary exposure trends for "other" agricultural compounds (25+ year males)

		Estimated daily dietary exposure (µg/kg bw/day)			
Compound	ADI	1990/91 NZTDS	1997/98 NZTDS	2003/04 NZTDS	2009 NZTDS
Bifenthrin	10	NA	NA	0.0004 [g]	0.0001 [k]
Bromopropylate	30	0.0018 [e]	0.0010 [e]	0.0001 [g]	0 [k]
Carbaryl	8	NA	NA	0.056 [h]	0.013 [h]
Deltamethrin	10	0 [d]	0 [d]	0 [f]	0.020 [f]
Chlorpropham	50	NA	NA	0.008 [f]	0.033 [k]
Indoxacarb	10	NA	NA	0.0017 [h]	0.0002 [f]
Permethrin	50	0.007 [c]	0	0.0060 [f]	0.0007 [j]
Piperonyl butoxide	200	0.006 [a]	0.061 [f]	0.010 [i]	0.123 [k]
Propham	No ADI	0.80 [b]	0.39 [f]	0.24 [f]	0.15 [k]

Notes

0 = not detected in any food analysed in respective NZTDS.
NA = Not analysed.
a LOD 2 mg/kg.
b LOD 0.45 mg/kg.
c LOD 0.1 mg/kg.
d LOD 0.07 mg/kg.
e LOD 0.04 mg/kg.
f LOD 0.01 mg/kg.
g LOD 0.007 mg/kg.
h LOD 0.005 mg/kg.
i LOD 0.003 mg/kg.
j LOD 0.002 mg/kg.
k LOD 0.001 mg/kg.

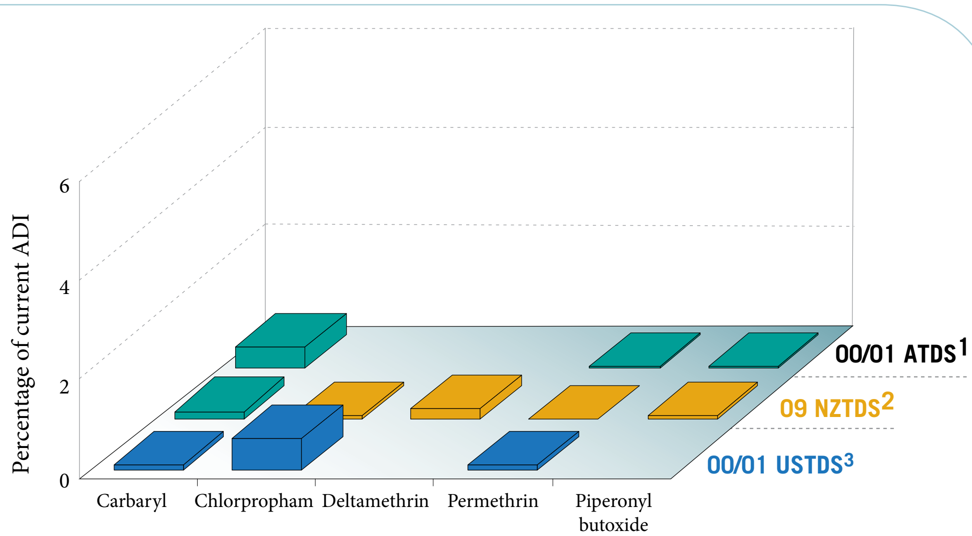
increase in 2009, consistent with it representing more than half of all "other" agricultural compound detections (108 out of 204 total). Of those 108 detections, 19 were due to the three-fold lower LOD in 2009, and these combined contributed less than 0.001 µg/kg bw/day towards the increase.

Risk characterisation

Estimated dietary exposures to "other" agricultural compounds for all age-gender cohorts of the 2009 NZTDS were extremely low, being all less than or equal to 0.56% of the ADI set by WHO (Appendix 7).

Dietary exposures to "other" agricultural compounds in New Zealand are generally low in comparison with Australia and the USA (Figure 14). In the Australian study, chlorpropham and deltamethrin were not screened for. Dietary exposures in all three countries are at very low levels.

Figure 14: Comparative dietary exposures to "other" agricultural compounds (25+ year males)



Notes

1 ATDS Australian Total Diet Study (2000/01).

2 NZTDS New Zealand Total Diet Study (2009).

3 USTDS United States Total Diet Study (2000/01).

CONTAMINANT ELEMENTS: RESULTS AND DISCUSSION 4

4.1 Introduction

The four contaminant elements investigated in the 2009 NZTDS were arsenic, cadmium, lead, and mercury. These are priority contaminants of the WHO GEMS/Food programme and their inclusion maintains continuity with previous NZTDSs. Mercury is not essential for humans and the essentiality of arsenic, cadmium, and lead has yet to be demonstrated. All of these contaminants are toxic when ingested at sufficient doses and as such they pose a greater risk to humans than any concern about a lack in the diet as nutrients (UK DoH, 1991). Contaminant elements are naturally occurring and ubiquitous in our environment, so the contaminant content of foods can vary significantly over time. In addition to total mercury in the 2009 NZTDS, methylmercury was also investigated on fish and shellfish because this is the major form of mercury in these species, and it has higher toxicity than inorganic mercury.

4.2 Contaminant element results

4.2.1 Concentration data and estimated dietary exposures of the 2009 NZTDS

Methodology for determining mean concentration data and dietary exposure estimates has been explained previously in section 2.4.2 and section 2.5, respectively.

Details of the concentrations of contaminant elements in the 123 individual foods assessed in the 2009 NZTDS are contained in the Appendix 9.

Appendix 10 provides a summary of the resultant estimated dietary exposures of contaminant elements for the 2009 NZTDS. Where possible, these exposures are also shown as a percentage of the international health-based guidance value, either the Provisional Tolerable Weekly Intake (PTWI) or the Provisional Tolerable Monthly Intake (PTMI).

4.2.2 Comparison of 2009 NZTDS with previous NZTDSs

In comparing the 2009 NZTDS with previous NZTDSs, the 19–24 year young males and 6–12 month infant cohorts have been used as examples throughout the discussion because the high energy intake for young males and low body weight for infants increases their potential risk from exposure to contaminant elements.

4.2.3 Comparison of 2009 NZTDS with overseas TDSs for contaminant elements

The weekly dietary exposures for 25+ year males in the 2009 NZTDS have been compared to adult males in overseas TDSs, and these studies are detailed in Table 7.

Such comparisons need due caution, and the reasons for this have been detailed previously (section 3.2.3). It is also important to understand how "not detected" results are dealt with. The protocol for this in the 2009 NZTDS has been explained in section 2.4.2. Table 7 includes footnotes which summarise these protocols in the overseas TDSs used for comparison. When possible, calculations have been undertaken to enable comparisons on a similar basis to the NZTDS LOD/2 values, so for example for Australia, a mean of their ND=0 and ND=LOD results has provided LOD/2 estimates for comparison.

4.3 Contaminant elements discussion

4.3.1 Arsenic

Arsenic is a common element, widespread in nature in both living systems and geologically. It is present in all soils, but the geology of a particular soil determines the quantity present. Apart

Table 7: Comparative overseas TDSs

Country	Time period	Person	Body weight (kg)	Age (years)	Reference
NZTDS [a, b, c]	2009	Males	82	25+	This study
Australia [a, c]	2000/01	Adult males	82	25–34	FSANZ, 2003
USA [a, b, c]	2007/08	Males	86	25+	Egan, 2011
UK [a, c]	2006	Adults	NS	16–64	Rose *et al.*, 2010
China [b]	2007	Males	63	18–45	Li, 2011
Czech Republic [b]	2008/09	Males	70	18–59	Ruprich, 2011
Basque Country [c]	1992–95	Adults	68	25–60	Jalón *et al.*, 1997
France [b, d]	2000/01	Adults	65	15+	Leblanc *et al.*, 2005

Notes
NS = Not specified.
a Using zero values for "not detected" data.
b Using half limit detection for "not detected" data.
c Using limit of detection for "not detected" data.
d Using half limit quantitation for "not quantified" data.

from the geological origin, soil content may be affected by the past use of arsenic-containing agricultural compounds, proximity to smelters or coal-fired power plants, or erosion caused by intensive land use. In addition, water often contains arsenic and extremely high levels may be found in groundwater from areas with geothermal activity and with arsenic-rich rocks (Anke, 1986).

Most foods contain some arsenic, which occurs in different organic and inorganic forms. Fish and seafoods can accumulate arsenic from their environment, and their arsenic content is generally more than 90% organic arsenic (WHO, 2010c, 1981). The arsenic content of plants such as rice, grain and vegetables is usually determined by the arsenic content of the soil, water, air, fertilisers and other chemicals, and is predominantly inorganic arsenic.

Hazard identification

Inorganic arsenic compounds are more toxic to humans than the organic forms, in contrast to lead and mercury, for which the organic forms are more toxic. Inorganic arsenic can cause a range of acute and chronic health effects at much higher doses than is usually found in foods. These include skin effects (thickening and pigmentation changes), heart problems, peripheral vascular disorders, and both central and peripheral neurological damage. Prolonged exposure to high levels of trivalent or pentavalent inorganic arsenic has also been linked to skin tumours of low malignancy (Reilly, 1991; WHO 1989c, 1981). The International Cancer Research Agency (IARC) has classified arsenic in category 1 (carcinogenic to humans) (IARC, 1987). The main contributors to dietary inorganic arsenic are rice and rice products. Where consumers live in areas where groundwater is contaminated with arsenic, as in southern Asia (for example, Bangladesh and West Bengal), then drinking water is also one of the most significant sources of inorganic arsenic exposure. In addition, rice, other cereals and vegetables grown or cooked in arsenic contaminated waters or soils will also be significant contributors of inorganic arsenic (Zhu *et al.*, 2008; Smith *et al.*, 2006).

For consumers of fish and seafood, which generally have 10 times the arsenic content of other foods, this usually makes the biggest contribution to total arsenic exposure. But most of the arsenic present in marine fish and shellfish are organic arsenic compounds, mainly arsenobetaine (Larsen *et al.*, 1993). The bulk of this arsenic is excreted unaltered from humans within several days (Tam *et al.*, 1982). In contrast to inorganic arsenic, organic forms of arsenic, like arsenobetaine, are generally of low toxicity (WHO, 1981, 1989c; Reilly, 1991).

Hazard characterisation

In 1967, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) set a Maximum Acceptable Daily Load (MADL) of total arsenic (inorganic plus organic) of 50 µg/kg bw/day (WHO, 1967), but withdrew it in 1983 because, on the basis of available data, no figure could be arrived at for organic arsenicals in food (WHO, 1983). In 1989, JECFA established a PTWI of

15 µg/kg bw/week for inorganic arsenic (WHO, 1989b). In February 2010, JECFA withdrew the PTWI for inorganic arsenic, as it considered it was no longer appropriate, given the PTWI was in the region of the benchmark dose limit for a 0.5% increased incidence of lung cancer ($BMDL_{0.5}$) of 3.0 µg/kg bw/day. The $BMDL_{0.5}$ had been determined from epidemiological studies and a range of assumptions to estimate total dietary exposure to inorganic arsenic from drinking water and food (WHO, 2010a).

Dietary exposure assessment

Prevalence/concentrations

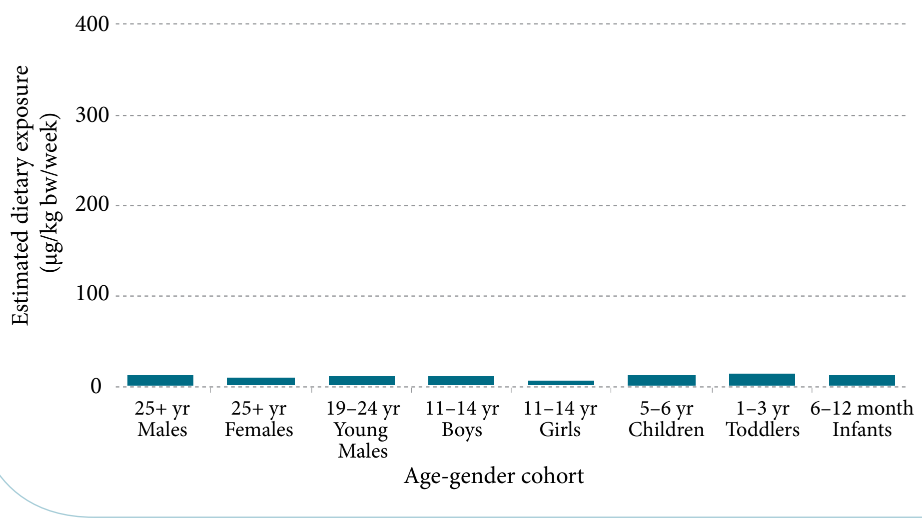
The concentrations of total arsenic in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in Appendix 9.1 of this report, detailing the minimum, maximum and arithmetic mean concentrations of total arsenic for the 2009 NZTDS foods.

Most foods in the 2009 NZTDS had mean total arsenic concentrations less than 0.01 mg/kg. Arsenic was primarily found in fish, seafood and related products. The arsenic content of fish fingers was 1.02 mg/kg, battered fish (2.66 mg/kg), canned fish (0.66 mg/kg), fresh fish (3.99 mg/kg), mussels (2.22 mg/kg) and oysters (2.38 mg/kg). The concentrations of total arsenic in seafood products of the 2009 NZTDS were consistent with previous NZTDSs (Vannoort *et al.*, 1995b, 2000; Vannoort and Thomson, 2005b) and overseas findings (Rose *et al.*, 2010; Millour *et al.*, 2011; Dabeka *et al.*, 1993).

Dietary exposure estimates

The lower, mid-point and upper bound estimated weekly dietary exposures to total arsenic based on ND=0, LOD/2 and LOD, respectively, for the eight age-gender cohorts of the 2009 NZTDS are given in Appendix 10, and presented in Figure 15. The exposures are all less than or equal to 13.3 µg/kg bw/week.

Figure 15: Dietary exposures to total arsenic (2009 NZTDS)



Although the five seafoods – fresh, battered and canned fish, mussels and oysters – constitute only 8% of the simulated diet by weight for the 19–24 year young males, they contributed 92% of their dietary total arsenic exposure. With oysters and mussels replaced by fish fingers in the 6–12 month infants' simulated typical diet (Appendix 3), the four seafood products (5% of diet by weight) contributed 85% of dietary exposure to total arsenic.

International studies have reported that 2–7% of total arsenic in fish/seafood is present as inorganic arsenic (Munoz *et al.*, 2000). The United States Food and Drug Administration (US FDA) has assumed that 10% of total arsenic in fish/seafood is inorganic, and that the arsenic in all other foods is 100% inorganic (Tao and Bolger, 1999). Using the US FDA assumptions, which it acknowledges are conservative, the 2009 NZTDS dietary exposures estimated for inorganic arsenic ranged from a low of 1.3 µg/kg bw/week for inorganic arsenic for the 11–14 year girls, to a high of 3.1 µg/kg bw/week for the 6–12 month infants (see Appendix 10).

The 2009 NZTDS weekly dietary exposures to total arsenic for young males are compared to previous NZTDSs in Table 8. As is the case with most overseas TDSs, there is no clear trend in total dietary arsenic exposure over time. Dietary exposure to arsenic in NZTDSs seems to vary with the arsenic levels in fish/seafood in each study and their associated consumption levels, although given likely sampling and analytical uncertainties, it is unlikely that these differences are significant.

Table 8: Dietary exposures to total arsenic (19–24 year young males)

Element	Estimated weekly dietary exposure (µg/kg bw/week)				
	1987/88 [a] NZTDS	1990/91 [b] NZTDS	1997/98 [c] NZTDS	2003/04 [d] NZTDS	2009 [e] NZTDS
Arsenic (total)	6.7	15	8.7	9.1	10.4

Notes
a ESR/MoH, 1994.
b Vannoort *et al.*, 1995b.
c Vannoort *et al.*, 2000.
d Vannoort and Thomson, 2005a.
e This study.

Table 9 compares the 2009 NZTDS weekly dietary exposure to total arsenic for the 25+ year males with those of Australia, the USA, the UK, France, the Czech Republic, the Basque Country and China for a similar age-gender cohort. The 2009 NZTDS estimated weekly dietary exposure to total arsenic (11.5 µg/kg bw/week) is of a similar magnitude to the weekly dietary exposures of the UK. The dietary exposures to total arsenic for Australia, USA, France and China are lower than New Zealand's. The 2008/09 Czech weekly dietary exposure to total arsenic reflects the low consumption of seafood, freshwater fish and related products (77 g/average person/week; Ruprich *et al.*, 2000) compared to New Zealand (294 g/25+ year male/week; Appendix 3). The highest total arsenic weekly dietary exposures have been reported by the Basque Country, which correlates with their very high consumption of fish/seafood (623 g/Basque adult/week; Jalón *et al.*, 1997).

Risk characterisation

The estimated weekly dietary exposures to total arsenic for the eight age-gender cohorts in this study were very low and consistent with previous NZTDSs.

The estimated dietary exposures to inorganic arsenic range from 1.3–3.1 µg/kg bw/week.

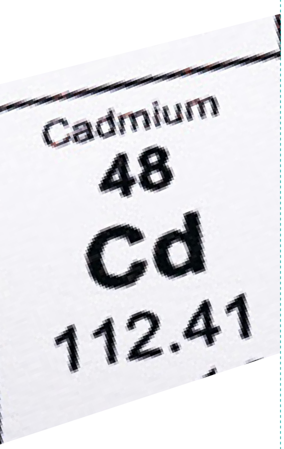
Even though the MADL for total arsenic and PTWI for inorganic arsenic have been withdrawn, given consistency of the 2009 NZTDS findings with previous NZTDSs, the international thinking would be that the 2009 NZTDS exposures to total arsenic and inorganic arsenic are likely to be already as low as reasonably achievable (ALARA) and unlikely to represent a significant health risk to New Zealand consumers.

Table 9: Comparative dietary exposures to total arsenic

Element	Estimated weekly exposure (µg/kg bw/week)							
	NZTDS 2009 males 25+ yr	Australia 2000/01 males 25–34 yr	USA 2007/08 males 25+ yr	UK 2006 males 16–64 yr	France 2000/01 adults 15+ yr	Czech 2008/09 males 18+ yr	Basque 1992/95 adults 25–60 yr	China 2007 males 18–45 yr
Arsenic (total)	11.5 [2]	5.0 [a, 2]	2.4 [b, 2]	11.7 [c, 2]	4.3 [d, 2, 4]	2.7 [e, 4]	31 [f, 3]	7 [g, 2]

Notes
- a 2000/01 data (FSANZ, 2003).
- b 2007/08 data (Egan, 2011).
- c 2006 data (Rose *et al.*, 2010).
- d 2000/01 data (Leblanc *et al.*, 2005.
- e 2008/09 data (Ruprich, 2011).
- f 1992–95 data (Jalón *et al.*, 1997).
- g 2007 data (Li, 2011).
- 1 Using zero values for "not detected" data.
- 2 Using half limit detection for "not detected" data.
- 3 Using limit of detection for "not detected" data.
- 4 Using half limit quantitation for "not quantified" data.

4.3.2 Cadmium



Cadmium is a heavy metal that occurs naturally at low levels in the environment. Anthropogenic activity can add amounts of cadmium to soil, water and air. Industrial processes, such as mining and smelting for non-ferrous metals, or electroplating, are often linked to incidents of cadmium pollution. Agricultural practices, particularly the addition of fertilisers (both natural and manufactured), may also increase the levels of cadmium in agricultural areas. Volcanic activity is also a major source of cadmium released into the environment. This is of relevance to New Zealand because of its extinct, dormant and active volcanoes and geothermal areas.

The content of cadmium in plants tends to reflect the levels in the soil, particularly if the soil is acidic. Shellfish and the kidney of stock animals can concentrate cadmium from their local environment (WHO, 1992a, b).

Exposure to cadmium from anthropogenic sources is a relatively recent phenomenon. It has occurred over the last two centuries in humans, arising from both industrial activity and cigarette smoking. Inhaled cadmium is absorbed much more efficiently than ingested cadmium (Kostial, 1986).

Hazard identification

Cadmium can have serious effects on health if ingested at high enough doses. The renal cortex appears to be the most sensitive target tissue in humans, resulting in chronic kidney failure. Osteomalacia (softening of the bones) is also seen. Toxicity is in part due to cadmium's extremely long half-life in mammalian systems, being about 15 years in human kidneys, so a steady state would be achieved in 45–60 years of exposure (WHO, 2010b). The ICRC has classified cadmium as carcinogenic to humans (Group 1) (IARC, 1993).

Hazard characterisation

In 1989, JECFA established a PTWI of 7 µg/kg bw/week for cadmium (WHO, 1989b). In June 2010, JECFA replaced this with a PTMI for cadmium of 25 µg/kg bw/month, in recognition of its exceptionally long half-life, such that daily ingestion in food has a small or even negligible effect on overall exposure. They concluded that dietary exposure should be assessed over a period of at least a month, rather than weekly (WHO, 2010b).

In light of the new PTMI set by JECFA, the European Food Safety Authority (EFSA) Panel on Contaminants in the Food Chain (CONTAM) re-evaluated its Tolerable Weekly Intake (TWI) of 2.5 µg/kg bw/week, and concluded that the approach adopted for its previous opinion on cadmium in food was appropriate and thus confirmed its PTWI (EFSA, 2011), a view not shared by JECFA.

Dietary exposure assessment

Prevalence/concentrations

The concentrations of cadmium in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in Appendix 9.2 of this report, detailing the minimum, maximum and arithmetic mean concentrations of cadmium for the 2009 NZTDS foods.

The presence of cadmium in the majority of these foods probably reflects New Zealand's geology, and may also reflect New Zealand's historic use of phosphate rock from Nauru for production of superphosphate fertilisers. This rock was significantly contaminated with cadmium compared to some other sources of phosphate rock (for example, southern, eastern USA or Russia), but it was relatively inexpensive (Reilly, 1991). The New Zealand fertiliser industry has set and achieved a voluntary industry standard of 280 mg Cd/kg phosphate for phosphatic fertilisers (Fert Research, 2010).

The levels of cadmium in the 2009 NZTDS foods were generally consistent with internationally documented levels (Rose *et al.*, 2010; Millour *et al.*, 2011; FSANZ, 2003; WHO, 1992a; Jensen, 1992). A few key 2009 NZTDS mean cadmium food levels are listed in Table 10 with comparative data from previous NZTDSs and overseas. In 1997/98, it appeared that the mean concentration of cadmium in food staples, such as bread, milk and potatoes, had increased since 1990/91. However, sample numbers for each individual food in the 1997/98 NZTDS were limited (2–10), so a more in-depth follow-up survey was undertaken in 2000, with 32 samples of seven key foods, including white bread, wheatmeal bread, whole milk, and potatoes (Vannoort, 2001), thus providing additional and more robust mean concentration for comparison purposes.

The cadmium concentrations of white and wheatmeal breads, whole milk, and liver lamb's fry, in the 2009 NZTDS are almost identical to those of 2003/04, and consistent with results in earlier NZTDSs. Oysters are lower in 2009, but still much higher than international values, consistent with some dredge oysters being included in the composites analysed, which are known to have up to 7.9 mg/kg cadmium (Nielsen and Nathan, 1975). Peeled potatoes have similar cadmium levels in NZTDSs back to 1997/98.

Dietary exposure estimates

The lower, mid-point and upper bound estimated monthly dietary exposures to cadmium based on ND=0, LOD/2 and LOD, respectively, for the eight age-gender cohorts of the 2009 NZTDS have been summarised in Appendix 10. Exposures are expressed as µg/kg bw/month, and as a percentage of the PTMI.

The mid-point estimated dietary cadmium exposures of the 2009 NZTDS are also presented in Figure 16 for simulated typical diets including and excluding oysters. Inclusion of oysters represents a worst case scenario because for most New Zealanders, oysters are likely to be a very minor or seasonal component of the diet, if consumed at all. The 1997 NNS reported that 39%

Table 10: Comparative cadmium concentrations in key foods

Food	Mean [c] cadmium concentrations (mg/kg)						
	1990/91 NZTDS	1997/98 NZTDS	2000 NZ [a]	2003/04 NZTDS [b]	2009 NZTDS [b]	Overseas Concn.	Overseas reference
Bread, white	0.012	0.018	0.018	0.015	0.015	0.010	FSANZ, 2003
Bread, wheatmeal	0.017	0.025	0.022	0.018	0.018	0.015	FSANZ, 2003
Milk, whole	0.00033	0.0015	<0.001	0.0002	0.0001	0.0004	Dabeka *et al.*, 1992
Liver lambs fry	0.255	0.113	NA	0.101	0.103	0.084	Rose *et al.*, 2010
Oysters, raw	0.39	4.48	NA	2.92	1.33	0.35	FAO/UNEP/ WHO, 1988
Potatoes, peeled	0.009	0.028	0.016	0.023	0.027	0.022	Millour *et al.*, 2011

Notes

a Vannoort, 2001; number of samples analysed n = 30 per food.

b n = 8 per food.

c Mean based on assigning ND = LOD/2.

of adults over 15 years of age never consumed shellfish, and 55% rarely did so (Russell *et al.*, 1999). The type of oyster can also influence the cadmium exposure, with dredge oysters being much higher in cadmium than Pacific oysters.

Figure 16 shows that estimated monthly dietary exposures for the eight age-gender cohorts are all below the PTMI for cadmium, and that these exposures are reduced by approximately 1.1–1.7 µg/kg bw/month (4–7% of PTMI) for 25+ year males and females and 19–24 year young males when the 3–4 oysters per fortnight are excluded from their simulated diet. Oysters are not included in the simulated typical diets for other cohorts (Appendix 3).

As Figure 17 shows, oysters (26%) make a major contribution to dietary cadmium exposure for the 25+ year male. It should be noted, however, that bioavailability of cadmium from Bluff (dredge) oysters is relatively low, and contributes much less to cadmium body burden than might be expected (McKenzie *et al.*, 1986). This is due to the cadmium being protein bound (Nordberg *et al.*, 1986), and the high levels of zinc, iron and selenium also present (Nielsen and Nathan, 1975), which have been suggested as counteracting the absorption of cadmium in the body (Reilly, 1991).

Potatoes and related products (26%), all breads (10%), mussels (3%) and carrots (3%) are the other specific foods which contribute significantly to dietary cadmium exposure of 25+ year males (Figure 17). In fact, only five specific foods contribute 68% of the monthly dietary cadmium exposure. Potatoes (32%), breads (11%), and carrots (5%) also contribute significantly to the estimated dietary cadmium exposure for the 1–3 year toddlers. Without oysters in their simulated typical diet, wheat biscuit cereals (4%) and chocolate biscuits (4%) also come through as other specific foods contributing to dietary cadmium exposure. Cocoa and related products, such as chocolate and chocolate biscuits, are recognised as a potential source of cadmium.

Figure 16: Dietary exposures to cadmium (2009 NZTDS)

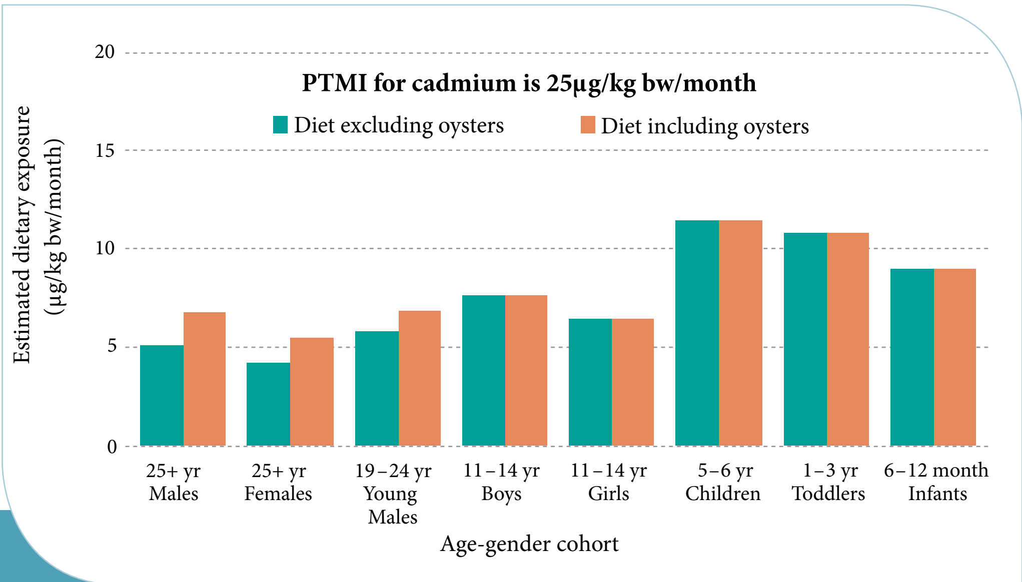
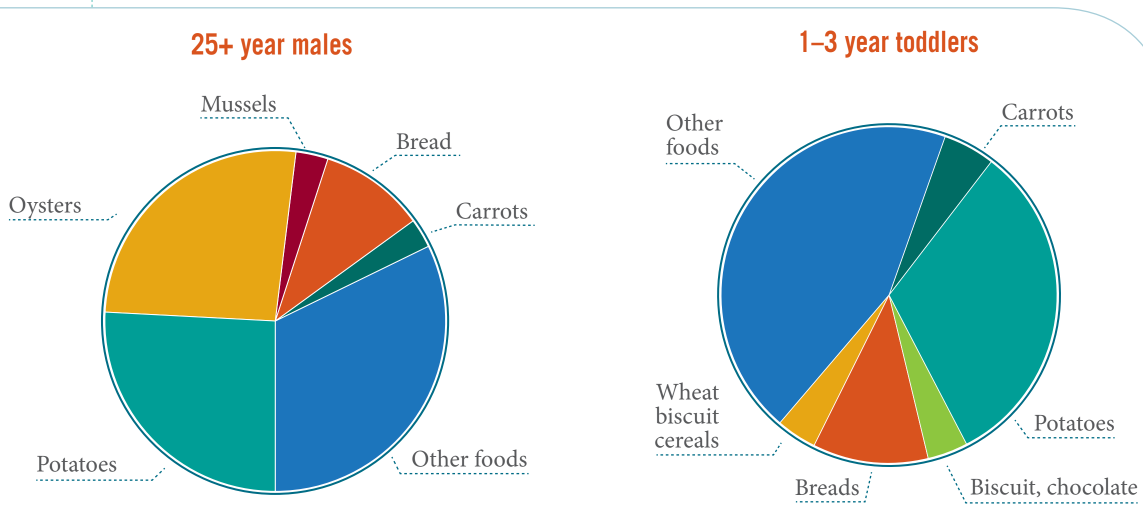


Figure 17: Specific foods contributing to dietary exposure to cadmium (2009 NZTDS)



The 2009 NZTDS monthly dietary exposures to cadmium for young males are compared to previous NZTDSs in Table 11. Exposure estimates also consider the simulated typical diets either including or excluding oysters.

The 1990/91 NZTDS dietary exposure estimate including oysters was much lower than that of 1987/88. This was attributable both to an improved analytical method (50 times lower LOD), and the significantly lower mean oyster concentrations encountered in 1990/91 (0.39 mg/kg) compared to 1987/88 (3.48 mg/kg). Bluff (dredge) oyster harvests were very small in 1990/91 because of the *Bonamia* parasite problem. The 10-fold lower cadmium oyster concentrations in the 1990/91 NZTDS suggest the oysters were probably entirely of a different type – Pacific or imported. In the 1997/98 NZTDS, Bluff (dredge) oysters were included and produced a mean oyster cadmium concentration of 4.48 mg/kg. This resulted in an estimated monthly dietary exposure to cadmium for 19–24 year young males of 12.1 µg/kg bw/month. The NZTDS mean oyster concentration in 2003/04 was 2.92 mg/kg, and contributed 44% of dietary exposure for 25+ year males (Vannoort and Thomson, 2005a, b). In the 2009 NZTDS, mean cadmium levels in

Table 11: Dietary exposure trends for cadmium (19–24 year young males)

	Estimated monthly exposure (µg/kg bw/month)				
Element	1987/88 [a] NZTDS	1990/91 [b] NZTDS	1997/98 [c] NZTDS	2003/04 [d] NZTDS	2009 NZTDS
Cadmium (diet including oysters)	35.5	12.1	12.1	7.8	6.9
% of PTMI *	142%	49%	49%	31%	27%
Cadmium (diet excluding oysters)	17.3	10.0	7.4	5.6	5.8
% of PTMI *	69%	40%	29%	23%	23%

Notes

* Current PTMI of 25 µg/kg bw/month has been used as reference standard for all NZTDSs for comparability.

a ESR/MoH, 1994.

b Vannoort *et al.*, 1995b.

c Vannoort *et al.*, 2000.

d Vannoort and Thomson, 2005.

oysters were 1.33 mg/kg (range 0.19–3.89 mg/kg), from a mix of Bluff (dredge) oysters and Pacific oysters, and the contribution of oysters to total dietary exposure had dropped to 26%.

If oysters are excluded from the estimated dietary cadmium exposures, the impact of the 50 times lower LOD from 1987/88 to 1990/91 is still clearly evident, with exposures decreasing from 17.3 to 10.0 µg/kg bw/month. From 1990/91 to 2009, the LOD has been essentially unchanged, and estimated dietary exposure to cadmium for 19–24 year young males has dropped from 10.0 to 5.8 µg/kg bw/month (see Table 11). This presumably reflects dietary consumption and cadmium concentrations in key foods, especially New Zealand staples, such as breads and potatoes.

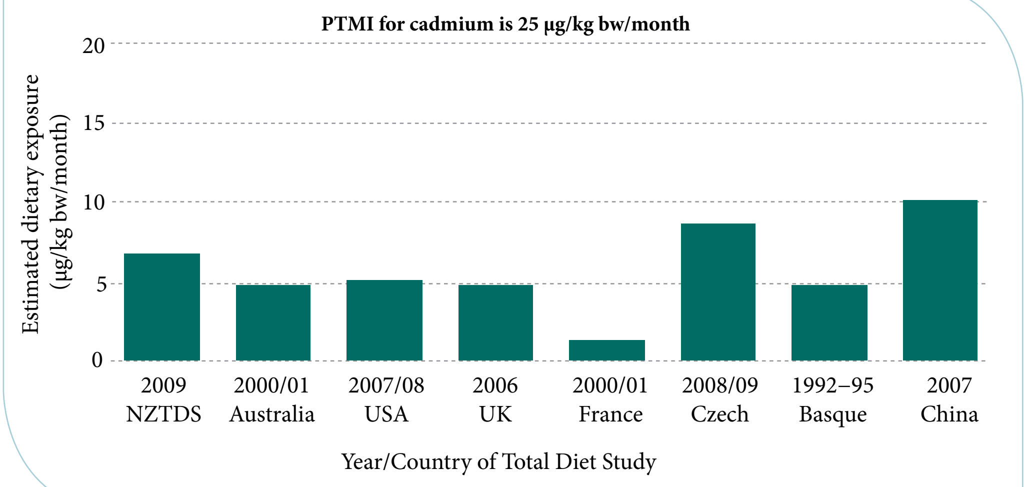
Figure 18 shows that the 2009 NZTDS estimated monthly dietary exposure to cadmium for 25+ year males (6.8 µg/kg bw/month) is moderate when compared with those from overseas TDSs. The cadmium exposure from foods in Australia (4.8 µg/kg bw/month, FSANZ, 2003); the USA (5.1, Egan, 2011); the UK (4.7, Rose *et al.*, 2010); and the Basque Country (4.8, Jalón *et al.*, 1997) are lower than in New Zealand. Of the other countries considered, France reported the lowest monthly cadmium dietary exposures (1.3 µg/kg bw/month; Leblanc *et al.*, 2005), while the Czech Republic had a higher dietary exposure for its 18–59 year males (8.6, Ruprich, 2011), and China also for its 18-year males (10.1, Li, 2011).

Risk characterisation

Cadmium estimated monthly dietary exposures ranged from a low of 22% of the PTMI for the 19–24 year young males to 46% and 44% of the PTMI for the 5–6 year children and the 1–3 year toddlers, respectively (Appendix 10, Figure 16).

It should be noted, however, that the dietary exposures in the 2009 NZTDS are based on average energy consumption figures. Generally, high consumers at the 95th percentile levels of energy intake may approximate three times the population average consumption figure for individual

Figure 18: Comparative dietary exposures to cadmium (25+ year males)



foods, and up to twice the total amount consumed by the population as a whole (FAO/UNEP/WHO, 1985). This would have the potential to significantly increase their dietary exposure to cadmium.

4.3.3 Lead

Lead is another heavy metal. It is ubiquitous in the environment and varies widely in concentration (Quarterman, 1986). Human exposure to lead has largely been the result of pollution, particularly from alkyl lead fuel additives and lead-based paints. The concentration of lead in foods is extremely variable. In crops, the concentrations of lead reflect the level of pollution during the growing season. The use of lead solder in the manufacture of cans has also been a significant contributor to dietary intakes of lead (Reilly, 1991; WHO, 1989a, 1977). This manufacturing process has been discouraged and is now outmoded in New Zealand, and similarly for imported canned foods.

Hazard identification

Lead is a cumulative metabolic poison that targets the haematopoietic (blood cell producing) system, the nervous system, the male reproductive system and the kidneys. Lead can be transported across the placenta, and may affect the developing foetus (Stevenson, 1990). In addition to the foetus, infants and children are at particular risk. Blood levels greater than 10 mg/dL, which could result from polluted urban environments, have been shown to cause adverse effects, including neurobehavioural development problems (WHO, 1993, 1987a).

Hazard characterisation

In 2010, based on dose-response analyses, JECFA estimated that its previously established PTWI of 25 µg/kg bw/week (WHO, 2000) is associated with a decrease of at least three intelligence quotient (IQ) points in children and an increase in systolic blood pressure of approximately 3 mmHg (0.4 kPa)[10] in adults. It considered that while such effects may be insignificant at the individual level, these changes are important when viewed as a shift in the distribution of IQ or blood pressure within a population. JECFA concluded, therefore, that the PTWI could no longer be considered health protective and withdrew it. Furthermore, as the dose-response analyses did not provide any indication of a threshold for the key adverse effects of lead, the Committee concluded that it was not possible to establish a new PTWI that would be health protective (WHO, 2010b). United States Environmental Protection Agency (US EPA) evaluations have concluded there is no apparent threshold for the relationship between blood lead and neurobehavioural developmental deficiencies (US EPA, 1991). On this basis, lead residues in foods should be ALARA.

Dietary exposure assessment

Prevalence/concentrations

The concentrations of lead in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated

10 mmHg = millimetres mercury, kPa = kilopascals.

in Appendix 9.3 of this report, detailing the minimum, maximum and arithmetic mean concentrations of lead for the 2009 NZTDS foods.

Almost all the individual 2009 NZTDS foods making a contribution to dietary lead exposure had mean lead levels consistent with, or lower than overseas data (Millour *et al*., 2011; Rose *et al*., 2010; FSANZ, 2003; MAFF, 1998). Canned foods, which in the past have been a major source of dietary lead, contained low lead levels reflecting widespread use of welded cans rather than lead soldered cans.

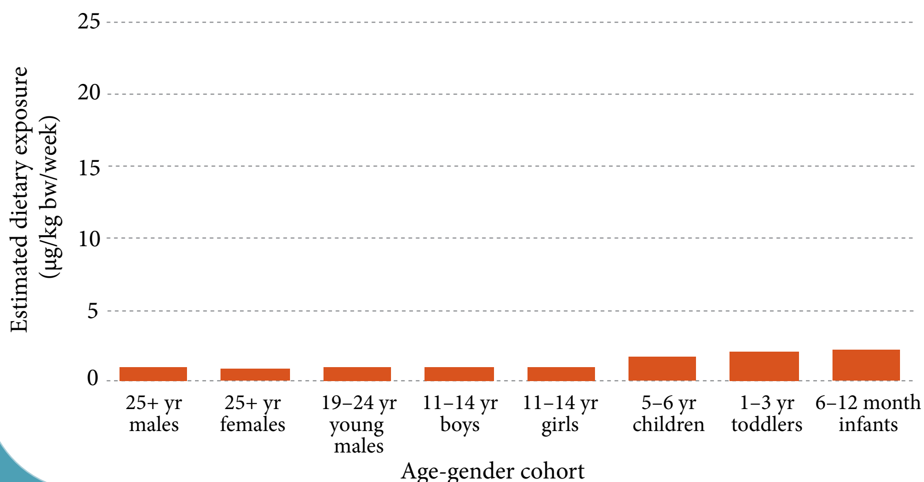
Dietary exposure estimates

The lower, mid-point and upper bound estimated monthly dietary exposures to lead for the eight age-gender cohorts of the 2009 NZTDS are given in Appendix 10. Exposures are expressed as µg/kg bw/week only, given the PTWI has been withdrawn.

Figure 19 shows the estimated exposures to lead for the eight cohorts in the 2009 NZTDS. The weekly dietary lead exposures in New Zealand are now down to 0.9 µg/kg bw/week for the 25+ year males and 2.1 µg/kg bw/week for infants. All exposures are essentially the same as in 2003/04, except for the 6–12 month infants, whose dietary exposure has dropped from 2.9 to 2.1 µg/kg bw/week. This is a direct benefit of not having any lead contamination in the infant baby foods in 2009, as had occurred on one occasion in the 2003/04 NZTDS (0.472 mg/kg lead in infant custard/fruit weaning food, when normal levels are 0.002 mg/kg) (Vannoort and Thomson, 2005b).

Essentially all food groups in the 2009 NZTDS contribute to dietary lead exposure for all age-gender cohorts, reflecting lead's ubiquitous environmental presence. Grains contributed 26–30% of dietary lead for 19–24 year young males, 25+ year males and females, and 37–44% for 11–14 year boys and girls and 5–6 year children/1–3 year toddlers. Chicken, eggs, fish and meat; and takeaways contributed 10–13% and 8–17% of 19–24 year and 25+ year adult dietary

Figure 19: Dietary exposures to lead (2009 NZTDS)



lead, respectively, and similarly they contributed 6–9% and 9–13% for 11–14 year boys/girls and 5–6 year children/1–3 year toddlers, respectively. The main food groups contributing to dietary exposure to lead for 6–12 month infants are grains (27%), fruit (20%), infant formula and weaning foods (19%), dairy products (10%), takeaways (6%) and vegetables (6%).

Figure 20 indicates a consistent downward trend in the weekly dietary exposures to lead for the 19–24 year young males over successive NZTDSs. The exposure trend for the young males is reflective of the other age-gender cohorts in the NZTDSs.

The decrease of weekly dietary exposure to lead for the 19–24 year young males from 26 µg/kg bw/week in 1982 to 9.4 µg/kg bw/week in 1987/88 demonstrates the effectiveness of governmental risk management strategies. These included encouraging the food industry to implement new canning technologies to eliminate the use of lead solder in canned foods, and regulating the reduction of lead additives in retail petroleum products. The decrease from 1987/88 (9.4 µg/kg bw/week) to 1990/91 (3.3 µg/kg bw/week) (Figure 20) was mainly the result of two factors. Firstly, a further reduction in the lead in petroleum products lowered environmental lead and thus lead concentrations in foods; and secondly the 10 times lower LOD offered by the use of ICP-MS technology which meant significantly fewer "not detected" foods (31/107 foods in 1990/91 versus 80/105 in 1987/88 NZTDS). This effectively reduced the degree of uncertainty associated with dietary exposure estimates caused by assigning half the LOD to "not detected" foods when calculating dietary exposures. In 1997/98, the LOD was the same as in 1990/91, and the lower weekly dietary exposure of 1.2 µg/kg bw/week in 1997/98 could be attributed to the complete removal of lead additives from retail petrol by the Government in 1996. In 2003/04 and 2009 NZTDS, the LOD is essentially unchanged and dietary exposure to lead for young males has dropped slightly to 1.0 µg/kg bw/week, and in the 2009 NZTDS appears to have levelled out, presumably reflecting the residual or natural environmental content of lead still able to enter the food supply.

Figure 20: Dietary exposure trend for lead (19–24 year young males)

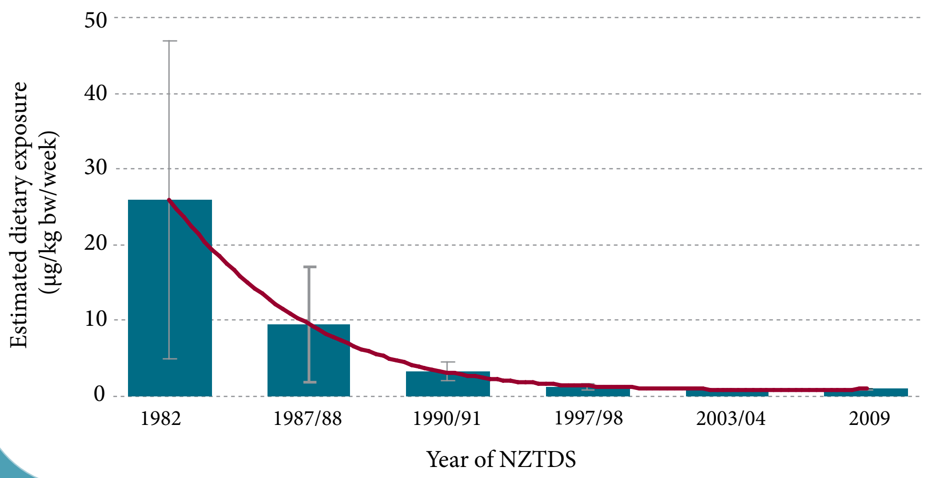


Table 12 shows that New Zealand now appears to have one of the lowest dietary exposures to lead for 25+ year males (0.9 µg/kg bw/week) when compared to overseas TDS reference studies, and it is only 15% of dietary exposures to lead in China.

Risk characterisation

Lead estimated weekly exposures since the last NZTDS in 2003/04 have now generally plateaued out for all age-gender cohorts, except the 6–12 month infants which decreased from 2.9 µg/kg bw/wk to 2.1 µg/kg bw/wk. Levels of lead in our diet now appear to be ALARA.

Dietary lead exposures in New Zealand are amongst the lowest in the world.

Although the PTWI for lead has been withdrawn in 2010, international thinking would be that our dietary exposures to lead are unlikely to represent a significant risk to public health. Nonetheless, it remains important to keep dietary exposures to lead ALARA.

Table 12: Comparative dietary exposures to lead (2009 NZTDS)

Element	Estimated weekly exposure (µg/kg bw/week)						
	2009 NZTDS males 25+ yr	Australia males 25–34 yr	USA males 25–30 yr	UK males 16–64 yr	France males 15+ yr	China males 18 yr	Czech males 18–59 yr
Lead	0.9 [2]	1.6 [a, 2]	0.88 [b, 2]	0.67 [c, 1, 3]	1.9 [d, 2, 4]	6.1 [e, 2]	2.4 [f, 4]

Notes

a 2000/01 data (FSANZ, 2003).
b 2007/08 data (Egan, 2011).
c 2006 data (Rose *et al.*, 2010).
d 2000/01 data (Leblanc *et al.*, 2005).
e 2007 data (Li, 2011).
f 2008/09 data (Ruprich, 2011).
1 Using zero values for "not detected" data.
2 Using half limit of detection for "not detected" data.
3 Using limit of detection for "not detected" data.
4 Using half limit of quantitation for "not quantified" data.

4.3.4 Mercury and methylmercury

Mercury is concentrated in the earth's crust into a relatively small number of rich ore belts associated with volcanic activity (Clarkson, 1987).

Mercury and methylmercury are naturally occurring substances to which all living organisms are exposed, in varying degrees, depending on natural, biological, chemical, and physical processes. Mercury is used in the manufacture of electrical apparatus, paint, dental preparations and pharmaceuticals. Geothermal and volcanic activity, which New Zealand has, also influences the amount of mercury in the surrounding environment.

The metabolic behaviour of mercury varies greatly with the chemical form in which it is presented to the animal, the extent to which it interacts with other elements in the diet, and with genetic differences. Both inorganic and organic forms of mercury are found in food. The level of mercury in foods is variable and reflects the levels of contamination in the area of cultivation. Stock animals concentrate environmental mercury in the liver and kidney. The large predatory species of fish, such as sharks and swordfish, bioaccumulate methylmercury and may contain very high concentrations of the element (WHO, 1991a, 1991b; Reilly, 1991).

Hazard identification

Occupational hazards associated with both ingestion and inhalation of mercury have been recognised for a long time. Organic mercury, particularly methylmercury, is significantly more toxic than the inorganic form of mercury in foodstuffs. In seafood, mercury is most commonly found in the organic form, usually methylmercury. Methylmercury is a cumulative toxin that can cause disruption of the developing central nervous system, resulting in retarded mental and physical development (WHO, 1978a, 1989b, 1991a). The embryo and foetus are the most vulnerable life-stage with respect to the adverse effects of methylmercury (WHO, 2007). While the placenta provides an effective barrier to the transfer of inorganic mercury, methylmercury is readily transferred across the placental barrier to the foetus (Clarkson, 1987). A study among the fish-eating population of the Faroe Islands did find a correlation between adverse neurodevelopment effects and levels of mercury in cord blood at birth (Grandjean *et al.*, 1997). In contrast, a similar study among the fish-eating community of the Seychelles for *in utero* exposure to methylmercury from maternal consumption of fish indicated that exposures of 5.18–11.2 µg/kg bw/week were not associated with any developmental delays up to nearly six years of age (Shamlaye *et al.*, 1995).

Hazard characterisation

JECFA set a total mercury PTWI of 5 µg/kg bw/week (WHO, 1972), which it reconfirmed in 1978 (WHO, 1978b). JECFA also set a PTWI for methylmercury of 3.3 µg/kg bw/week in 1978 (WHO, 1978b), which has been revised twice, with the latest PTWI for methylmercury being 1.6 µg/kg bw/week (WHO, 2007). This methylmercury PTWI is considered sufficient to protect developing foetuses, the most sensitive subgroup of the population. In light of the revised PTWI for methylmercury, JECFA also revisited the PTWI for total mercury. In 2010, JECFA established a new PTWI for inorganic mercury of 4 µg/kg bw/week. In the absence of evidence to the contrary, the new PTWI for inorganic mercury was considered applicable to dietary exposure to total mercury from foods other than fish and shellfish (WHO, 2010a).

Dietary exposure assessment

Prevalence/concentrations

In the 2009 NZTDS, total mercury was determined on 94 of the 123 foods, and methylmercury on only the fish and shellfish. The 29 foods not analysed for total mercury were high fat (for example, butter) or dry foods (biscuits) because limits of detection in these matrices were inadequate in this study.

In order to estimate total dietary exposures, a mean concentration was needed for each food. To achieve this, the 29 foods "not analysed" in the 2009 NZTDS were separately assigned a mean concentration value based on previous NZTDS or other New Zealand data (Vannoort *et al.*, 2000).

The concentrations of total mercury in individual foods, and methylmercury in fish and shellfish, of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in Appendices 9.4 and 9.5 of this report, detailing the minimum, maximum and arithmetic mean concentrations of mercury and methylmercury for the 2009 NZTDS foods.

Of the 94 foods analysed for total mercury in the 2009 NZTDS, only 10 foods had detectable concentrations, namely the four fish and two shellfish foods, as well as liver, pork chops, eggs and silverbeet. In the second French TDS, they found only 118 (9%) out of 1319 food samples analysed with detectable mercury levels (LOD 0.005 mg/kg; Millour *et al.*, 2011), and the 2006 UK TDS found that 17 out of the 20 food groups they analysed for mercury had levels less than their 0.5–3 µg/kg detection limit (Rose *et al.*, 2010).

The concentrations of mercury in fish in the 2009 NZTDS were consistent with international literature. Most oceanic species have average mercury levels of about 0.15 mg/kg or less. However, large predatory species (shark, tuna, and lemon fish) usually have mercury levels in the 0.20–1.5 mg/kg range (FAO/UNEP/WHO, 1988). In the 2009 NZTDS, the highest concentrations were in battered fish, being up to 0.48 mg/kg total mercury, close to the FSANZ maximum limit (ML) of 0.5 mg/kg.

The fish samples in the 2009 NZTDS had mean methylmercury concentrations ranging from 0.023 mg/kg in canned fish to 0.195 mg/kg in battered (takeaway) fish, with an overall mean of 0.087 mg/kg. Mussels and oysters had mean methylmercury of 0.007 and 0.010 mg/kg, respectively. Mean methylmercury in fish was 68–73% of mean total mercury, and 39–41% in shellfish.

Mean methylmercury concentrations in fish and shellfish were 0.013 mg/kg in the 2007 China TDS (Shang *et al.*, 2010), and 0.048 mg/kg in 280 fish samples in Hong Kong (Tang *et al.*, 2009). Methylmercury in 71 seafood products (fish, shellfish, crustacea, n=159) were a low of 0.02 mg/kg in anchovy and 0.038 mg/kg in salmon, while not unexpectedly, predatory fish had the highest concentrations, with 0.330 mg/kg in tuna and 0.944 mg/kg in swordfish (Sirot *et al.*, 2008).

Dietary exposure estimates

The lower, mid-point and upper bound estimated weekly dietary exposures to total mercury for the eight age-gender cohorts of the 2009 NZTDS are given in Appendix 10. Exposures are expressed as µg/kg bw/week, and as a percentage of the PTWI. It should be noted that total mercury is determined for all foods in the NZTDS, as has been traditionally undertaken in previous NZTDSs and internationally, as well as calculated for the NZTDS diets excluding fish and shellfish as an approximation to inorganic mercury, as the PTWI is on this basis. In addition, methylmercury exposures have been determined based on fish and shellfish analysed.

Table 13 summarises the mid-point exposures (based on ND=LOD/2 values, see section 2.4.2), for total mercury on all NZTDS foods, total mercury in foods excluding fish and shellfish, and methylmercury only on fish and shellfish.

Fish and shellfish contributions ranged from 73% of the 19–24 year young male's dietary mercury exposure down to 55% for the 6–12 month infant. Essentially all the remaining dietary exposure to total mercury is calculated after assigning half the LOD to "not detected" foods (explained in section 2.4.2). As a result, the 2009 NZTDS dietary exposures to total mercury from all NZTDS foods (Table 13) may be overestimated because of the high proportion (92%) of "not detected" foods (114 not detected foods out of 123 NZTDS foods). The lower and upper bound dietary exposure estimates are given in Appendix 10, based on "not detected" foods assigned zero and LOD, respectively, and the significant difference between the lower and upper bounds directly reflects the uncertainty associated with the current LOD and the high percentage of "not detected" foods.

Table 13: Dietary exposures to total mercury and methylmercury

		Estimated weekly exposure (µg/kg bw/week)							
Elements	PTWI (µg/kg bw/wk)	25+ yr males	25+ yr females	19–24 yr young males	11–14 yr boys	11–14 yr girls	5–6 yr children	1–3 yr toddlers	6–12 month infants
Mercury (total) [a] (all NZTDS foods)		0.69	0.57	0.73	0.69	0.43	0.98	1.18	1.15
Mercury (total) [a] (NZTDS diet excluding fish and shellfish)	4 [b]	0.20	0.18	0.17	0.20	0.17	0.33	0.44	0.52
% of PTWI (inorganic mercury)		5%	4.5%	4.3%	5%	4.3%	8.3%	11%	13%
Methylmercury [a] (fish and shellfish)	1.6 [c]	0.33	0.27	0.37	0.34	0.19	0.46	0.52	0.45
% of PTWI (methylmercury)		21%	17%	23%	21%	12%	29%	33%	28%

Notes

a The estimated dietary exposures for each age-gender cohort are mid-point based on assigning "not detected" results to half LOD (as explained in section 2.4). For lower and upper bound intake estimates, based on assigning ND = 0 and ND = LOD, see Appendix 10.

b PTWI inorganic mercury, for all foods excluding fish and shellfish (WHO, 2010a).

c PTWI for methylmercury (WHO, 2007).

The more toxicologically relevant methylmercury has been determined on fish and shellfish. All fish and seafood had detectable concentrations of methylmercury. The methylmercury dietary exposures range from 0.27–0.37 µg/kg bw/week for 19–24 year young males and 25+ year males and females, 0.19–0.34 µg/kg bw/week for 11–14 year boys and girls, and 0.45–0.52 µg/kg bw/week for 6–12 month infants, 1–3 year toddlers and 5–6 year children (Appendix 10).

Table 14 compares the estimated weekly dietary exposures to total mercury and methylmercury for 19–24 year young males in this study with those of previous NZTDSs. Young males have been used in previous NZTDSs for comparison purposes, and their exposures generally reflect the other age-gender cohorts.

The weekly dietary exposure to total mercury from all NZTDS foods for young males increased from 0.91 µg/kg bw/week in the 1987/88 NZTDS to 1.3 µg/kg bw/week in the 1990/91 NZTDS (Table 14). This was due to the contribution from fish and shellfish, an unexpected level of mercury found in imported tea (0.008 mg/kg), and the amount of tea consumed in the young male diet. In the 1997/98 NZTDS, the weekly dietary exposure to mercury for young males was down again to 0.73 µg/kg bw/week. The main reason was the much lower consumption of fish/shellfish of 175 g/week in 1997/98 NZTDS compared to 525 g/week in the 1990/91 NZTDS, and also the lower mean mercury content of tea (0.003 mg/kg). The 2003/04 and 2009 estimated dietary exposure to mercury for young males is the same as in 1997/98, despite a higher consumption of fish/shellfish (245 g/week) in the simulated diet (Appendix 3).

Given fish and shellfish were not analysed for methylmercury in previous NZTDSs, the weekly exposure to methylmercury from these foods has been derived from total mercury exposures

Table 14: Dietary exposure trends for total mercury and methylmercury (19–24 year young males)

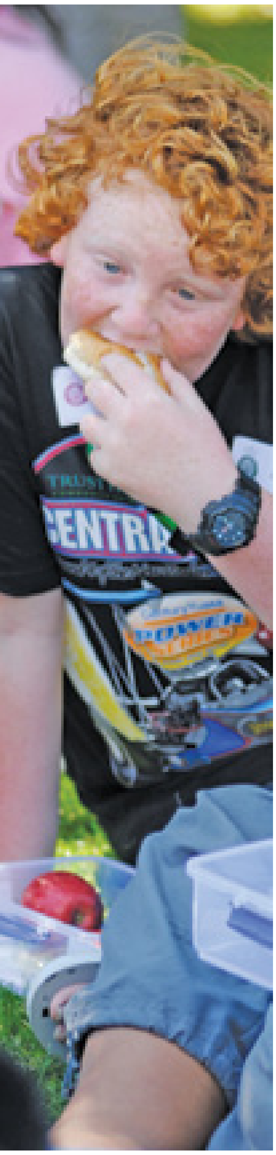
Element	PTWI	Estimated weekly exposure (µg/kg bw/week)				
		1987/88 [a] NZTDS	1990/91 [b] NZTDS	1997/98 [c] NZTDS	2003/04 [d] NZTDS	2009 NZTDS
Mercury (total); (all NZTDS foods)		0.91	1.33	0.73	0.74	0.73
Mercury (total); (NZTDS diet excluding fish and shellfish)	4 [b]	0.46	0.67	0.29	0.19	0.20
% of PTWI (inorganic mercury)		12%	17%	7%	5%	5%
Methylmercury (from fish and shellfish)	1.6 [f]	0.46 [g]	0.65 [g]	0.52 [g]	0.55 [g]	0.37
% PTWI (methylmercury)		29%	41%	33%	34%	23%

Notes

a ESR/MoH, 1994.
b Vannoort *et al.,* 1995.
c Vannoort *et al.,* 2000.
d Vannoort and Thomson, 2005a.
e PTWI (inorganic mercury, food excluding fish and shellfish) = 4 µg/kg bw/week; WHO, 2010a.
f PTWI (methylmercury) = 1.6 µg/kg bw/week; WHO, 2007.
g Dietary exposures to methylmercury have been derived from total mercury exposures in fish and shellfish in past NZTDSs, assuming 100% of total mercury is methylmercury, as they were not analysed for methylmercury.

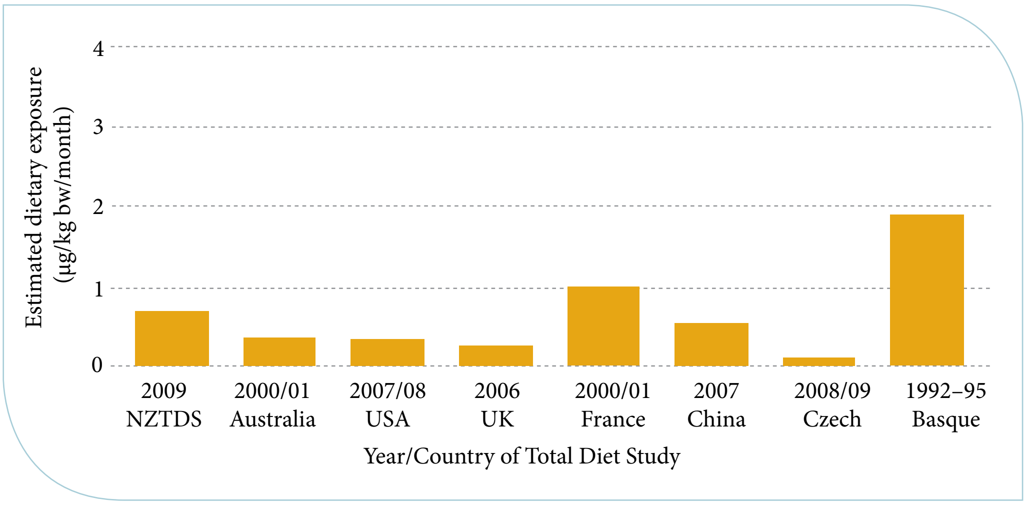
in fish and shellfish, assuming 100% of total mercury is methylmercury. If the 2009 NZTDS ratio of methylmercury to total mercury of 0.70 is applied to fish and 0.40 to shellfish, then the dietary exposures to methylmercury would be essentially unchanged from 1997/98 to 2003/04 to the present study.

Figure 21 shows that the 2009 NZTDS weekly dietary exposure to total mercury for 25+ year males (0.69 µg/kg bw/week) is similar in magnitude to China (0.53, Li, 2011) and France (1.0, Leblanc *et al.*, 2005). It is approximately double that of Australia (0.35 µg/kg bw/week, FSANZ, 2003) and the USA (0.34, Egan, 2011) and almost three times that of the UK (0.25, Rose *et al.*, 2010). The Czech weekly dietary exposure to mercury (0.093, Ruprich, 2011) is an order of magnitude lower than New Zealand and the lowest estimated amongst other countries using LOD/2 for "not detected" results. This is explained by two reasons: the much lower consumption of fresh/saltwater fish and related products in the Czech Republic (77 g/average person/week, Ruprich *et al.*, 2000) compared to New Zealand (295 g/25+ year male/week, Appendix 3); and the Czech LOD (0.1 µg/kg) is also much lower than the 2009 NZTDS (1–2 µg/kg most foods). The higher the LOD, the greater the extent of potential overestimation in any dietary exposure estimate, when non-zero values are assigned to "not detected" concentration data. The Basque Country, with fish/seafood consumption of 623 g/Basque adult/week, had the highest estimated dietary exposure to mercury (1.9 µg/kg bw/wk, Jalón *et al.*, 1997) of the overseas countries considered.



To date, specific analyses for methylmercury has not been performed in many TDSs. In the 2007 Chinese TDS, adult males 18–45 years had mean methylmercury dietary exposures from fish/shellfish of 0.041 µg/kg bw/week. These were much lower than the 2009 NZTDS because the consumption of predatory fish is rare across China, resulting in very low mean methylmercury concentrations of 0.013 µg/kg (Shang *et al.*, 2010), compared to mean methylmercury concentrations of 0.087 mg/kg in fish in the 2009 NZTDS. In non-TDS studies, Tang *et al.* (2009) found that secondary school students in Hong Kong had methylmercury dietary

Figure 21: Comparative dietary exposures to total mercury (25+ year males)



exposures from a variety of fish (n=280) of 0.4–0.5 µg/kg bw/week for an average consumer, and 1.2–1.4 µg/kg bw/week for a high (95th percentile) consumer, which is approximately three times the average consumer. In France, 385 frequent seafood consumers aged 18+ years had mean methylmercury dietary exposures of 1.5±1.2 µg/kg bw/week, with 35% of consumers exceeding the PTWI (Sirot *et al.*, 2008), although consumption was up to 4500 grams per week compared to 2009 NZTDS 25+ males consumption of 294 grams per week.

Risk characterisation

In the 2009 NZTDS, the estimated dietary exposures to total mercury for all eight age-gender cohorts were less than 13% of the PTWI for inorganic mercury for simulated diets excluding fish and shellfish.

Methylmercury dietary exposures derived from fish and shellfish were less than 34% of the PTWI for methylmercury for all cohorts.

It should be noted that dietary exposures in the 2009 NZTDS were based on average energy diets for each of the age-gender cohorts. High percentile fish consumers have the potential to have significantly higher exposures.

NUTRIENT ELEMENTS: RESULTS AND DISCUSSION 5

5.1 Introduction

The nutrient elements iodine, selenium and sodium were investigated in the 2009 NZTDS. Iodine and selenium are core elements of past NZTDSs, enabling intake trends to be followed over time. Both are essential micronutrients that are deficient in New Zealand soils, with the potential for low intakes for New Zealanders.

The last two NZTDSs have found decreasing levels of iodine intake. Iodine is involved in thyroid function, and affects both mental and physical development (Hetzel and Maberly, 1986; Mann and Truswell, 1998). Mild iodine deficiency was found in a sample of New Zealand schoolchildren (Skeaff *et al.,* 2002).

Selenium is an antioxidant that plays a part in the body's defence mechanisms (Hoekstra, 1975; Garland *et al*., 1994).

Sodium was included as an analyte of potentially high intake based on the 2003/04 NZTDS (Vannoort and Thomson, 2005a). Sodium had been identified as a nutrient element where high intakes are associated with increased risk of hypertension, a risk factor for cardiovascular disease, a key health concern for New Zealand.

5.2 Nutrient element results

5.2.1 Concentration data and estimated dietary intakes of the 2009 NZTDS

Methodology for determining mean concentration data and dietary intakes estimates has been explained previously in section 2.4.2 and section 2.5, respectively.

Details of the concentrations of nutrient elements in the 123 individual foods assessed in the 2009 NZTDS are contained in Appendix 11.

Appendix 12 provides a summary of the lower, mid and upper bound daily dietary intake

estimates of the nutrient elements iodine, selenium and sodium (µg/day) for each age-gender cohort of the 2009 NZTDS. Nutrient reference values (NRVs), and either the estimated average requirement (EAR), adequate intake (AI) or upper levels of intake (UL) for each nutrient element and each age-gender cohort are also shown.

Comparison of intakes against EARs is a significant change from previous NZTDSs which compared intakes to recommended dietary intakes (RDIs). It is now recognised internationally that EARs are the more appropriate NRVs for representing average nutrient requirements within an age-gender cohort, whereas RDIs reflect nutrient requirements for nearly all (97–98%) healthy individuals within a particular group (NHMRC, 2006). RDIs are derived from EARs, and incorporate generous factors to accommodate variations in absorption and metabolism. RDIs therefore exceed the actual nutrient requirements of practically all healthy persons and are not synonymous with requirements (NHMRC, 2006). Mean intake estimates were compared with the relevant EAR, when available, as a benchmark for nutrient inadequacy within each age-gender cohort. The deterministic simulated diet approach of this study does not allow a more robust assessment of the prevalence of nutrient inadequacy within each group.

AIs and not EARs have been established for infants, and so these are the NRVs used for this population cohort, whereas EARs are used for all other age-gender cohorts. Where the NZTDS age cohorts were different to those for which NRVs were derived, the lower (more conservative) NRV value was used for interpretation of nutrient intakes.

5.2.2 Comparison of 2009 NZTDS with previous NZTDSs

In comparing the 2009 NZTDS with previous NZTDSs, the 19–24 year young males, 25+ females and 1–3 year toddlers cohorts have been used as representative examples throughout the discussion.

5.2.3 Comparison of 2009 NZTDS with overseas TDSs for nutrient elements

The simulated daily dietary intakes for 25+ year males and females in the 2009 NZTDS were compared to adult males and females in the 2000 and 2004 Australia TDSs (FSANZ, 2003, 2008), the 2007/08 US TDS (Egan, 2011), the UK TDS (Rose *et al.*, 2010), the 2008/09 Czech Republic TDS (Ruprich, 2011) and the 2007 China TDS (Li, 2011). Other published data were also used where available (Rasmussen *et al.*, 2002; Leblanc *et al.*, 2005; Anderson *et al.*, 2010).

Such comparisons need due caution, and the reasons for this have been detailed previously (section 3.1.3). It is also important to understand how "not detected" results are dealt with. The protocol for this in the 2009 NZTDS has been explained in section 2.4.2. Literature references to comparative data in figures or table footnotes summarise protocols used overseas.

5.3 Nutrient elements discussion

5.3.1 Iodine

Iodine is an essential dietary trace mineral for animals and humans but not plants (Butler *et al.*, 2007; Hetzel and Maberly, 1986). Iodine is present in food and water predominantly as iodide and iodate, and is sometimes organically bound to amino acids. Iodine occurs naturally, or is added to New Zealand foods as iodised salt. Naturally occurring iodine in foods is most likely a function of climate and soil types (Butler *et al.*, 2007). Ingested iodine is rapidly absorbed throughout the length of the gastro-intestinal tract (Hetzel and Maberly, 1986). However, certain other dietary components, namely goitrogens, as found in cabbage, broccoli, cauliflower and cassava, can interfere with iodine metabolism by inhibiting the production of thyroid hormones, leading to symptoms resembling iodine deficiency (Hetzel and Maberly, 1986).

Hazard identification

Iodine is an essential element in thyroid hormones required for normal growth and metabolism of tissues such as the central nervous system, for maintaining energy production and metabolic rate (Hetzel and Maberly, 1986).

Iodine deficiency may lead to goitre, hypothyroidism, and impaired mental and physical development (Hetzel and Maberly, 1986). Dietary iodine requirements increase from childhood to adulthood, with the greatest requirement being for lactating and pregnant women (NHMRC, 2006). Iodine-deficiency goitre was endemic in New Zealand by the early 1900s before the iodisation of salt in 1924 (Thomson, 2004). Estimated dietary intake of iodine in New Zealand has decreased over the past 25 years due to decreased use of iodine-containing disinfectants in the dairy industry and changing food consumption patterns. Sutcliffe reported a dramatic decrease in iodine concentration of milk from 0.44 mg/kg in 1978 to 0.12 mg/kg in 1988 that accounts for the decrease in iodine intake seen between 1982 and 1987/88 (Sutcliffe, 1990). The decreasing iodine intake since 1987/88 is consistent with decreased consumption of milk and eggs, based on simulated diets for a 19–24 year young male, rather than a change in iodine concentrations of major contributing foods (Thomson *et al.*, 2008). Low iodine intake is consistent with evidence of low and decreasing urinary iodide levels as a measure of iodine status in New Zealand (MoH, 2003; Skeaff *et al.*, 2002, 2005; Thomson *et al.*, 1997, 2001).

Excess iodine intake may also lead to enlargement of the thyroid gland and elevated production of thyroid-stimulating hormone (Henjum *et al.*, 2010; NHMRC, 2006).

Hazard characterisation

NRVs for Australia and New Zealand have been established by the Australian National Health Medical Research Council (NHMRC, 2006). The NRVs for iodine are included in Appendix 12 for each of the age-gender cohorts of the 2009 NZTDS.

The EAR for iodine in adults is 100 µg/day, (Table 15) based on iodine balance and a New Zealand urinary iodide study (NHMRC, 2006; Thomson *et al.*, 2001). The EAR of 75 µg/day for 11–14 year boys and girls was extrapolated from adults using metabolic body weight ratios. EARs of 65 µg/day for young children and toddlers were based on balance studies. For the infants (6–12 months), an AI of 110 µg/day was extrapolated from adequately breast milk fed infants using a metabolic weight ratio (NHMRC, 2006).

An UL of 1100 µg/day for iodine in those 19 years and over was derived, by the NHMRC, on the basis of a lowest observed adverse effect level (LOAEL) of 1700 µg/day and an uncertainty factor of 1.5. In the absence of further evidence for other age groups, ULs of 900, 600, 300 and 200 µg/day were extrapolated, by the NHMRC, for the 14–18 years, 9–13 years, 4–8 years and 1–3 years from the adult recommendation on a metabolic body weight basis and age groups, respectively. For the infant, an UL could not be established (NHMRC, 2006).

Dietary exposure assessment

Prevalence/concentration of iodine in foods

The concentrations of iodine in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in Appendix 11.1 of this report, detailing the minimum, maximum and arithmetic mean concentrations of iodine for the foods analysed in the 2009 NZTDS. Most of these foods had mean iodine concentrations of less than 0.050 mg/kg.

Consistent with previous NZTDSs, mussels (1.88 mg/kg) and oysters (1.74 mg/kg) had the highest levels of iodine. Eggs had the next highest mean iodine content of 0.47 mg/kg, directly comparable to the 0.52 mg/kg in 2003/04 (Vannoort and Thomson, 2005b) and 0.37 mg/kg in the 22nd Australian TDS (FSANZ, 2008).

Chocolate, corned beef, all three types of biscuits, mixed grain and wheatmeal breads, infant and follow-on formula, and meat pies all had mean iodine levels more than 40% above 2003/04 NZTDS levels (Table 15), with iodine concentrations in mixed grain and wheatmeal breads consistent with concentrations found in the 1997/98 NZTDS. With the exception of chocolate and infant and follow-on formula, these foods may reflect the use of iodised salt in preparation. Conversely, beer, cereal-based infant weaning food and soy milk exhibited more than a 40% decrease in mean iodine content from 2003/04. The latter result is most likely due to the absence of seaweed-containing product that gave rise to an exceptionally high level of iodine in one soy milk sample, and an elevated mean iodine concentration, in the 2003/04 samples. The reason for the remaining differences is unclear. Further trend information for foods that showed an

Table 15: Iodine concentration trends

Food	Mean iodine concentration (mg/kg)				
	1987/88 [a] NZTDS	1990/91 [b] NZTDS	1997/98 [c] NZTDS	2003/04 [d] NZTDS	2009 NZTDS
Beef, corned	0.11	0.040	NR	0.025	0.140
Biscuits, chocolate	0.39	0.052	0.011	0.055	0.094
Biscuits, cracker	0.24	0.050	0.010	0.008	0.063
Biscuits, plain sweet	0.11	0.060	0.010	0.007	0.035
Bread, mixed grain	NR	NR	0.016	0.012	0.017
Bread, wheatmeal	<0.01	0.063	0.010	0.005	0.013
Bread, white	0.03	0.079	0.013	0.003	0.002
Cake	0.19	0.170	0.079	0.130	0.109
Chocolate, plain milk	0.09	0.130	0.109	0.153	0.209
Egg	0.21	0.160	0.544	0.519	0.465
Fish in batter	NR	NR	0.175	0.166	0.131
Fish, fresh	0.21	0.275	0.376	0.216	0.237
Infant and Follow-on formula	NR	NR	NR	0.079	0.133
Meat pie	0.11	0.030	0.036	0.008	0.076
Milk, 0.5%	0.11	0.074	0.093	0.096	0.103
Milk, 3.25%	0.10	0.064	0.085	0.086	0.094
Mussels	NR	NR	1.523	1.532	1.270
Oysters	0.67	0.260	1.045	0.970	1.298
Potato, hot chips	NR	NR	0.035	0.070	0.004

Notes

NR = No result.

a ESR/MoH, 1994.

b Hannah *et al.,* 1995.

c Vannoort *et al.,* 2000.

d Vannoort and Thomson, 2005b.

Table 16: Dietary iodine intakes

	25+ yr males	25+ yr females	19–24 yr young males	11–14 yr boys [d]	11–14 yr girls [d]	5–6 yr children [e]	1–3 yr toddlers	6–12 month infants [f]
2009 NZTDS [a]	86	63	89	61	50	43	48	66
EAR [b] (µg/day)	100	100	100	75	75	65	65	110 (AI, not EAR)
UL [c] (µg/day)	1100	1100	1100	600	600	300	200	B/F

Notes

a The intake for each age-gender cohort is mid-point based on assigning "not detected" results to half LOD (as explained in section 2.4). For lower and upper bound intake estimates, based on assigning ND=0 and ND=LOD, see Appendix 12.

b Estimated Average Requirement (NHMRC, 2006).

c Upper Level of intake (NHMRC, 2006).

d Nutrient Reference Values (NRV) for 11–14 year boys/girls extrapolated from values for 9–13 year children.

e NRVs for 5–6 year children extrapolated from 4–8 year children.

f NRVs for 6–12 month infants extrapolated from 7–12 month infants.

increased concentration of iodine compared with the 2003/04 NZTDS, or were major iodine contributing foods, is shown in Table 15.

Dietary intake estimates

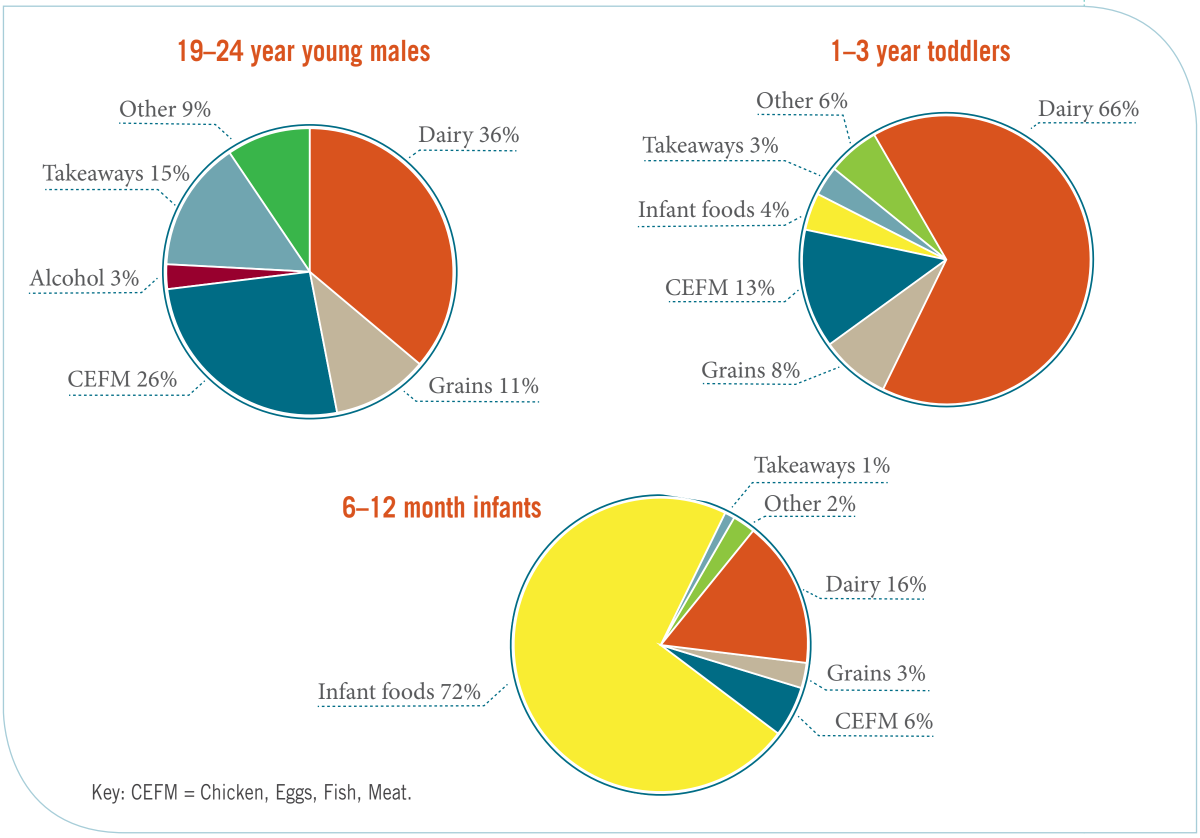
Estimated daily dietary intakes of iodine vary little between lower and upper bounds (Appendix 12). Mid-point (LOD/2) mean estimates of iodine intake in each age-gender cohort are shown in Table 16.

The mean iodine intake for each age-gender cohort was below the EAR, reflecting an inadequate iodine intake for more than 50% of each age-gender cohort. With the exception of the 6–12 month infants, mean iodine intakes were comparable with those reported in the 2003/04 NZTDS (Figure 23). Iodine intake for the 6–12 month infants (66 µg/day, Table 16), showed a 12% increase from that of 2003/04 (49 µg/day), due to the increase in mean iodine content of infant and follow-on formula between the two studies.

It is important to note that consistent with previous NZTDSs, the 2009 NZTDS did not take into account the addition of discretionary (iodised) salt used either during cooking, or added at the table.

Figure 22 shows that a combination of dairy foods, other animal sources (eggs, mussels, fresh fish and oysters), and takeaways (meat pie, hamburger, Chinese dish, and pizza) provided the

Figure 22: Major iodine contributing food groups (2009 NZTDS)

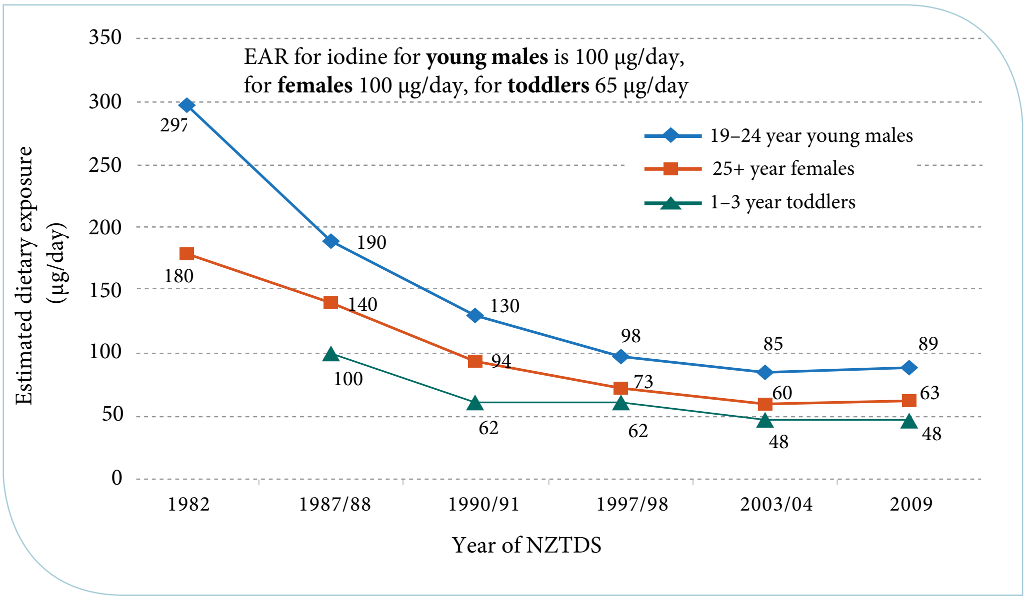


majority of iodine in the diet of 19–24 year young males. A similar pattern was observed for 25+ year males and females and 11–14 year boys and girls (not shown), although only 25+ year males and 19–24 year young males gain 3% of iodine intake from beer consumption. Dairy foods (66%) still make the most significant contribution to iodine intake for 1–3 year toddlers. Intake of iodine for 6–12 month infants is totally dominated by infant foods, specifically infant and follow-on formula, for which the mean iodine content has increased considerably from 0.079 mg/kg in 2003/04 to 0.133 mg/kg in the 2009 NZTDS. This is also consistent with mean iodine content of 0.112 mg/kg in infant formula (n=32) (Cressey, 2008).

Intake estimates from the NZTDSs (Figure 23), which are based on simulated typical diets, show that for the first time since 1982 that iodine intakes for all age-gender cohorts have either stopped decreasing or plateaued.

Estimated mean dietary iodine intakes (using simulated diets) in New Zealand are low compared with data from international studies. The estimated mean daily intakes of 89 and 63 µg/day for 19–24 year young males and 25+ year females, respectively in the 2009 NZTDS are about two thirds of mean daily iodine intakes of 134 µg/day for 19–29 year males and 93 µg/day for 30–49 year females reported in the 22nd Australian TDS (FSANZ, 2008). Similarly, the iodine intake of New Zealanders is low compared to Danish 25+ year males and 60–65 year females, with intakes of 127 and 109 µg/day iodine respectively (Rasmussen *et al.*, 2002). The 2009 NZTDS mean iodine intakes are only about one third of the 2008/09 Czech TDS adult males (233 µg/day) and females (174 µg/day) aged 18–59 years old (Ruprich, 2011). The 2007/08 US TDS 19–24 year young males (264 µg/day) and 25+ year females (222 µg/day) had even higher mean iodine intakes (Egan, 2011), while the 2007 China TDS adult males 18–45 years had the highest comparative mean iodine intakes of 425 µg/day (Li, 2011).

Figure 23: Dietary iodine intake trends



Risk characterisation

The estimated mean iodine intakes in the 2009 NZTDS were considerably lower than the EAR for all age-gender cohorts, therefore these diets indicate that iodine intake may be inadequate for more than 50% of each age-gender cohort.

The ULs for iodine range from 200 µg/day for 1–3 yr toddlers to 1100 µg/day for 19–24 year young males and 25+ year males and females (NHMRC, 2006). Since mean iodine intakes are estimated to be inadequate for each age-gender cohort, it is extremely unlikely that potential toxicity from iodine intakes is an issue in the 2009 NZTDS.

5.3.2 Selenium

Selenium is an essential dietary trace mineral. Selenium varies greatly in its soil concentration around the world and can range from <0.01 mg/kg to 1000 mg/kg, with plant food content reflecting this range. In Australia and New Zealand, the main dietary sources are seafood, poultry and eggs and, to a lesser extent, other muscle meats (NHMRC, 2006). The levels of selenium in grains and other seeds depend on the concentration of selenium in soils from which these foods are sourced. Much plant selenium is in the form of selenomethionine, selenocysteine or selenocysteine metabolites. Meats and seafoods also contain selenoproteins with selenium in the form selenocysteine (NHMRC, 2006).

Absorption of selenium from food is about 55–70% and occurs primarily in the small intestine, with selenium being equally well absorbed by selenium-deficient and selenium-loaded subjects (Levander, 1986; Whanger, 1998).

Hazard identification

Selenium functions as an antioxidant and in redox reactions and normal thyroid function via several selenoproteins. The most important are the glutathione peroxidises (GP_xs), selenoprotein P, iodothyronine deiodinases and thioredoxin reductases. Selenium is implicated both as a protective, and a risk factor for cancer (NHMRC, 2006).

Selenium requirements have been calculated for optimum plasma GP_x activity (NHMRC, 2006). More severe selenium deficiency in the diet can lead to Keshan Disease, an endemic heart disease presenting as cardiac enlargement, heart failure, arrhythmias and premature death (KDRG, 1979). This has been observed in certain regions of China where intakes are very low (3–22 µg/day; Levander and Burk, 1994). Kashin-Beck disease, a cartilage condition, may also occur in selenium-deficient areas, although it does not respond to selenium supplementation. Selenium deficiency in conjunction with iodine-deficiency has been reported to increase the risk of cretinism (NHMRC, 2006). Whilst no clinical signs of selenium deficiency have been identified in New Zealand, multiple studies indicate that the selenium status of New Zealand residents, and particularly those in the South Island, is low (Thomson, 2004).

Symptoms of selenium toxicity are brittleness and loss of hair and nails, gastrointestinal disturbance, skin rash, fatigue, irritability and nervous system abnormalities. An increased risk

of skin cancer with supplements of 200 µg/day was reported for individuals at high risk of such skin cancers (Duffield-Lillico *et al.*, 2003).

Hazard characterisation

NRVs for Australia and New Zealand have been established by the Australian National Health Medical Research Council (NHMRC, 2006). The NRVs for selenium are included in Appendix 12 for each of the age-gender cohorts of the 2009 NZTDS.

The EARs for selenium are 60 µg/day for the 25+ year males and 19–24 year young males, 50 µg/day for the 25+ year females, 40 µg/day for the 11–14 year boys and girls, 25 µg/day for the 5–6 year children, and 20 µg/day for the 1–3 year toddlers. The EARs for these cohorts were based on GP_x experimental data of Duffield *et al.*, (1999) and Xia *et al.*, 2005 (as cited in NHMRC, 2006) with correction for body weights. For the 7–12 month infants, an AI of 15 µg/day has been established based on adequate intake of breast milk with correction for body weight (NHMRC, 2006).

The UL of selenium intake from food and supplements for all adults is 400 µg/day based on a possible increased cancer risk at 200 µg/day with an uncertainty factor of two to allow for knowledge and data gaps. ULs of 280 µg/day for the 11–14 year boys and girls, 150 µg/day for the 5–6 year children, 90 µg/day for the 1–3 year toddlers and 60 µg/day for the 6–12 month infants were estimated on a body weight basis from a No Observable Adverse Effect Level (NOAEL) of 47 µg/day for a breastfed infants (NHMRC, 2006) with correction for body weight.

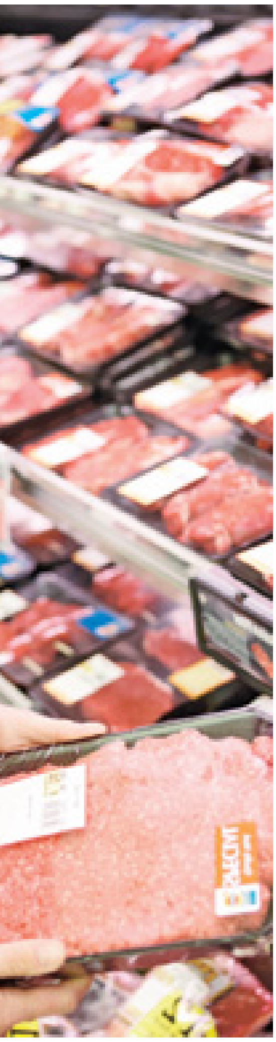


Table 17: Selenium concentration trends

Food (n)	Mean selenium concentrations (mg/kg) 1997/98 [a] NZTDS	2003/04 [b] NZTDS	2009 [c] NZTDS	2004 [d] ATDS
Bread, white (4 NI, 4 SI)	0.094 (NI) 0.025 (SI)	0.066 (NI) 0.005 (SI)	0.111 (NI) 0.026 (SI)	0.113
Wheat biscuit cereals (8)	0.033	0.031	0.199	NS
Milk, whole (8)	0.014	0.007	0.006	0.008
Egg, boiled (8)	0.391	0.269	0.240	0.240
Chicken nuggets (8)	0.163	0.109	0.094	NS
Pork chops (8)	0.165	0.137	0.167	0.335
Beef mince (8)	0.072	0.057	0.061	0.150 [e]
Lamb/mutton (8)	0.103	0.053	0.058	0.166
Fish fingers (8)	0.253	0.255	0.285	0.290
Peanut butter (8)	0.086	0.129	0.060	0.183

Notes
NS = Not sampled.
n = Number of samples.
NI = North Island.
SI = South Island.
a Vannoort *et al.*, 2000.
b Vannoort and Thomson, 2005b.
c This study.
d FSANZ, 2008.
e Beef steak.

Dietary exposure assessment

Prevalence/concentrations

The concentrations of selenium in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). These data have now been consolidated in Appendix 11.2 of this report, detailing the minimum, maximum and arithmetic mean concentrations of selenium for the foods analysed in the 2009 NZTDS.

Table 17 summarises comparative data for some of the key individual foods contributing to selenium intake estimates between the current study, former NZTDSs, and the 22nd ATDS (FSANZ, 2008). The table shows that white bread and wheat biscuit cereals have increased since the 2003/04 NZTDS, probably reflecting greater use of imported grain. Eggs, chicken, and peanut butter have lower concentrations than 2003/04, while most other foods are consistent with 1997/98 or 2003/04 levels. The selenium concentrations for the 2009 NZTDS foods are generally lower than concentrations reported for Australian foods, particularly pork, beef, lamb/mutton and peanut butter (Table 17).

The selenium content of white breads (Table 17) shows a geographical difference, with South Island breads continuing to have less selenium than North Island breads (Vannoort *et al.*, 2000; Vannoort and Thomson 2005b). This is consistent with most of the grain used in the South Island being domestically grown, under low selenium soil conditions. Following deregulation of New Zealand's grain industry in the 1980s, North Island breads are likely to contain more imported grain from Australia or North America, with their higher selenium contents. White breads sampled in the North Island during the 2009 NZTDS have a mean selenium content (0.111 mg/kg) consistent with the white breads in the 22nd (2004) ATDS (0.113 mg/kg; FSANZ, 2008), whereas South Island white bread is much lower (0.026 mg/kg).

Dietary intake estimates

Lower, mid-point and upper bound estimated daily dietary intakes of selenium are given in Appendix 12, and vary little between lower and upper bounds. Table 18 summarises the mid-

Table 18: Dietary selenium intakes

	25+ yr males	25+ yr females	19–24 yr young males	11–14 yr boys [d]	11–14 yr girls [d]	5–6 yr children [e]	1–3 yr toddlers	6–12 month infants [f]
2009 NZTDS [a]	78	56	82	70	51	41	26	21
EAR [b] (µg/day)	60	50	60	40	40	25	20	15 (AI)
UL [c] (µg/day)	400	400	400	280	280	150	90	60

Notes

a The intake for each age-gender cohort is mid-point based on assigning "not detected" results to half LOD (as explained in section 2.4). For lower and upper bound intake estimates, based on assigning ND=0 and ND=LOD, see Appendix 12.
b Estimated Average Requirement (NHMRC, 2006).
c Upper Level of intake (NHMRC, 2006).
d Nutrient Reference Values (NRV) for 11–14 year boys/girls extrapolated from values for 9–13 year children.
e NRVs for 5–6 year children extrapolated from 4–8 year children.
f NRVs for 6–12 month infants extrapolated from 7–12 month infants.

Figure 24: Major selenium contributing food groups (2009 NZTDS)

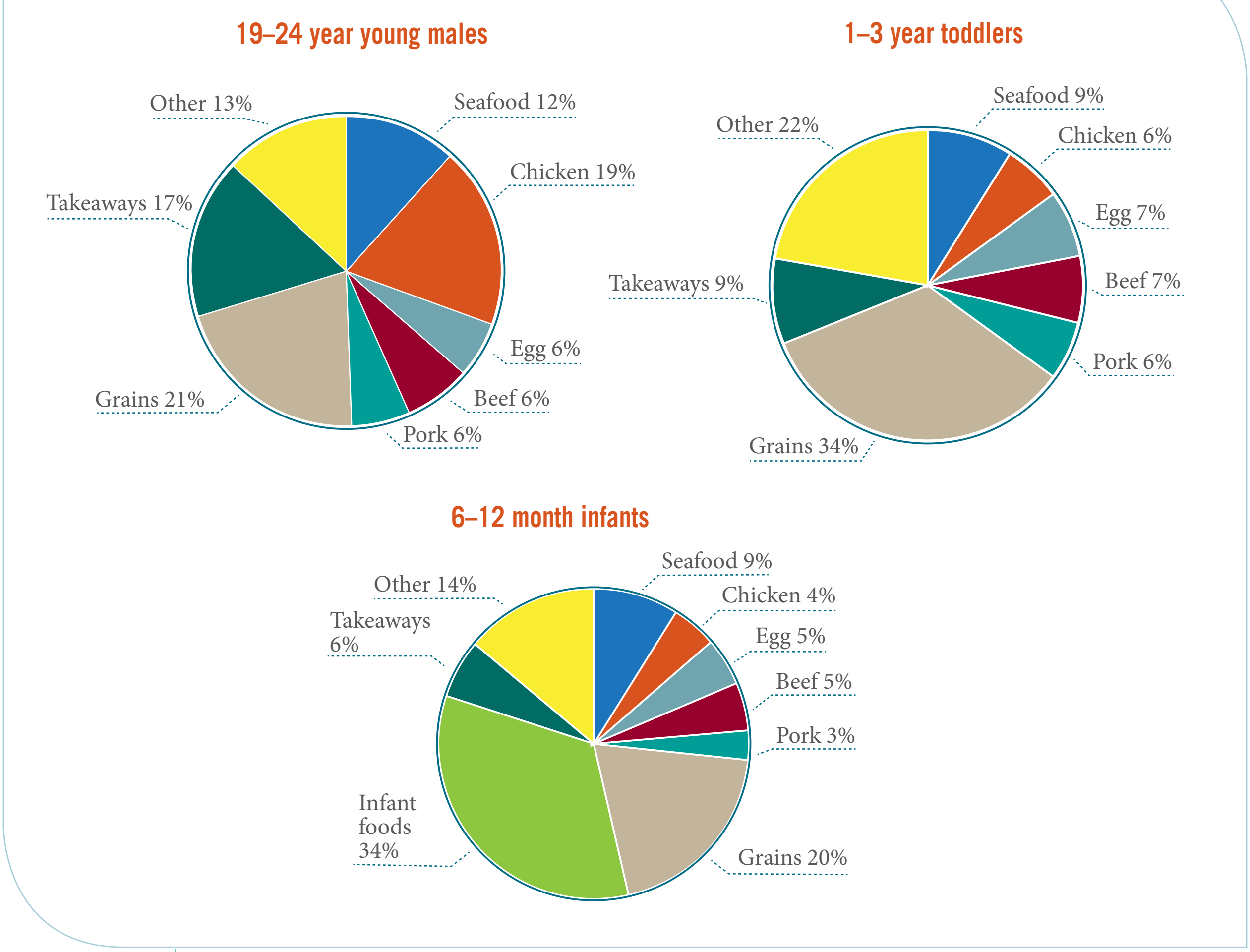
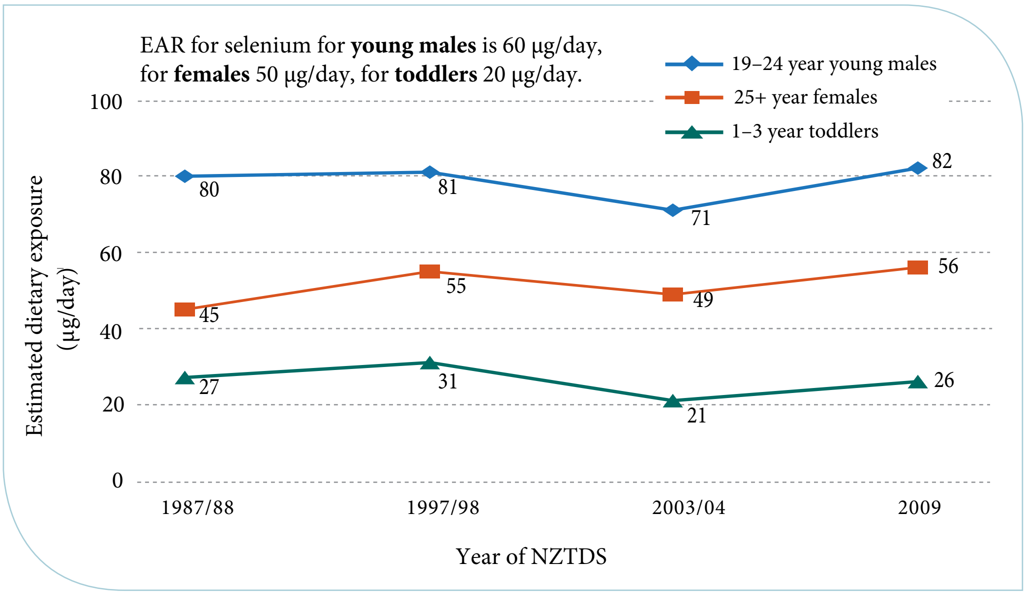


Figure 25: Selenium intake trends



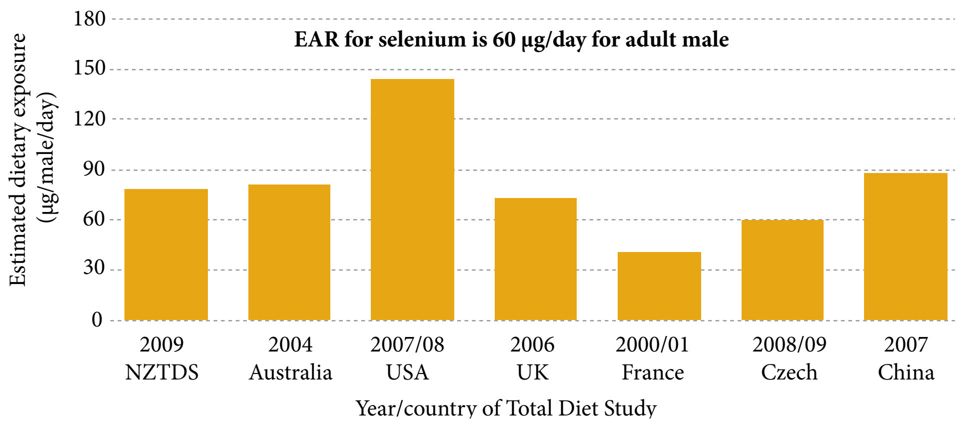
point (based on ND=LOD/2) estimated intakes of selenium for all age-gender cohorts in the 2009 NZTDS, along with the relevant NRVs.

Grain products, seafood, chicken, eggs, beef and pork provide the majority of selenium in the diets of all age-gender cohorts in the 2009 NZTDS, except for 6–12 month infants for whom infant weaning foods contribute 34%. Figure 24 identifies the key sources of selenium in the diets of 19–24 year young males, 1–3 year toddlers and 6–12 month infants. The distribution of foods providing selenium in the diet of the 19–24 year young males is also representative of the 25+ year males and 25+ year females. Adolescent boys and girls (11–14 years) show higher contributions from white bread and chicken than their adult (19–24 and 25+ year) counterparts, reflecting their preference for these foods. Animal feed and supplements include selenium and that accounts for eggs and meats as a key contributor to selenium intake.

Figure 25 shows estimates of selenium intake from four NZTDSs for the 19–24 year young males, 25+ year females and 1–3 year toddler age-gender cohorts. Across each population cohort, selenium intakes have been relatively consistent over a 20-year period. Changes in simulated diets over this period have likely been offset by the differing importations of wheat from areas richer in selenium (Winterbourn *et al.*, 1992; Thomson and Robinson, 1996), and the use of livestock supplements (Vannoort *et al.*, 2000).

The estimated dietary selenium intake for 25+ year males in the 2009 NZTDS is moderate when compared to adult males in overseas studies (Figure 26). Mean intakes of selenium for the Australian population cohorts are similar to those for New Zealand's cohorts, with the exception of Australian toddlers and infants, who have higher mean selenium intakes than their New Zealand counterparts (FSANZ, 2008). The USA has much higher dietary selenium intakes than New Zealand, with 137–150 µg/day for 25+ year US males and 65–70 µg/day for their two-year toddlers (Egan, 2011). By assuming average body weights of 82 kg and 13 kg for

Figure 26: Comparative dietary selenium intakes (25+ year males)



Note: The intake for Australian males is for the 30–49 year males, older males consume less selenium. UK value is for both male and female cohorts.

adults and toddlers respectively, the UK 2006 TDS resulted in a mean daily intake of selenium of approximately 73 µg/day for 19–64 year adults, and 27 µg/day for 1.5–4.5 year toddlers (Rose *et al*., 2010). New Zealand intakes are higher than those reported for the 50th percentile of consumers in the first French TDS, where intakes were 40 µg/day for 15+ year adults and 30 µg/day for 3–14 year children (Leblanc *et al*., 2005). A daily intake of 60 µg/day has been reported for 18–59 year males and 35 µg/day for females of the same age in the Czech Republic (Ruprich, 2011), and 88 µg/day for 18 year males in the 2007 China TDS (Li, 2011).

Risk characterisation

Estimated mean daily intakes of selenium are above the EAR for each of the age-gender cohorts in the 2009 NZTDS, suggesting that more than half of each cohort is likely to have an adequate selenium intake.

An intake of up to 400 µg/day selenium is considered safe for adults, with correspondingly lower UL for younger people (NHMRC, 2006). The 2009 NZTDS confirms that selenium intakes are unlikely to constitute a toxicity problem for any of the New Zealand age-gender cohorts.

5.3.3 Sodium

Sodium is an essential dietary mineral. Sodium occurs naturally in food or is added, as sodium chloride (salt), sodium bicarbonate, monosodium glutamate, sodium phosphate, sodium carbonate, and sodium benzoate (NRC, 1989; NHMRC, 2006).

Salt accounts for about 90% of total sodium intake for countries like New Zealand and Australia and may be added to processed foods, at the time of cooking or at the table (Fregly, 1984; Mattes and Donnelly, 1991).

Hazard identification

Sodium is the principal cation in extracellular fluid. Its physiological roles are closely linked to those of potassium and include the maintenance of extracellular fluid volume, acid-base balance, the active transport of molecules across cell membranes, transmission of nerve impulses, and the contraction of muscles (Mann and Truswell, 1998; NHMRC, 2006).

Sodium levels in the body are maintained by the kidneys (Mann and Truswell, 1998).

The major adverse effect of increased sodium intake is elevated blood pressure, a risk factor for cardiovascular and renal diseases. Blood pressure increases progressively in a dose-dependent relationship with sodium intake (NHMRC, 2006). People with hypertension, diabetes and chronic kidney disease, and older-age persons, tend to be more susceptible to increased blood pressure from sodium intake (NHMRC, 2006) and are therefore

likely to benefit by not consuming excessive dietary sodium (NRC, 1989). Cardiovascular disease is a leading cause of death in New Zealand (MoH, 1999).

Hazard characterisation

In the absence of sufficient data to set EARs for sodium, an AI of 460–920 mg/day was set for adults to ensure basic requirements are met and to allow adequate intakes of other nutrients. Children and adolescent AIs were derived from adult values, with adjustment for relative energy intakes (NHMRC, 2006).

An UL for adults of 2300 mg/day is based on population studies showing low levels of hypertension (less than 2%) in communities with sodium intakes below 1600 mg/day, in addition to experimental studies that show an additional reduction in blood pressure at intakes of 1500 mg/day compared with 2500 mg/day in people on a control diet (NHMRC, 2006).

Dietary exposure assessment

Prevalence/concentrations

The concentrations of sodium in individual foods of the 2009 NZTDS have been previously presented (Vannoort, 2009b; NZFSA, 2009a, b, 2010b). This data has now been consolidated in Appendix 11.3 of this report, detailing the minimum, maximum and arithmetic mean concentrations of sodium for the foods analysed in the 2009 NZTDS.

The concentration of sodium in the 123 foods of the 2009 NZTDS ranged from <10 to 35,000 mg/kg, with the highest level measured in a yeast extract. Mean sodium concentrations varied markedly between and within food groups. The lowest sodium concentrations were generally in the fruit, vegetable and infant weaning food groups. It is also apparent that much higher mean sodium concentrations are found in processed compared with unprocessed foods. For example, tomatoes contained 9 mg/kg sodium, whereas tomato sauce contained a mean of 8332 mg/kg. Similarly, pork chops contained 908 mg/kg sodium, while bacon contained a mean of 16,910 mg/kg; and whole milk 352 mg/kg, with cheese a mean of 6747 mg/kg sodium.

Dietary intake estimates

Lower, mid-point and upper bound sodium dietary intake estimates for the eight age-gender cohorts are included in Appendix 12, and mid-point estimates (based on ND=LOD/2) are summarised in Table 19, along with the relevant NRVs.

The daily intake estimates in Table 19 include only sodium inherent in the food and sodium added in processing, but not discretionary salt. Sodium inherent in foods has been estimated to contribute about 12%, and sodium from processing 65–70% of total sodium intake (UK SACN, 2003; Mattes and Donnelly, 1991). Discretionary salt added at the time of cooking or at the table has been estimated to account for 5–20% of total sodium intake (Anderson *et al.*, 2010; Reinivuo *et al.*, 2006; UK SACN, 2003; Mattes and Donnelly, 1991). Hence, if discretionary salt is included, sodium intake may be up to 20% higher than the values given in Table 19.

Table 19: Dietary sodium intakes

	25+ yr males	25+ yr females	19–24 yr young males	11–14 yr boys [d]	11–14 yr girls [d]	5–6 yr children [e]	1–3 yr toddlers	6–12 month infants [f]
2009 NZTDS [a]	2901	2049	3405	2862	2318	1866	1306	805
AI [b] (mg/day)	460–920	460–920	460–920	400–800	400–800	300–600	200–400	170
UL [c] (mg/day)	2300	2300	2300	2000	2000	1400	1000	unable to be set

Notes

a The intake for each age-gender cohort is mid-point based on assigning "not detected" results to half LOD (as explained in section 2.4). Given almost all foods have detectable sodium and many have high concentrations, lower and upper bound intake estimates for sodium are the same as mid-point intake estimates (see Appendix 12).

b Adequate Intake range (NHMRC, 2006).

c Upper Level of intake (NHMRC, 2006).

d Nutrient Reference Values (NRV) for 11–14 year boys/girls extrapolated from values for 9–13 year children.

e NRVs for 5–6 year children extrapolated from 4–8 year children.

f NRVs for 6–12 month infants extrapolated from 7–12 month infants.

Table 20: Sodium concentration trends

	Mean sodium concentration (mg/kg)			
Food	1987/88 NZTDS	1990/91 NZTDS	2003/04 NZTDS	2009 NZTDS
Bread, white	5815	5960	5063	4542
Bread, mixed grain	NA	NA	4469	4247
Cheese	6880	6513	6304	6747
Ham	NA	NA	13,275	11,114
Hamburger	NA	NA	4745	4353
Meat pie	4462	3733	4599	4131
Milk, 3.25%	760	520	383	352
Noodles, instant	NA	NA	3074	3619
Sausages	7635	7085	7352	7035

Note

NA = Not analysed.

Figure 27: Major sodium contributing food groups (2009 NZTDS)

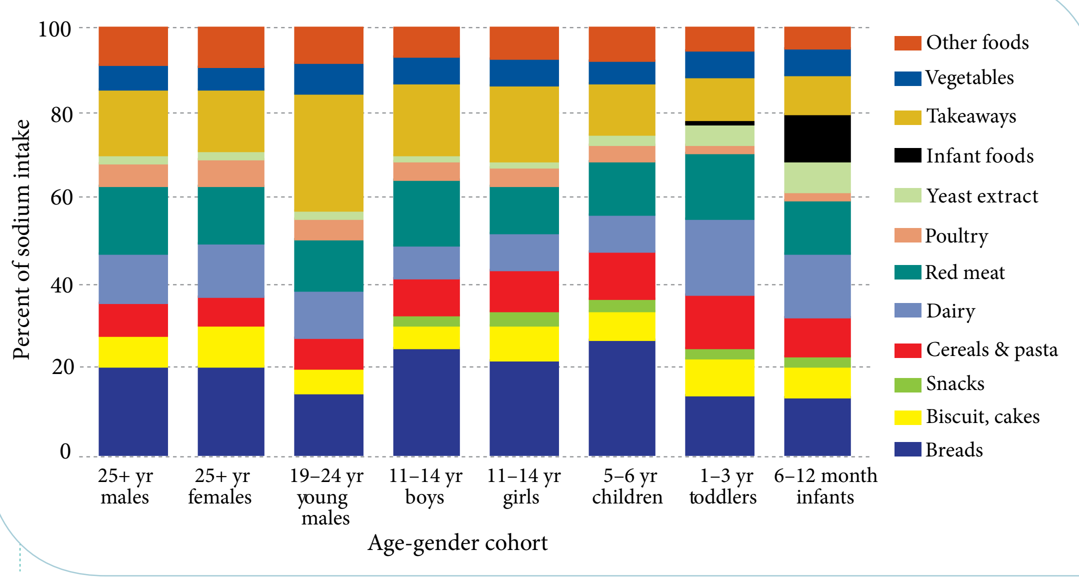


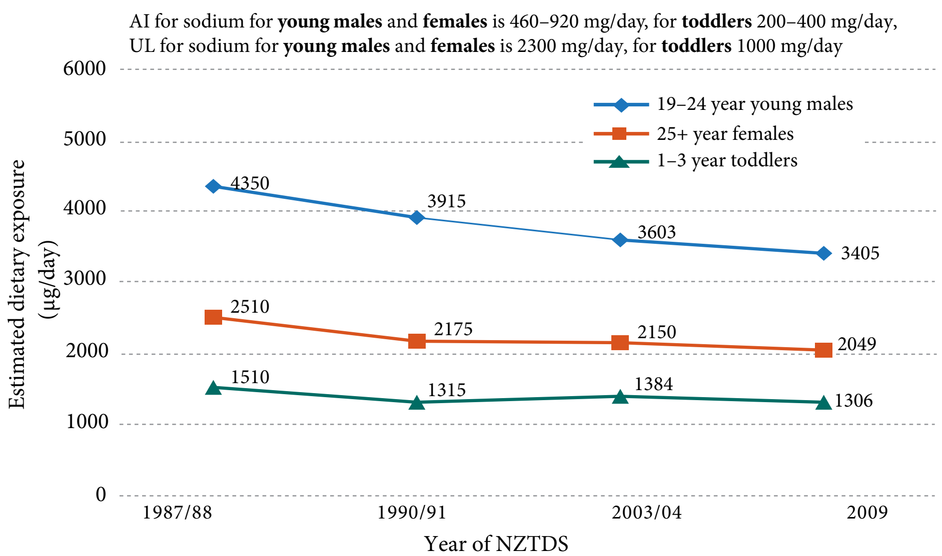
Figure 27 shows the distribution of foods and food groups contributing to sodium intake for all the eight population cohorts. The greatest individual food contributor to sodium intake is bread, accounting for 14–27% across all eight cohorts, followed by processed red meats (corned beef, sausages, bacon and ham) contributing 11–16% of total sodium intake. Grain products collectively account for 27–48% of sodium intake, similar to the estimate of 35% from the UK but higher than the 20% reported for the USA (Anderson *et al*., 2010). Takeaways also make a significant contribution to sodium intake in the 2009 NZTDS (ranging from 9% for infants to 28% for the 19–24 year young males). Given that the majority of sodium intake is from processed foods, these remain the most likely foods to target for sodium reduction.

Sodium concentrations in foods that contributed more than 5% to total sodium intake in the 2009 NZTDS for any of the age-gender population cohorts are shown in Table 20, with comparative concentration data from the 1987/88 (ESR/MoH, 1994), 1990/91 NZTDS (Hannah *et al.,* 1995) and 2003/04 NZTDS (Vannoort and Thomson, 2005b).

The sodium content of white bread, mixed grain bread, ham, hamburgers, whole milk and sausages are all lower than the last NZTDS, whereas the sodium concentration of instant noodles is up from the last NZTDS, as it is also in cheese, with the latter levels comparable to those in the 1987/88 NZTDS. Since 1987/88, the mean sodium content of New Zealand staples such as white bread and milk have dropped by 22% and 54%, respectively.

The trends for mean daily intake of sodium over the period from 1987/88 to 2009 are shown in Figure 28. Since 1987/88, sodium intakes have decreased by 22, 18, and 14% for young males, females, and toddlers, respectively. Since the last NZTDS in 2003/04, sodium intakes for the same age-gender cohorts have decreased by 5, 5, and 6%, respectively.

Figure 28: Sodium intake trends



Note
Sodium was not analysed in the 1997/98 NZTDS.

Internationally, sodium intakes have ranged from less than 200 mg/day for the Yanomamo Indians of Brazil, to over 10,300 mg/day in Northern Japan (Rose *et al.*, 1988; NRC, 1989). More recent estimates of average sodium intakes for men and women aged 40–59 years in the UK, the USA, and Japan were 3406, 3660, and 4651 mg/day respectively (Anderson *et al.*, 2010). Approximately 30% of the USA estimate was from salt added at restaurants, to fast foods and in the home. In the Czech Republic TDS of 2008/09, sodium intake for 18–59 year adult males was 3851 mg/day and for same age females, 2495 mg/day (Ruprich, 2011). China had the highest sodium intake of 6068 mg/day, for its 18–45 year males, and reflects that salt is also used extensively during cooking (Li, 2011). This comparative data for dietary sodium for 25+ year males and females from the 2009 NZTDS and overseas is summarised in Table 21. New Zealand mean sodium intakes are lower when compared with international studies.

Risk characterisation

Mean daily sodium intakes were significantly above the AI for all eight age-gender cohorts in the 2009 NZTDS, and exceeded the UL for 25+ year males, 19–24 year young males, 11–14 year boys and girls, 5–6 year children and 1–3 year toddlers by up to 48% for the average consumer. This excludes any contribution from discretionary salt use during cooking or at table for taste, which could add up to 20% to sodium intakes.

High consumer (95th percentile) intake of sodium can be approximately twice that of an average consumer across the diet (FAO/UNEP/WHO, 1985), potentially resulting in sodium intakes up to 6800 mg/day for the 19–24 year young males, close to three times the UL.

Table 21: Comparative dietary exposures to sodium

Intake (mg/day)	2009 NZTDS [1]	USA [a]	UK [a, 2]	Japan [a]	Czech [b]	China [c]
Intake (age-gender)	2901 (25+ yr males) 2049 (25+ yr females)	3660 (adult)	3406 (adult)	4651 (adult)	3851 (18–59 yr males) 4952 (18–59 yr females)	6068 (18–45 yr males)

Notes

a Anderson *et al.*, 2010.
b 2008/09 data, Ruprich, 2011.
c 2007 data, Li, 2011.

1 Excludes table and cooking salt.
2 Excludes table salt.

CONCLUSIONS 6

The 2009 NZTDS enables New Zealand's food safety regulators to:

» assess the actual concentrations of certain chemical compounds in the New Zealand foods as "normally consumed";

» indicate any potential exposure concerns, identify key contributing food groups or foods to those exposures, and thus helps target any necessary risk management or risk communication;

» demonstrate trends in dietary exposure; and

» make comparisons with exposure estimates derived in other countries.

The NZTDS has shown that dietary exposures to agricultural compounds are well below their respective ADIs. Given that ADIs are based on the No Observed Adverse Effect Level in animals and has large additional safety factors built in for humans (generally 100–1000), exposures at the ADI represent insignificant risk (WHO, 1997b). Estimated dietary exposures to the agricultural compounds for all age-gender cohorts in the 2009 NZTDS are therefore unlikely to represent a risk to public health.

Dietary exposure to the contaminant elements cadmium, mercury and methylmercury are also below international health standards, such as the PTWI or PTMI. In the absence of such standards for total arsenic, inorganic arsenic or lead, and given consistency of the 2009 NZTDS findings with the previous NZTDS, international thinking would be that our dietary exposures to these contaminants are unlikely to represent a significant risk to public health. While these contaminants are naturally ubiquitous and cannot be avoided, it remains important to keep such dietary exposures ALARA.

The mean daily intakes of iodine in New Zealand have steadily declined over the past 20 years, but appear to have levelled off in the 2009 NZTDS. The estimated mean iodine intake for each age-gender cohort in the 2009 NZTDS was below the EAR, reflecting an inadequate iodine intake for more than 50% of each age-gender cohort. Intakes in New Zealand from the 2009

NZTDS data remain low compared with intakes in Australia, Denmark, the Czech Republic and China. Conversely, sodium intakes exceeded ULs for most of the population. The 2009 NZTDS has shown selenium intakes are adequate, although geographical differences may exist depending on source of grain used for breads.

It should be noted that dietary exposures in the 2009 NZTDS were based on average energy diets for each of the age-gender cohorts. High percentile consumers have the potential to have significantly higher exposures. This may be relevant for consumers of Bluff (dredge) oysters in regards to cadmium, and especially relevant for fish consumers in regards to methylmercury, and the diet as a whole regarding sodium. Any advisories to at-risk groups regarding mercury and fish consumption should also highlight the importance of fish as part of a balanced diet.

REFERENCES 7

ADHA (Australian Department of Health and Aging). (2010). *ADI List: Acceptable Daily Intakes for Agricultural and Veterinary Chemicals.* Office of Chemical Safety and Environmental Health. ISSN 1446-1412. Current as at September 2010. Accessed 10 Nov 2010 at http://www.health.gov.au/internet/main/publishing.nsf/Content/ocs-adi-list.htm

Anderson CAM, Appel LJ, Okuda N, Brown IJ, Chan Q, Zhao L, Ueshima H, Kesteloot H, Miura K, Curb JD, Yoshita K, Elliott P, Yamamoto ME, Stamler J. (2010). Dietary Sources of Sodium in China, Japan, the United Kingdom, and the United States, Women and Men Aged 40 to 59 Years: The INTERMAP Study. *Journal of the American Dietetic Association;* 110(5): 736-745.

Anke M. (1986). Arsenic. In: Mertz W (ed). *Trace Elements in Human Nutrition and Animal Nutrition (Fifth Edition),* Volume 2. Orlando: Academic Press; 347-372.

Boobis AR, Ossendorp BC, Banasiak U, Hamey PY, Sebestyen I and Moretto A. (2008). Cumulative risk assessment of pesticide residues in food. *Toxicology Letters* 180; 137-150.

Boon PE, van der Voet H, van Raaij MTM, and van Klaveren JD. (2008). Cumulative risk assessment of the exposure to organophosphorus and carbamate insecticides in the Dutch diet. *Food and Chemical Toxicology* 46: 3090-3098.

Butcher M. (2010). Dithiocarbamate usage on apples grown in New Zealand (personal communication).

Butler ECV, Grose MR, Burrett CF, Pook M, Doyle R. (2007). *Iodine cycling in the ecosphere, and its relevance to Tasmania.* In: PAC Richards; JC Stewart (eds). Goitre monitor, The history of iodine deficiency in Tasmania. Launceston, Tasmania: Myola House of Publishing.

Clarkson TW. (1987). Mercury. In: Mertz W (ed). *Trace Elements in Human and Animal Nutrition* (Fifth Edition), Volume 1. San Diego: Academic Press; 417-428.

Codex (Codex Alimentarius Commission). (2009). J*oint FAO/WHO Food Standards. Pesticide residues in food – Maximum residue limits*. http://www.codexalimentarius.net/mrls/pestdes/jsp/pest_q-e.jsp

Cressey PJ. (2008). *Iodine in infant and toddler formula.* ESR Client Report FW08022 for NZFSA: Wellington.

Cressey PJ, Vannoort RW, Silvers K and Thomson BM. (2000). *The 1997/98 New Zealand Total Diet Survey Part 1 – Pesticide Residues.* ESR Client Report FW99/64. Wellington: MoH. ISBN 0-478-23931-9 (Internet). Accessed 15 February 2011 at http://www.moh.govt.nz/moh.nsf/0/A48868055568B2814C2568B100823CEF/$File/PesticidesFinal.pdf

Dabeka RW, McKenzie AD. (1992). Total Diet Study of Lead and Cadmium in Food Composites: Preliminary Investigations. *Journal of AOAC International;* 75(3): 386-394.

Dabeka RW, McKenzie AD, Lacroix GMA, Cleroux C, Bowe S, Graham RA, Conacher HBS, Verdier P. (1993). Survey of arsenic in food composites and estimation of the dietary intake of arsenic by Canadian adults and children. *Journal of AOAC International;* 76(1): 14-25.

Dick GL, Hughes JT, Mitchell JW, Davidson F. (1978a). Survey of trace elements and pesticide residues in the New Zealand diet: Part 1 – Trace element content. *New Zealand Journal of Science;* 21: 57-69.

Dick GL, Heenan ML, Love JL, Udy PB, Davidson F. (1978b). Survey of trace elements and pesticide residues in the New Zealand diet: Part 2 – Organochlorine and organophosphorus pesticide residue content. *New Zealand Journal of Science*; 21: 71-8.

Duffield-Lillico AJ, Slate EH, Reid ME, Turnbull BW, Wilkins PA, Combs Jr GF, Park HK, Gross EG, Graham GF, Stratton MS, Marshall JR, Clark LC. (2003). Selenium supplementation and secondary prevention of nonmelanoma skin cancer in a randomized trial. *Journal of the National Cancer Institute;* 95(19): 1477-1481.

EFSA (European Food Safety Authority). (2009). Modification of the existing MRL for dithiocarbamates, expressed as CS2. *EFSA Scientific Report* 237:1-40. http://www.efsa.europa.eu/en/efsajournal/doc/237r.pdf

EFSA (2011). Statement on tolerable weekly intake for cadmium. EFSA Panel on Contaminants in the Food Chain (CONTAM). *EFSA Journal* 2011; 9(2):1975-1994. Accessed 8 Mar 2011 http://www.efsa.europa.eu/en/efsajournal/pub/1975.htm

Egan SK, Tao SS-H, Pennington JAT, and Bolger PM. (2002). US Food and Drug Administration's Total Diet Study: Intake of nutritional and toxic elements, 1991-96. *Food Additives and Contaminants,* Vol 19, No. 2, 103-125.

Egan SK. (2005). US FDA Total Diet Study. Dietary intakes of pesticides for 2000/01 (personal communication).

Egan SK. (2011). US FDA Total Diet Study. Dietary intakes of selected contaminant and nutrient elements for 2007/08 (personal communication).

ERMA (Environmental Risk Management Authority) (2008). Endosulfan approvals revoked. http://archive.ermanz.govt.nz/news-events/archives/media-releases/2008/mr-20081215.html

ESR (Institute of Environmental Science and Research Ltd)/MoH. (1994). *The 1987/88 New Zealand Total Diet Survey.* Wellington.

FAO (Food and Agriculture Organization). (1998). Pesticide residues in food – 1997. *FAO Plant Production and Protection Paper* 145. Rome: Food and Agriculture Organization.

FAO/UNEP/WHO. (1985). GEMS (Global Environmental Monitoring System). *Guidelines for the study of dietary intake of chemical contaminants – Report of the Joint FAO/UNEP/WHO Food Contamination Monitoring Programme*, WHO Offset publication No. 87. Geneva: World Health Organization.

FAO/UNEP/WHO. (1988). GEMS (Global Environmental Monitoring System). *Assessment of Chemical Contaminants in Foo*d – Joint FAO/UNEP/WHO Food Contamination and Monitoring Programme. Geneva: World Health Organization.

FAO/UNEP/WHO. (1992). GEMS (Global Environmental Monitoring System). *Assessment of Dietary Intake of Chemical Contaminants – Joint UNEP/FAO/WHO Food Contamination Monitoring and Assessment Programme*. WHO/HPP/FOS/92.6. Geneva: World Health Organization.

FAO/WHO. (1996). Dithiocarbamates (Maneb, Zineb, Mancozeb). W*HO/FAO Data sheets on Pesticides* No. 94. WHO/PCS/DS/96.94. Geneva: World Health Organization.

FAO/WHO. (2003). Assuring food safety and quality. Guidelines for strengthening food control systems. *FAO Food and Nutrition Paper* 76. Rome: World Health Organization.

Fert Research (2010). *How much cadmium is in superphosphate?* Accessed 25 January 2010 at http://www.fertresearch.org.nz/faq/how-much-cadmium-is-in-superphosphate

Fregly MJ. (1984). Sodium and potassium. In *Nutrition Reviews' Present knowledge in Nutrition,* 5th edition. Washington, DC: The Nutrition Foundation, 1984. pp 439-458.

FSANZ (Food Standards Australia New Zealand). (2003). *The 20th Australian Total Diet Study.* Canberra: Food Standards Australia New Zealand. Accessed 25 August 2009 at http://www.foodstandards.gov.au/scienceandeducation/publications/20thaustraliantotaldietsurveyjanuary2003/

FSANZ. (2008). *The 22nd Australian Total Diet Study.* Canberra. Food Standards Australia New Zealand. ISBN 978-0-642-34561-5. Accessed 20 August 2009 at http://www.foodstandards.gov.au/scienceandeducation/publications/22ndaustraliantotaldietstudy/

Garland M, Stampfer MJ, Willet WC, Hunter DJ. (1994). The epidemiology of selenium and human cancer. In Frei B (ed). *Natural antioxidants in human health and disease.* San Diego: Academic Press; 263-286.

Grandjean P, Weihe P, White RF, Debes F, Arakai S, Yokohama K, Murata K, Sorenson N, Dahl R, Jorgensen PJ. (1997). Cognitive deficit in 7-year-old children with prenatal exposure to methylmercury. *Neurotoxicology Teratology;* 20:1-12.

Hannah ML, Vannoort RW, Pickston L. (1995). *1990/91 New Zealand Total Diet Survey, Part 3: Nutrients*. ESR Client Report FW95/8. Wellington: ESR.

Henjum S, Barikmo I, Gjerlaug AK, Mohamed-Lehabib A, Oshaug A, Arne Strand T, Torheim LE. (2010). Endemic goitre and excessive iodine in urine and drinking water among Saharawi refugee children. *Public Health Nutrition;* 13(9): 1472-1477.

Hetzel BS, Maberly GF. (1986). Iodine. In: Mertz W (ed). *Trace Elements in Human and Animal Nutrition*. Fifth Edition (Volume 2). Orlando: Academic Press; 139-208.

Hoekstra WG. (1975). *Biochemical function of selenium and its relation to vitamin E.* Federation Proceedings; 34: 2083-2089.

International Agency for Research on Cancer (IARC). (1987). *Overall evaluations of carcinogenicity.* Updating IARC Monographs Vols 1-42. Suppl 7, p 100. Accessed 13 December 2010 at http://monographs.iarc.fr/ENG/Monographs/suppl7/Suppl7.pdf

IARC (1993). Monographs on evaluation of carcinogenic risk to humans. Vol 58, p 210. *Beryllium, Cadmium, Mercury and exposures in the Glass manufacturing industry.* Accessed 29 October 2010 at http://monographs.iarc.fr/ENG/Monographs/vol58/index.php

IPCS (International Programme on Chemical Safety). (2009). *Inventory of IPCS and other WHO pesticide evaluations and summary of toxicological evaluations performed by the Joint Committee on Pesticide Residues (JMPR) through to 2009*. WHO/PCS/06.2 Geneva: World Health Organization. http://www.who.int/ipcs/publications/jmpr/introduction_edition10.pdf

Jalón M, Urieta I, Macho ML, Azpiri M. (1997). *Vigilancia de la contaminación quimica de los alimentos en la Comunidad Autónoma del Pais Vasco, 1990-1995 (Food chemical surveillance in the Basque Country, 1990-1995).* Bilbao, Spain: Servicio Central de Publicaciones del Gobierno Vasco.

Jensen A, Bro-Rasmussen F. (1992). Environmental Cadmium in Europe. *Review of Environmental Contamination and Toxicology*; 125: 101-176.

Jones JM. (1993). *Food Safety*. St. Paul: Eagan Press.

Keshan Disease Research Group (KDRG). (1979). Epidemiologic studies on the etiologic relationship of selenium and Keshan disease. *Chinese Medical Journal;* 92(7): 477-482.

Keith LH, Crummett W, Deegan J Jr. (1983). Principles of Environmental Analysis. *Analytical Chemistry;* 55: 2210-2218.

Kostial K. (1986). Cadmium. In: Mertz W (ed). *Trace Elements in Human and Animal Nutrition, Fifth Edition* (Volume 2). Orlando: Academic Press; 319-346.

Larsen EH, Pritzl G, Hansen SH. (1993). Arsenic speciation in seafood samples with emphasis on minor constituents: an investigation using high-performance liquid chromatography with detection by inductively coupled plasma mass spectrometry. *Journal of Analytical Atomic Spectrometry*; 8: 1075-1084.

Leblanc J-C, Guérin T, Noel L, Calamassi-Tran G, Volatier J-L and Verger P. (2005). Dietary exposure estimates of 18 elements from the 1st French Total Diet Study. *Food Additives and Contaminants*; 22, 624-641.

Lesperance L. (2009). *The Concise New Zealand Food Composition Tables*. 8th Edition. Palmerston North: New Zealand Institute of Plant and Food Research; Wellington: Ministry of Health. Available at http://www.crop.cri.nz/home/products-services/nutrition/foodcompdata/Concise_8_Edition.pdf

Levander OA. (1986). Selenium. In: Mertz W (ed). *Trace Elements in Human and Animal Nutrition, Fifth Edition* (Volume 2). Orlando: Academic Press; 209-280.

Levander OA, Burk RF. (1994). Selenium. In: Shils ME, Olsen JA, Shike M (eds). *Modern Nutrition in Health Disease*. Malvern PA, USA: Lea and Febiger: 242-251.

Li XW. (2011). Selected dietary exposures of 2007 Chinese TDS. Personal communication.

MAFF (Ministry of Agriculture, Fisheries and Food – United Kingdom). (1997). *Annual report of the working party on pesticide residues: 1996*. Supplement to the Pesticides Register 1997. London: MAFF.

MAFF. (1998). *Cadmium, mercury and other metals in food*. Food Surveillance Paper No. 53. London: The Stationery Office.

Mann J and Truswell S. (1998). *Essentials of human nutrition.* Oxford: Oxford University Press.

Mattes RD and Donnelly D. (1991). Relative contributions of dietary sodium sources. *Journal of the American College of Nutrition;* 19 (4): 383-393.

McKenzie J, Kjellstrom T and Sharma R. (1986). *Cadmium intake via oysters, and health effects in New Zealand: Cadmium intake, metabolism and effects in people with a high intake of oysters in New Zealand*. Project summary: EPA/600/S1-86/004. Research Triangle Park, NC: US Environmental Protection Agency.

Millour S, Noel L, Kadar A, Chekri R, Vastel C, Sirot V, Leblanc J-C, and Guerin T. (2011). Pb, Hg, Cd, As, Sb, and Al levels in foodstuffs from the 2nd French Total Diet Study. *Food Chemistry;* 126: 1787-1799.

MoH (Ministry of Health). (1999). Our health, our future. The health of New Zealanders, 1999. Wellington: Ministry of Health. http://www.moh.govt.nz/moh.nsf/pagesmh/635?Open

MoH (Ministry of Health). (2003). *NZ Food NZ Children: Key results of the 2002 National Children's Nutrition Survey.* Wellington: Ministry of Health. Available at http://www.moh.govt.nz/moh.nsf/pagesmh/4330?Open

Munoz O, Devesa V, Suner MA, Velez D, Montoro R, Urieta I, Macho ML and Jalon M. (2000). Total and Inorganic Arsenic in fresh and processed fish products. *Journal of Agricultural Food Chemistry;* 48: 4369-4376.

NHMRC (National Health and Medical Research Council). (2006). *Nutrient Reference Values for Australia and New Zealand including Recommended Dietary Intakes.* Canberra: Commonwealth of Australia. http://www.moh.govt.nz/moh.nsf/pagesmh/4678?Open

NPIC (National Pesticide Information Centre). *Chapter 15. Fungicides,* page 137. http://npic.orst.edu/RMPP/rmpp_ch15.pdf

NRC (National Research Council), Food and Nutrition Board. (1989). *Recommended dietary allowances* 10th edition. Washington, DC: National Academy Press.

NRC. (1993). *Pesticides in the diets of infants and children.* Washington: National Academy Press.

Nielsen SA, Nathan A. (1975). Heavy metal levels in New Zealand molluscs. *New Zealand Journal of Marine and Freshwater Research*; 9(4): 467-81.

Nordberg M, Nuottaniemi I, Cheiran MG, Nordberg GF, Kjellstrom T, and Garvey JS. (1986). Characterisation studies on the cadmium-binding proteins from two species of New Zealand oysters. *Environmental Health Perspectives,* Vol 65, 55-62.

NZFSA (New Zealand Food Safety Authority). (2004). *Source of lead-contaminated cornflour traced*. Accessed 17 Febryary 2011 at http://www.foodsafety.govt.nz/elibrary/industry/Source_Lead-Nzfsa_Confident.htm

NZFSA. (2008). *Food List in Agreed Outline and Content of 2009 New Zealand Total Diet Study.* Accessed 25 February 2011 at http://www.foodsafety.govt.nz/elibrary/industry/Agreed_Outline-Presents_Final.pdf

NZFSA. (2009a). *2009 New Zealand Total Diet Study Analytical Results – Q2.* September 2009. ISBN number 978-0-478-32299-6. Accessed 8 March 2011 http://www.foodsafety.govt.nz/elibrary/industry/2009_Zealand-Quarter_2.pdf

NZFSA. (2009b). *2009 New Zealand Total Diet Study Analytical Results – Q3.* December 2009. ISBN number 978-0-478-33709-9. Accessed 8 March 2011 at http://www.foodsafety.govt.nz/elibrary/industry/2009_Zealand-Quarter_3.pdf

NZFSA. (2010a). *2009 New Zealand Total Diet Study: simulated diet review.* ISBN number 978-0-478-33719-8 (online). Accessed on 8 March 2011 at http://www.foodsafety.govt.nz/elibrary/industry/2009_Zealand-Primary_Objective.pdf

NZFSA. (2010b). *2009 New Zealand Total Diet Study Analytical Results – Q4.* March 2010. ISBN 978-0-478-33720-4 (online). Accessed 8 March 2011 at http://www.foodsafety.govt.nz/elibrary/industry/2009_Zealand-Quarter_4.pdf

Pickston L, Brewerton HV, Drysdale JM, Hughes JT, Smith JM, Love JL, Sutcliffe ER, Davidson F. (1985). The New Zealand diet: a survey of elements, pesticides, colours, and preservatives. *New Zealand Journal of Technology;* 1: 81-89.

Pickston L, Vannoort RW. (1995). *Compliance Report on the Foods of the 1990/91 New Zealand Total Diet Survey*. ESR Client Report FW 95/5. Wellington: ESR.

Quarterman J. (1986). Lead. In: Mertz W (ed). *Trace Elements in Human and Animal Nutrition, Fifth Edition* (Volume 2). Orlando: Academic Press; 281-318.

Rasmussen LB, Ovesen L, Bülow I, Jørgensen T, Knudsen N, Laurberg P, Perrild H. (2002). Dietary iodine intake and urinary iodine excretion in a Danish population: Effect of geography, supplements and food choice. *British Journal of Nutrition;* 87(1): 61-69.

Reilly C. (1991). *Metal Contamination of Food, Second Edition.* London: Elsevier Science Publications Ltd.

Reinivuo H, Valsta LM, Laatikainen T, Tuomilehto J, Pietinen P. (2006). Sodium in the Finnish diet: II trends in dietary sodium intake and comparison between intake and 24-h excretion of sodium. *European Journal of Clinical Nutrition;* 60(10): 1160-1167.

Rose G, Stamler J, Stamler R, Elliott P *et al.* (1988). Intersalt: An international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. *British Medical Journal;* 297: 319-328.

Rose M, Baxter M, Brereton N and Baskaran C. (2010). Dietary exposure to metals and other elements in the 2006 UK Total Diet Study and some trends over the last 30 years. *Food Additives and Contaminants;* 27 (10), 1380-1404.

Ruprich J, Dofkova M, Resova, D, Rehurkova, I. *et al.* (2000). *Food basket for the Czech Republic.* 1. edition, Prague: SZU Prague, 2000, ISBN 80-7071-166-3.

Ruprich J. (2011). Selected exposures from 2008/09 Czech TDS. Personal communication. Department of Food Safety and Nutrition, National Institute of Public Health, Czech Republic.

Russell DG, Parnell WR, Wilson NC *et al.* (1999). *NZ Food: NZ People. Key results of the 1997 National Nutrition Survey.* Ministry of Health: Wellington.

Shamlaye CF, Marsh DO, Myers GJ, Cox C *et al.* (1995). The Seychelles child development study on neurodevelopmental outcomes in children following *in utero* exposure to methylmercury from a maternal fish diet: Background and demographics. *Neuro Toxicology;* 16: 597-612.

Shang XH, Li XW, Zhang L, Zhao YF and Wu YN. (2010). *Food Additives and Contaminants: Part B.* Vol 3, No 4, December 2010, 236-245.

Skeaff SA, Thomson CD, Gibson RS. (2002). Mild iodine deficiency in a sample of New Zealand schoolchildren. *European Journal of Clinical Nutrition;* 2002;56:1169-75.

Skeaff SA, Ferguson EL, McKenzie JE, Valeix P, Gibson RS, Thomson CD. (2005). Are breast-fed infants & toddlers in New Zealand at risk of iodine deficiency? *Nutrition;* 21:325-31.

Sirot V, Guérin T, Mauras Y, Garraud H, Volatier J-L, and Leblanc J-C. (2008). Methylmercury exposure assessment using dietary and biomarker data among frequent seafood consumers in France CALIPSO study. *Environmental Research* 107; 30-38.

Smith NM, Lee R, Heitkamper DT *et al.* (2006). Inorganic arsenic in cooked rice and vegetables from Bangladeshi households. *Science of the Total Environment;* 370: 294-301.

Soh P, Ferguson EL, McKenzie JE, Skeaff S, Parnell W, Gibson RS. (2002). Dietary intakes of 6–24-month-old urban South Island New Zealand children in relation to biochemical iron status. *Public Health and Nutrition;* 5(2): 339-346.

Stevenson CD. (1990). Dietary Lead Intakes. In: Hay JE, Mora S de (eds). *Symposium on Lead in the New Zealand Environment*: 102-116.

Sutcliffe E. (1990). Iodine in New Zealand milk. *Food Technology in New Zealand;* 32-38.

Tam GKH, Charbonneau SM, Bryce F, Sandi E. (1982). Excretion of a single oral dose of fish-arsenic in man. *Bulletin of Environmental Contamination and Toxicology;* 28: 669-673.

Tang ASP, Kwong KP, Chung SWC, HO YY and Xiao Y. (2009). Dietary exposure of Hong Kong school students to total mercury and methylmercury from fish intake. *Food Additives and Contaminants: Part B.* Vol 2 No 1, June 2009, 8-14.

Tao SSH, Bolger PM. (1998). Dietary arsenic intakes in the United States: FDA Total Diet Study, September 1991–December 1996. *Food Additives and Contaminants;* 16 (11): 465-472.

Thomson BM, Vannoort RW, Haslemore RM. (2008). Dietary exposure and trends of exposure to nutrient elements iodine, iron, selenium and sodium from the 2003-4 New Zealand Total Diet Survey. *British Journal of Nutrition;* 99:614-25.

Thomson CD. (2003). The declining iodine status of New Zealanders: Reasons, consequences and possible solutions. *Proceedings of the Nutrition Society of New Zealand;* 28: 35-42.

Thomson CD. (2004). Selenium and iodine intakes and status in New Zealand and Australia. *British Journal of Nutrition;* 91(5): 661-672.

Thomson CD, Colls AJ, Conaglen JV, Macormack M, Stiles M, Mann J. (1997). Iodine status of New Zealand residents as assessed by urinary iodide excretion and thyroid hormones. *British Journal of Nutrition;* 78(6): 901-912.

Thomson CD, Packer MA, Butler JA, Duffield AJ, O'Donaghue KL, Whanger PD. (2001). Urinary selenium and iodine during pregnancy and lactation. *Journal of Trace Elements in Medicine and Biology;* 14(4): 210-217.

Thomson CD, Robinson MF. (1996). The changing selenium status of New Zealand residents. *European Journal of Clinical Nutrition;* 50(2): 107-114.

UK DoH (United Kingdom Department of Health). (1991). Report on Health and Social Subjects 41: Dietary Reference Values for Food Energy and Nutrients for the United Kingdom: *Report of the Panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy.* London: HMSO.

UK SACN (United Kingdom Scientific Advisory Committee on Nutrition). (2003). Salt and Health. Norwich: *The Stationery Office.* http://www.sacn.gov.uk/pdfs/sacn_salt_final.pdf

US EPA (United States Environmental Protection Agency). (1991). *Integrated Risk Information System Substance Profile – Lead and compounds (inorganic).* 1A. Reference dose for chronic oral exposure (RfD). Accessed 6 August 2009 at http://www.epa.gov/iris/subst/0277.htm.

US EPA. (2011). *Types of Pesticides*. Accessed 20 February 2011 at http://www.epa.gov/pesticides/about/types.htm

Vannoort RW, Hannah ML, Pickston L, Fry JM. (1995a). 1990/91 New Zealand Total Diet Survey, Part 1: Pesticide Residues. *ESR Client Report* FW 95/6. Wellington: MoH.

Vannoort RW, Hannah ML, Pickston L, Fry JM. (1995b). 1990/91 New Zealand Total Diet Survey, Part 2: Contaminant Elements. *ESR Client Report* FW 95/7. Wellington: MoH.

Vannoort RW, Cressey PJ, Silvers K. (2000). 1997/98 New Zealand Total Diet Study Part 2: Elements. *ESR Client Report* FW99/47. Wellington: MoH. ISBN 0-478-23929-7 (Internet). http://www.moh.govt.nz/moh.nsf/pagesmh/975?Open

Vannoort RW. (2001). Cadmium in selected New Zealand foods. *ESR Client Report F*W01/42. Christchurch: ESR.

Vannoort RW and Thomson BM. (2005a). *2003/04 New Zealand Total Diet Survey. Agricultural Compound Residues, Selected Contaminants and Nutrients.* Wellington: NZFSA. At http://www.foodsafety.govt.nz/science/research-projects/total-diet-survey/2003-2004.htm

Vannoort RW and Thomson BM. (2005b). *Auxiliary data for the 2003/04 New Zealand Total Diet Survey.* Wellington: NZFSA. Available at http://www.foodsafety.govt.nz/science/research-projects/total-diet-survey/2003-2004.htm

Vannoort RW. (2009a). *2009 New Zealand Total Diet Study Procedures Manual.* Revised 6 January 2009. ESR Client Report FW08/102. Wellington: NZFSA.

Vannoort RW. (2009b). *2009 New Zealand Total Diet Study Analytical Results – Q1.* August 2009. ESR Client Report FW0977. Wellington: NZFSA. Available at http://www.foodsafety.govt.nz/elibrary/industry/2009_Zealand-Quarter_1.pdf

Walker J, Manktelow D, Gumsey S, Stevens *et al.* (2005). *Trends in Pesticide Use in New Zealand*: 2004. Accessed 8 March 2011 at http://archive.ermanz.govt.nz/news-events/archives/presentations/JimWalker05.pdf

Watson P, Rush E, Wall C *et al.* (2001). *Development & pretesting of methodologies for the children's nutrition survey*. Report 3 Validation report. Wellington: Ministry of Health.

Weber J. (1997). *Feeding children: mothers' feeding decisions and the diets of their children from birth to two years.* PhD Thesis. Auckland: Massey University.

Whanger PD. (1998). Metabolism of selenium in humans. *Journal of Trace Elements in Experimental Medicine;* 11(2-3): 227-240.

WHO (World Health Organization). (1967). Tenth report of the Joint FAO/WHO Expert Committee on Food Additives. *Technical Report Series* 773. Geneva.

WHO. (1972). Evaluation of mercury, lead, cadmium, and the food additives amaranth, diethyl pyrocarbamate, and octyl gallate. *Food Additive Series 4*. Geneva: World Health Organization.

WHO. (1977). Lead. *Environmental Health Criteria No. 3*. Geneva: World Health Organization.

WHO. (1978a). Summary of toxicological data of certain food additives and contaminants. *Food Additive Series 13.* Geneva: World Health Organization.

WHO. (1978b). Evaluation of certain food additives and contaminants (22nd Report of the Joint FAO/WHO Expert Committee on Food Additives). *WHO Technical Report Series,* No 631. Geneva: World Health Organization.

WHO. (1981). Arsenic. *Environmental Health Criteria No. 18.* Geneva: WHO.

WHO. (1983). Evaluation of certain food additives and contaminants (Twenty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives). *WHO Technical Report Series*, No. 696, 1983. Geneva: World Health Organization

WHO. (1987a). Toxicological evaluation of certain food additives and contaminants, Cambridge University Press. *Food Additive Series 21.* Geneva: World Health Organization.

WHO. (1987b). Principles for the safety assessment of food additives and contaminants in food. *Environmental Health Criteria 70.* Geneva: World Health Organization.

WHO. (1989a). Lead: Environmental Aspects. *Environmental Health Criteria No. 85.* Geneva: World Health Organization.

WHO. (1989b). Toxicological evaluation of certain food additives and contaminants. *Food Additive Series 24.* Geneva: World Health Organization.

WHO. (1989c). Evaluation of certain food additives (33rd Report of the Joint FAO/WHO Expert Committee on Food Additives). *WHO Technical Report Series 776.* Geneva: World Health Organization.

WHO. (1990). Selected Mycotoxins: ochratoxins, trichothecenes, ergot. *Environmental Health Criteria 105.* Geneva: World Health Organization.

WHO. (1991a). Methylmercury. *Environmental Health Criteria No. 101.* Geneva: World Health Organization.

WHO. (1991b). Mercury – inorganic. *Environmental Health Criteria No. 118.* Geneva: World Health Organization.

WHO. (1992a). Cadmium. *Environmental Health Criteria No. 134.* Geneva: WHO.

WHO. (1992b). Cadmium: Environmental Aspects. *Environmental Health Criteria No. 135.* Geneva: World Health Organization.

WHO. (1993). Evaluation of certain food additives and contaminants (41st Report of the Joint FAO/WHO Expert Committee on Food Additives). *WHO Technical Report Series, No 837.* Geneva: World Health Organization.

WHO. (1994). *Pesticide residues in food – 1993 evaluations. Part II – Toxicology.* WHO/PCS/94.4; Geneva: World Health Organization.

WHO. (1997a). Joint FAO/WHO Meeting on Pesticide Residues (JMPR) Pesticide Residues in Food – 1996 evaluations. Part 1 – Residues. *FAO Plant Production and Protection Paper* 142. http://www.fao.org/ag/AGP/AGPP/Pesticid/JMPR/Download/96_eva/ziram.pdf

WHO. (1997b). *Guidelines for predicting dietary intake of pesticide residues (revised).* WHO/FSF/FOS/97/7. World Health Organization.

WHO. (2000). Evaluation of certain food additives and contaminants (53rd Report of the Joint FAO/WHO Expert Committee on Food Additives). *WHO Technical Report Series, No 896.* Geneva: World Health Organization.

WHO. (2005). *Total Diet Studies: A recipe for safer food.* Brochure prepared by GEMS/Food, Food Safety Department, WHO. Available at http://www.who.int/foodsafety/chem/TDS_recipe_2005_en.pdf.

WHO. (2007). Evaluation of certain food additives (67th Report of the Joint FAO/WHO Expert Committee on Food Additives). *WHO Technical Report Series 940*. Geneva: WHO.

WHO. (2009). Environmental Health Criteria 240. *Principles and Methods for the Risk Assessment of Chemicals in Foods: Chapter 6 – Dietary Exposure Assessment of Chemicals in Foods*. International Programme on Chemical Safety (IPCS). A joint publication of the Food and Agriculture Organization and World Health Organization. ISBN 978 92 4 157240 8.

WHO. (2010a). *Summary and Conclusions – 72nd meeting of the Joint FAO/WHO Expert Committee on Food Additives,* Rome, 16-25 February, 2010. Geneva: World Health Organization. Available at http://www.who.int/foodsafety/chem/summary72_rev.pdf

WHO. (2010b). *Summary and Conclusions – 73rd meeting of the Joint FAO/WHO Expert Committee on Food Additives,* Geneva, 8-17 June 2010. Geneva: World Health Organization. Available at http://www.who.int/foodsafety/publications/chem/summary73.pdf

WHO. (2010c). Evaluation of certain contaminants in food (72nd Report of the Joint FAO/WHO Expert Committee on Food Additives). *WHO Technical Report Series, No 959.* Geneva: World Health Organization.

WHO GEMS/Food-Euro. (1994). *Workshop on Reliable Evaluation of Low-level Contamination of Food, Kulmbach, Federal Republic of Germany, 3-5 March, 1994*. EUR/ICP/EHAZ.94.12/WS03. Geneva: World Health Organization.

WHO GEMS/Food-Euro. (1995). *Second workshop on Reliable Evaluation of Low-level Contamination of Food, Kulmbach, Federal Republic of Germany, 26-27 March, 1995*. EUR/ICP/EHAZ.94.12/WS04. Geneva: World Health Organization.

Winterbourn CC, Saville DJ, George PM, Walmsley TA. (1992). Increase in selenium status of Christchurch adults associated with deregulation of the wheat market. *New Zealand Medical Journal;* 105 (946): 466-8.

Zhu Y-G, Williams PN, and Mehrag AM. (2008). Exposure to inorganic arsenic from rice: A global health issue? *Environmental Pollution;* 154: 169-171.

APPENDICES 8

APPENDIX 1: NATIONAL (N) AND REGIONAL (R) FOODS SAMPLED IN THE 2009 NZTDS

2009 NZTDS Food	R/N	2009 NZTDS Food	R/N
Beverages, alcoholic		**Fruit**	
Beer	N	Apple	R
Wine, still red	N	Apple-based juice	N
Wine, still white	N	Apricot, canned	N
		Avocado	R
Beverages, non-alcoholic		Banana	R
Caffeinated beverage	N	Grapes	R
Carbonated drink	N	Kiwifruit	R
Chocolate beverage	N	Melons	R
Coffee beans, ground	R	Nectarine	R
Coffee, instant	N	Orange	N
Fruit drink	N	Orange juice	N
Tea	N	Peaches, canned	N
Water, bottled	R [a]	Pear	R
Water, tap	R [a]	Pineapple, canned	N
		Prunes	N
Chicken, eggs, fish and meat		Raisins/sultanas	N
Bacon	R	Strawberries	R
Beef, mince	R		
Beef, rump	R	**Grains**	
Chicken	N	Biscuits, chocolate	N
Corned beef	R	Biscuits, cracker	N
Egg	R	Biscuits, plain sweet	N
Fish fingers	N	Bran flake cereal, mixed	N
Fish, canned	N	Bread, mixed grain	R
Fish, fresh	R	Bread, wheatmeal	R
Ham	R	Bread, white	R
Lamb/mutton	R	Cake	R
Lambs liver	R	Cornflakes	N
Mussels	R	Muesli	N
Oysters	R	Muffin	R
Pork chop	R	Noodles, instant	N
Sausages	R	Oats, rolled	N
Soup, chicken	N	Pasta, dried	N
		Rice, white	N
Dairy products		Snacks, flavoured	N
Butter	R	Spaghetti in sauce, canned	N
Cheese	N	Wheat biscuit cereals	R [b]
Cream	R		
Dairy dessert	N	**Infant foods**	
Ice cream	N	Infant and Follow-on formula	N
Milk, 0.5% fat	R	Infant weaning food, cereal based	N
Milk, 3.25% fat	R	Infant weaning food, custard/fruit	N
Milk, flavoured	R	Infant weaning food, savoury	N
Yoghurt	N		

continued...

2009 NZTDS Food	R/N	2009 NZTDS Food	R/N
Nuts		**Vegetables**	
Peanut butter	N	Beans	N
Peanuts, whole	N	Beans, baked, canned	N
		Beetroot, canned	N
Oils		Broccoli/cauliflower	R
Margarine	N	Cabbage	R
Oil	N	Capsicum	R
Salad dressing	N	Carrot	R
		Celery	R
Spreads and sweets		Corn, canned	N
Chocolate, plain milk	N	Courgette	R
Confectionery	N	Cucumber	R
Honey	N	Kumara	R
Jam	N	Lettuce	R
Snack bars	N	Mushrooms	R
Sugar	N	Onion	R
Yeast extract	N	Peas	N
		Potato crisps	N
Takeaways		Potatoes, peeled	R
Chicken takeaway	R	Potatoes, with skin	R
Chinese dish	R	Pumpkin	R
Fish in batter	R	Silverbeet	R
Hamburger, plain	R	Soy milk	N
Indian takeaway	R [c]	Taro	R
Meat pie	R	Tomato	R
Pizza	R	Tomato sauce	N
Potato, hot chips	R	Tomatoes in juice	N

Notes

a Water split into bottled and tap in 2009 NZTDS.

b Wheat biscuit cereal changed from national food to regional food in 2009 NZTDS, recognising North Island/South Island factories tend to use different grain sources, imported and domestic, respectively.

c New addition to 2009 NZTDS.

APPENDIX 2: PREPARATION INSTRUCTIONS FOR FOODS SAMPLED IN THE 2009 NZTDS

Glossary of terms

In order for foods to be prepared in a consistent and unambiguous manner, terms used in this section have been clearly defined.

Chop

Samples are put into the appropriate sized food processor and chopped until a homogeneous mixture is attained – usually 6–8 minutes depending on the moisture content of the sample.

Blend

Samples are put into the appropriate sized blender (depending on the amount of the item being prepared) and blended until a homogeneous mixture is obtained – usually 2–4 minutes depending on the moisture content of the sample.

Combine

Units of the same sample are combined before chopping or blending. Regional or brand samples are kept separate.

Mix

When the preparation instructions state "mix" or "mix thoroughly" then the following procedures are to be followed:

For dry foods (such as flour) or semi-dry foods (such as cooked chopped meat):

» form the food into a cone or pile;

» flatten the cone slightly and separate into four equal segments;

» pull the segments apart so that four separate piles are formed;

» combine diagonally opposite piles and mix together thoroughly;

» this process should be repeated until thorough mixing of the foods has been achieved.

For foods containing juice (for example, nectarines):

» if possible, the food being prepared should be chopped in a large glass or stainless steel bowl so that all the juice is collected;

» mixing of the chopped pieces is then carried out in the bowl using gloved hands or stainless steel cutlery. It should be mixed as thoroughly as possible;

» unless cooking instructions state that the food must be drained, any juice must be regarded as an integral part of the food being prepared for analysis. A proportional amount of juice and seeds must be included in all sample containers.

For liquid samples (for example, oils and beer):

» Liquids are to be measured into a large receptacle, such as a bowl or jug made of stainless steel or Pyrex. Plastic containers are to be avoided.

» The total volume added to the receptacle should be thoroughly stirred with a stainless steel utensil before being poured into the sample containers.

Composite

Compositing involves thorough mixing/ blending/ chopping of equal weights of the indicated samples.

Food preparation equipment

Selection of appropriate food preparation equipment is a vital component of the contamination control procedures.

Gloves

Gloves are to be worn whenever the food being prepared could come into contact with hands. Non-lubricated surgical-style gloves should be used.

Utensils

» Stainless steel knives.
» Wooden (good quality, smooth, crack free) or glass chopping boards.
» Stainless steel or teflon-coated utensils. Glass equipment can also be used provided it is Pyrex.
» Large stainless steel or Pyrex receptacle (jug or bowl) for mixing liquids.
» Ceramic and enamel ware should be avoided at all times, as these may leach traces of lead or cadmium.

Equipment

» Domestic oven, with hotplates (electric).
» Blenders, glass with stainless steel blades.
» Food processors, high density plastic with stainless steel blades.
» Frying-pans (Teflon-coated).
» Large stainless steel pots.

Food preparation procedures

A key feature of a TDS is that foods are prepared as for normal consumption.

The following table summarises the procedures used to prepare food samples received by the food preparation laboratory. Foods are sorted alphabetically. Full details of food preparation methods are contained in the *2009 NZTDS Procedures Manual* (Vannoort, 2009a). All water used in food preparation was distilled.

2009 NZTDS Food	Food Preparation Method
Apple	Rinsed, cored, chopped, not peeled
Apple-based juice	Mixed
Apricot, canned	Mixed and chopped without juice
Avocado	Flesh chopped
Bacon	Rind and fat trimmed, then fried until cooked and chopped
Banana	Skin discarded, chopped
Beans	Boiled until cooked, drained, mixed and chopped
Beans, baked, canned	Mixed and chopped
Beef, mince	Fried, without added fat, until cooked, mixed and chopped
Beef, rump	Fat trimmed, then fried until cooked and chopped
Beer	Mixed
Beetroot, canned	Mixed and chopped
Biscuits, chocolate	Mixed and chopped
Biscuits, cracker	Mixed and chopped
Biscuits, plain sweet	Mixed and chopped
Bran flake cereal, mixed	Mixed and chopped
Bread, mixed grain	Mixed and chopped
Bread, wheatmeal	Mixed and chopped
Bread, white	Mixed and chopped
Broccoli/cauliflower	Florets rinsed, boiled, drained, mixed and chopped
Butter	Chopped and mixed
Cabbage	Outer leaves discarded, rinsed, combined and chopped
Caffeinated beverage	Mixed
Cake	Mixed and chopped
Capsicum	Stem and seeds discarded, rinsed and chopped
Carbonated drink	Mixed
Carrot	Peeled, rinsed, chopped
Celery	Leaves discarded and stems trimmed, then rinsed and chopped
Cheese	Chopped and mixed
Chicken	Fried until cooked, mixed and chopped
Chicken takeaway	Combined and chopped
Chinese dish	Mixed and chopped
Chocolate beverage	Prepared as per label instructions and mixed
Chocolate, plain milk	Mixed and chopped
Coffee beans, ground	Prepared in boiling water, cooled and combined
Coffee, instant	Prepared in boiling water, cooled and combined
Confectionery	Melted in an equal weight of boiling water
Corn, canned	Drained and chopped
Corned beef	Mixed and chopped
Cornflakes	Mixed and chopped
Courgette	Ends discarded, remainder rinsed and chopped
Cream	Mixed
Cucumber	Ends discarded, remainder rinsed and chopped

2009 NZTDS Food	Food Preparation Method
Dairy dessert	Mixed
Egg	Boiled, peeled and chopped
Fish fingers	Oven cooked to label instructions, combined and chopped
Fish in batter	Combined and chopped
Fish, canned	Brine or oil drained and discarded, mixed and chopped
Fish, fresh	Grilled until cooked, combined and chopped
Fruit drink	Prepared as per label instructions and mixed
Grapes	Stalks removed, rinsed and chopped
Ham	Mixed and chopped
Hamburger, plain	Combined and chopped
Honey	Mixed
Ice-cream	Mixed
Indian dish	Mixed and chopped
Infant and Follow-on formula	Prepared as per label instructions if necessary, with water and mixed
Infant weaning food, cereal based	Prepared as per label instructions if necessary, with water and mixed
Infant weaning food, custard/fruit dish	Prepared as per label instructions if necessary, with water and mixed
Infant weaning food, savoury	Prepared as per label instructions if necessary, with water and mixed
Jam	Mixed
Kiwifruit	Skin discarded, flesh mixed and chopped
Kumara	Peeled, rinsed, boiled and chopped
Lamb/mutton	Fried until cooked, combined and chopped
Lambs liver	Sliced and fried until cooked, combined and chopped
Lettuce	Inner leaves rinsed and chopped
Margarine	Mixed
Meat pie	Chopped and mixed
Melons	Rind and seeds discarded, flesh chopped
Milk, 0.5% fat	Mixed
Milk, 3.25% fat	Mixed
Milk, flavoured	Mixed
Muesli	Mixed and chopped
Muffin	Mixed and chopped
Mushrooms	Rinsed and chopped
Mussels	Flesh mixed and chopped
Nectarine	Stone discarded, flesh chopped
Noodles, instant	Cooked according to label instructions, flavour sachet added, mixed and chopped
Oats, rolled	Cooked in water, then mixed
Oil	Mixed
Onion	Peeled, sliced, fried and chopped
Orange	Skins and seeds discarded, flesh chopped
Orange juice	Mixed
Oysters	Flesh mixed and chopped
Pasta, dried	Boiled in unsalted water until cooked; mixed and chopped

2009 NZTDS Food	Food Preparation Method
Peaches, canned	Drained, combined and chopped
Peanut butter	Mixed
Peanuts, whole	Mixed and chopped
Pear	Core removed, chopped, not peeled
Peas	Boiled, mixed and chopped
Pineapple, canned	Drained, combined and chopped
Pizza	Cooked as per label instructions, combined and chopped
Pork chop	Flesh removed from bone, dry fried until cooked, mixed and chopped
Potato crisps	Mixed and chopped
Potato, hot chips	Mixed and chopped
Potatoes, peeled	Peeled, rinsed, boiled until cooked, drained and chopped
Potatoes, with skin	Scrubbed, cooked in microwave and chopped
Prunes	Mixed and chopped, with added water if necessary
Pumpkin	Cut into pieces, peeled, rinsed, boiled, drained and chopped
Raisins/sultanas	Mixed with an equal volume of water, chopped
Rice, white	Boiled in unsalted water until cooked; mixed and chopped.
Salad dressing	Mixed
Sausages	Pre-cooked in boiling water and then fried until cooked; combined and chopped
Silverbeet	Trim stems, wash, slice, boil, drain and chop
Snack bars	Combined and chopped
Snacks, flavoured	Mixed and chopped
Soup, chicken	Can contents or reconstituted sachet simmered for 5 minutes and mixed
Soy milk	Mixed
Spaghetti in sauce, canned	Mixed and chopped
Strawberries	Leaves and stem removed; chopped
Sugar	Mixed
Taro	Peeled, rinsed, boiled, drained and homogenised
Tea	Brewed with boiling water, cooled and combined
Tomato	Rinsed, combined, chopped
Tomato sauce	Mixed
Tomatoes in juice	Mixed and chopped
Water, bottled	Mixed
Water, tap	Mixed
Wheat biscuit cereals	Mixed and chopped
Wine, still red	Mixed
Wine, still white	Mixed
Yeast extract	Mixed
Yoghurt	Mixed

APPENDIX 3: SIMULATED DIETS OF THE 2009 NZTDS

Mean consumption of each food in the 2009 NZTDS for each age-gender cohort in grams per day based on 2-week simulated diets (NZFSA, 2010a)

2009 NZTDS Food	25+ yr males 82 kg	25+ yr females 70 kg	19–24 yr young males 78 kg	11–14 yr boys 54 kg	11–14 yr girls 55 kg	5–6 yr children 23 kg	1–3 yr toddlers 13 kg	6–12 months infants 9 kg
Apples	60	51	42	69	72	75	25	19
Apple-based juice	18	14	54	4	6	6	27	9
Apricots, canned	4	4	2	2	3	4	4	5
Avocado	2	4	2	2	2	1	1	1
Bacon	6	3	6	3	1	1	2	1
Banana	34	34	36	26	19	30	35	30
Beans	8	7	7	6	4	3	1	1
Beans, baked	9	6	7	7	6	6	7	4
Beef, mince	38	19	29	20	10	11	9	6
Beef, rump	21	11	21	14	11	6	4	2
Beer	386	32	364	–	–	–	–	–
Beetroot	2	3	2	2	2	1	–	–
Biscuits, chocolate	6	5	7	22	18	14	8	3
Biscuits, cracker	5	5	3	5	5	5	4	4
Biscuits, plain sweet	5	4	6	6	6	6	12	5
Bran flake cereal, mixed	2	2	3	3	3	1	2	1
Bread, mixed grain	26	26	13	12	13	16	2	–
Bread, wheatmeal	26	20	20	21	13	11	8	5
Bread, white	84	50	76	126	90	85	30	19
Broccoli/cauliflower	10	14	10	9	6	6	5	3
Butter	17	11	23	7	5	5	4	3
Cabbage	14	12	10	10	7	4	1	1
Caffeinated beverage	25	25	100	14	11	–	–	–
Cake	28	22	39	7	11	4	4	1
Capsicum	3	3	4	3	3	1	1	–
Carbonated drink	143	82	275	98	82	41	21	9
Carrot	20	16	17	13	11	11	8	5
Celery	2	3	2	4	2	1	1	–
Cheese	19	15	21	15	15	7	10	8
Chicken	32	27	47	48	31	24	4	3
Chicken takeaway	2	2	7	6	4	3	4	2
Chinese dish	13	13	14	9	7	–	–	–
Chocolate beverage	36	36	36	64	57	57	21	7
Chocolate, plain milk	6	5	12	13	9	7	1	1
Coffee beans, ground	136	86	29	–	–	–	–	–
Coffee, instant	300	339	125	7	11	–	–	–
Confectionery	3	3	4	14	9	7	3	1
Corn, canned	8	6	4	5	4	6	2	2
Corned beef	9	7	7	6	4	4	3	2
Cornflakes	5	3	11	8	5	8	4	2
Courgette	3	3	2	3	1	1	1	1

2009 NZTDS Food	25+ yr males 82 kg	25+ yr females 70 kg	19–24 yr young males 78 kg	11–14 yr boys 54 kg	11–14 yr girls 55 kg	5–6 yr children 23 kg	1–3 yr toddlers 13 kg	6–12 months infants 9 kg
Cream	6	5	5	3	2	1	1	1
Cucumber	3	4	3	3	1	1	1	1
Dairy dessert (Child)	–	–	–	5	9	21	33	9
Egg	22	18	21	16	14	11	8	4
Fish fingers (Child)	–	–	–	1	2	3	3	2
Fish in batter	10	7	14	7	4	6	3	2
Fish, canned	5	4	3	3	3	1	1	2
Fish, fresh	20	13	14	12	5	3	2	1
Fruit drink, powdered	43	29	129	69	50	86	59	25
Grapes	3	4	2	1	2	3	1	1
Ham	9	6	4	13	7	5	5	1
Hamburger, plain	14	11	57	21	19	7	6	3
Honey	5	3	5	3	2	2	1	1
Ice cream	16	10	14	34	26	26	11	6
Indian dish	13	13	14	9	7	–	–	–
Infant and Follow-on formula	–	–	–	–	–	–	14	350
Infant weaning food, cereal based	–	–	–	–	–	–	–	19
Infant weaning food, custard/ fruit dish	–	–	–	–	–	–	–	12
Infant weaning food, savoury dish	–	–	–	–	–	–	9	24
Jam	5	4	4	3	2	2	1	1
Kiwifruit	4	6	3	1	3	6	4	1
Kumara	6	6	3	2	5	1	2	2
Lamb/Mutton	16	9	6	7	6	3	3	2
Lambs liver	2	2	2	–	–	–	–	–
Lettuce	16	14	14	14	9	2	1	–
Margarine	13	8	9	9	7	6	3	2
Meat pie	24	9	61	26	23	14	6	4
Melon	2	3	2	1	2	3	2	2
Milk, flavoured	7	7	46	14	14	11	9	–
Milk, trim (0.5%)	110	98	78	23	21	16	14	–
Milk, whole	176	132	188	164	111	144	244	69
Muesli	6	7	7	3	3	1	1	–
Muffin/scone	14	18	6	12	18	10	5	3
Mushrooms	4	6	4	4	3	1	1	1
Mussels	3	1	2	1	1	0	–	–
Nectarines	18	20	6	7	6	9	2	4
Noodles, instant	25	15	21	21	33	21	11	4
Oats, rolled	24	11	4	5	6	5	9	5
Oil	13	8	15	6	4	3	3	1
Onion	19	14	16	9	6	5	1	1
Orange juice	25	21	61	4	6	6	20	8

2009 NZTDS Food	25+ yr males 82 kg	25+ yr females 70 kg	19–24 yr young males 78 kg	11–14 yr boys 54 kg	11–14 yr girls 55 kg	5–6 yr children 23 kg	1–3 yr toddlers 13 kg	6–12 months infants 9 kg
Oranges	19	26	27	31	51	44	19	8
Oysters	4	2	2	–	–	–	–	–
Pasta, dried	29	20	46	28	19	16	11	8
Peaches, canned	3	4	3	2	3	4	4	4
Peanut butter	2	1	2	5	3	4	1	–
Peanuts	3	1	3	1	1	1	–	–
Pears	9	14	12	9	11	9	5	4
Peas	18	14	14	12	9	6	4	3
Pineapple	5	6	4	2	2	5	1	1
Pizza	16	9	25	11	13	9	5	3
Pork chop	13	8	18	8	6	3	1	1
Potato crisps	3	3	8	10	11	6	3	1
Potato, hot chips	32	16	59	50	40	23	15	6
Potatoes, peeled	102	53	64	51	48	39	17	11
Potatoes, with skin	14	14	25	32	26	20	4	3
Prunes	3	2	1	1	1	1	1	1
Pumpkin	14	10	7	4	4	3	6	5
Raisins/sultanas	4	2	2	2	2	2	7	5
Rice, white	32	29	36	26	14	16	4	2
Salad dressing	4	4	4	2	2	1	–	–
Sausages, beef	16	10	18	21	14	14	11	5
Silverbeet	5	5	6	3	2	2	1	1
Snack bars	2	2	2	9	8	8	2	1
Snacks, flavoured (Child)	–	–	–	9	10	8	4	3
Soup, chicken	25	19	23	11	11	7	4	2
Soy milk	25	29	11	11	18	11	7	–
Spaghetti in sauce (canned)	14	11	14	14	11	9	11	7
Strawberries	4	4	2	1	3	1	1	1
Sugar	25	17	18	7	7	4	2	1
Taro	2	1	2	–	–	–	–	–
Tea	421	471	79	18	18	14	–	–
Tomato	31	30	13	17	20	6	5	3
Tomato sauce	9	5	18	8	5	3	4	2
Tomatoes in juice	13	9	16	8	5	4	3	3
Water, bottled	55	74	53	87	87	93	63	37
Water, tap	163	222	158	260	261	278	188	111
Wheat biscuit cereals	9	4	7	14	7	11	15	5
Wine, still red	20	21	14	–	–	–	–	–
Wine, still white	20	29	14	–	–	–	–	–
Yeast extract	2	1	2	1	1	1	2	2
Yoghurt	11	13	9	14	19	19	62	55
Total weight diet (g/day)	**3474**	**2792**	**3187**	**2051**	**1797**	**1633**	1275	1044

APPENDIX 4: LIST OF AGRICULTURAL COMPOUNDS SCREENED FOR IN THE 2009 NZTDS AND THEIR LIMITS OF DETECTION (LOD) IN PARTS PER MILLION (MG/KG)

The methods of analyses for the agricultural compounds screened for in the 2009 NZTDS have been detailed previously in section 2.3.1.

The limits of detection (LOD) varied for different agricultural compounds and different foods, and ranged from 0.0002–0.03 mg/kg, with most LODs generally 0.001–0.002 mg/kg. The limits set out in this appendix are those achieved with the triple quadruple gas chromatography mass spectrometry.

Agricultural compound	LOD (mg/kg)
Acephate	0.01
Acetochlor	0.001
Acrinathrin	0.01
Alachlor	0.001
Aldrin	0.002
Atrazine	0.002
Atrazine-desethyl	0.002
Atrazine-desisopropyl	0.005
Azaconazole	0.001
Azinphos-methyl	0.01
Azoxystrobin	0.002
Benalaxyl	0.001
Bendiocarb	0.002
Benodanil	0.001
Benoxacor	0.001
BHC-alpha	0.001
BHC-beta	0.001
BHC-delta	0.001
Bifenox	0.005
Bifenthrin	0.001
Bioresmethrin	0.001
Bitertanol	0.001
Bromacil	0.002
Bromophos-ethyl	0.001
Bromopropylate	0.001
Bupirimate	0.001
Buprofezin	0.001
Butachlor	0.001
Butamifos	0.001
Cadusafos	0.001
Captafol	0.01
Captan	0.01
Carbaryl	0.005
Carbofenothion	0.002
Carbofuran	0.001
Carboxin	0.001
Chlordane-cis	0.0002

Agricultural compound	LOD (mg/kg)
Chlordane-trans	0.0004
Chlorfenapyr	0.002
Chlorfenvinphos	0.001
Chlorfluazuron	0.001
Chlorobenzilate	0.001
Chlorothalonil	0.002
Chlorpropham	0.001
Chlorpyriphos	0.002
Chlorpyriphos-methyl	0.001
Chlorthal-dimethyl	0.001
Chlortoluron	0.001
Chlozolinate	0.001
Clomazone	0.001
Coumaphos	0.005
Cyanazine	0.005
Cyanophos	0.001
Cyfluthrin	0.004
Cyhalothrin	0.005
Cypermethrin	0.008
Cyproconazole	0.001
Cyprodinil	0.001
DDD-2,4'	0.001
DDE-2,4'	0.001
DDT-2,4'	0.001
DDD-4,4'	0.0002
DDE-4,4'	0.0002
DDT-4,4'	0.002
Deltamethrin	0.01
Demeton-S-methyl	0.002
Diazinon	0.001
Dichlobenil	0.001
Dichlofenthion	0.001
Dichlofluanid	0.001
Dichloran	0.002
Dichlorvos	0.001
Dicofol	0.002
Dicrotophos	0.005

Agricultural compound	LOD (mg/kg)
Dieldrin	0.002
Difenoconazole	0.002
Diflufenican	0.001
Dimethenamid	0.001
Dimethoate	0.005
Dimethomorph	0.002
Dimethylvinphos	0.001
Dinocap	0.002
Dioxabenzofos	0.001
Diphenamid	0.001
Diphenylamine	0.001
Disulfoton	0.002
DTCs	0.01
Diuron	0.001
Edifenphos	0.001
Endosulfan I	0.002
Endosulfan II	0.001
Endosulfan sulfate	0.002
Endrin	0.004
Endrin-aldehyde	0.002
Endrin-ketone	0.002
EPN	0.001
Epoxiconazole	0.001
EPTC	0.001
Esfenvalerate	0.002
Esprocarb	0.001
Ethion	0.001
Ethofumesate	0.002
Ethoprophos	0.002
Ethoxyquin	0.001
Etridiazole	0.002
Etrimfos	0.001
Famphur	0.001
Fenamiphos	0.002
Fenarimol	0.001
Fenchlorphos	0.001
Fenitrothion	0.001
Fenobucarb	0.001
Fenoxaprop-ethyl	0.001
Fenpiclonil	0.002
Fenpropathrin	0.002
Fenpropimorph	0.001
Fensulfothion	0.001
Fenthion	0.001
Fenvalerate	0.002
Flamprop-methyl	0.001
Fluazifop-butyl	0.001
Flucythrinate	0.002
Fludioxonil	0.001

Agricultural compound	LOD (mg/kg)
Fluometuron	0.001
Flusilazole	0.001
Flutriafol	0.001
Fluvalinate	0.003
Folpet	0.01
Fonofos	0.001
Furalaxyl	0.002
Furathiocarb	0.002
Halfenprox	0.002
Haloxyfop-methyl	0.002
Heptachlor	0.001
Heptachlor-epoxide	0.001
Heptenophos	0.001
Hexachlorobenzene	0.001
Hexaconazole	0.002
Hexazinone	0.001
Hexythiazox	0.002
Imazalil	0.001
Indoxacarb	0.01
Iodofenphos	0.001
Iprobenfos	0.001
Iprodione	0.01
Isazophos	0.001
Isofenphos	0.001
Isoprocarb	0.001
Kresoxim-methyl	0.001
Leptophos	0.001
Lindane (gamma BHC)	0.001
Linuron	0.001
Malathion	0.001
Mepronil	0.002
Metalaxyl	0.002
Methacrifos	0.002
Methamidophos	0.02
Methidathion	0.001
Methiocarb	0.001
Methoxychlor	0.001
Metolachlor	0.001
Metribuzin	0.001
Mevinphos	0.001
Molinate	0.001
Monocrotophos	0.02
Myclobutanil	0.001
Naled	0.03
Napropamide	0.001
Nitrofen	0.001
Nitrothal-isopropyl	0.001
Norflurazon	0.001
Omethoate	0.02

Agricultural compound	LOD (mg/kg)
Oxadiazon	0.001
Oxadixyl	0.001
Oxychlordane	0.001
Oxyfluorfen	0.005
Paclobutrazol	0.001
Parathion-ethyl	0.001
Parathion-methyl	0.001
Penconazole	0.001
Pendimethalin	0.001
Permethrin	0.002
Phenthoate	0.001
Phorate	0.001
Phosalone	0.002
Phosmet	0.002
Phosphamidon	0.005
Piperonyl-butoxide	0.001
Pirimicarb	0.001
Pirimiphos-methyl	0.001
Prochloraz	0.002
Procymidone	0.001
Profenofos	0.002
Prometryn	0.001
Propachlor	0.001
Propanil	0.001
Propaphos	0.001
Propargite	0.002
Propazine	0.001
Propetamphos	0.001
Propham	0.001
Propiconazole	0.003
Propoxur	0.001
Propyzamide	0.001
Prothiofos	0.002
Pyraclofos	0.01
Pyrazophos	0.001

Agricultural compound	LOD (mg/kg)
Pyrazoxyfen	0.01
Pyrethrin	0.03
Pyrifenox	0.003
Pyrimethanil	0.001
Pyriproxyfen	0.001
Quinalphos	0.001
Quintozene	0.001
Quizalofop-ethyl	0.002
Simazine	0.001
Simetryn	0.001
Sulfentrazone	0.001
Sulfotep	0.001
Tebuconazole	0.001
Tebufenpyrad	0.001
Tefluthrin	0.002
Terbacil	0.005
Terbufos	0.001
Terbumeton	0.001
Terbuthylazine	0.001
Terbuthylazine-desethyl	0.001
Terbutryn	0.001
Tetrachlorvinphos	0.001
Tetradifon	0.002
Thenylchlor	0.001
Thiobencarb	0.001
Thiometon	0.001
Tolclofos-methyl	0.001
Tolylfluanid	0.001
Triadimefon	0.005
Tri-allate	0.001
Triazophos	0.001
Trifloxystrobin	0.001
Trifluralin	0.001
Vinclozolin	0.001

APPENDIX 5: AGRICULTURAL COMPOUND RESIDUES AND 2009 NZTDS FOODS IN WHICH THEY WERE DETECTED

In this appendix, all agricultural compounds screened for in the 2009 NZTDS are listed in alphabetical order, along with the foods in which they were found, and associated concentrations.

In Appendix 6, all foods in the 2009 NZTDS are listed alphabetically, with agricultural compound residues detected and their associated concentrations.

In recording the minimum and maximum concentrations for each food, normal international convention has been followed for "not detected" results, namely the result is reported as "not detected". The associated limit of reporting for each agricultural compound residue is given in Appendix 4.

Mean concentrations are an intermediate in the calculation of the estimated dietary exposure, so have been reported to four decimal places.

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Acephate	Celery	8	1	0.0135	not detected	0.108
Acetochlor	not detected in any foods of 2009 NZTDS					
Acrinathrin	not detected in any foods of 2009 NZTDS					
Alachlor	Potato, hot chips	8	3	0.0004	not detected	0.001
Aldrin	not detected in any foods of 2009 NZTDS					
Atrazine	not detected in any foods of 2009 NZTDS					
Atrazine-desethyl	not detected in any foods of 2009 NZTDS					
Atrazine-desisopropyl	not detected in any foods of 2009 NZTDS					
Azaconazole	Tomato	8	1	0.0093	not detected	0.074
Azinphos-methyl	not detected in any foods of 2009 NZTDS					
Azoxystrobin	Capsicum	8	1	0.0061	not detected	0.049
	Potatoes, with skin	8	1	0.0007	not detected	0.005
Benalaxyl	not detected in any foods of 2009 NZTDS					
Bendiocarb	not detected in any foods of 2009 NZTDS					
Benodanil	not detected in any foods of 2009 NZTDS					
Benoxacor	not detected in any foods of 2009 NZTDS					
BHC-alpha	not detected in any foods of 2009 NZTDS					
BHC-beta	not detected in any foods of 2009 NZTDS					
BHC-delta	not detected in any foods of 2009 NZTDS					
Bifenox	not detected in any foods of 2009 NZTDS					
Bifenthrin	Capsicum	8	3	0.0032	not detected	0.011
	Courgette	8	2	0.0006	not detected	0.003
Bioresmethrin	not detected in any foods of 2009 NZTDS					
Bitertanol	Strawberries	8	2	0.0097	not detected	0.040
Bromacil	not detected in any foods of 2009 NZTDS					
Bromophos-ethyl	not detected in any foods of 2009 NZTDS					
Bromopropylate	not detected in any foods of 2009 NZTDS					
Bupirimate	not detected in any foods of 2009 NZTDS					

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Buprofezin	Capsicum	8	2	0.0021	not detected	0.011
	Cucumber	8	1	0.0003	not detected	0.002
	Grapes	8	5	0.0089	not detected	0.027
Butachlor	not detected in any foods of 2009 NZTDS					
Butamifos	not detected in any foods of 2009 NZTDS					
Cadusafos	not detected in any foods of 2009 NZTDS					
Captafol	not detected in any foods of 2009 NZTDS					
Captan	Apple	8	1	0.0041	not detected	0.033
	Nectarine	8	1	0.0093	not detected	0.074
	Pear	8	3	0.0194	not detected	0.082
	Strawberries	8	6	0.5196	not detected	1.278
Carbaryl	Jam	8	2	0.0134	not detected	0.075
	Nectarine	8	4	0.0471	not detected	0.340
	Peaches, canned	8	1	0.0040	not detected	0.032
	Strawberries	8	2	0.0287	not detected	0.224
Carbofenothion	not detected in any foods of 2009 NZTDS					
Carbofuran	not detected in any foods of 2009 NZTDS					
Carboxin	not detected in any foods of 2009 NZTDS					
Chlordane-cis	not detected in any foods of 2009 NZTDS					
Chlordane-trans	not detected in any foods of 2009 NZTDS					
Chlorfenapyr	not detected in any foods of 2009 NZTDS					
Chlorfenvinphos	not detected in any foods of 2009 NZTDS					
Chlorfluazuron	not detected in any foods of 2009 NZTDS					
Chlorobenzilate	not detected in any foods of 2009 NZTDS					
Chlorothalonil	Celery	8	4	0.0111	not detected	0.065
	Cucumber	8	3	0.0027	not detected	0.009
	Tomato	8	1	0.0043	not detected	0.034
Chlorpropham	Potato, hot chips	8	4	0.0859	not detected	0.253
Chlorpyriphos	Bran flake cereal, mixed	8	4	0.0025	not detected	0.010
	Bread, mixed grain	8	1	0.0003	not detected	0.002
	Bread, wheatmeal	8	2	0.0006	not detected	0.002
	Bread, white	8	2	0.0009	not detected	0.005
	Grapes	8	3	0.0047	not detected	0.018
	Indian dish	8	1	0.0030	not detected	0.024
	Kiwifruit	8	1	0.0006	not detected	0.005
	Muesli	8	2	0.0007	not detected	0.003
	Raisins/sultanas	8	2	0.0018	not detected	0.008
	Rice, white	8	1	0.0003	not detected	0.002
	Silverbeet	8	1	0.0017	not detected	0.013
	Snack bars	8	1	0.0004	not detected	0.004
Chlorpyriphos-methyl	Biscuits, chocolate	8	1	0.0012	not detected	0.010
	Biscuits, cracker	8	3	0.0098	not detected	0.037
	Biscuits, plain sweet	8	2	0.0190	not detected	0.084

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Bran flake cereal, mixed	8	1	0.0047	not detected	0.037
	Chicken takeaway	8	1	0.0002	not detected	0.001
	Hamburger, plain	8	3	0.0018	not detected	0.008
	Muesli	8	1	0.0008	not detected	0.007
	Muffin	8	4	0.0050	not detected	0.017
	Oats, rolled	8	1	0.0018	not detected	0.014
	Pasta, dried	8	2	0.0075	not detected	0.053
Chlorthal-dimethyl	not detected in any foods of 2009 NZTDS					
Chlortoluron	not detected in any foods of 2009 NZTDS					
Chlozolinate	not detected in any foods of 2009 NZTDS					
Clomazone	not detected in any foods of 2009 NZTDS					
Coumaphos	not detected in any foods of 2009 NZTDS					
Cyanazine	not detected in any foods of 2009 NZTDS					
Cyanophos	Chicken takeaway	8	1	0.0002	not detected	0.002
Cyfluthrin	not detected in any foods of 2009 NZTDS					
Cyhalothrin	not detected in any foods of 2009 NZTDS					
Cypermethrin	Bran flake cereal, mixed	8	1	0.0015	not detected	0.012
Cyproconazole	Cucumber	8	1	0.0006	not detected	0.005
	Silverbeet	8	1	0.0084	not detected	0.068
Cyprodonil	Bran flake cereal, mixed	8	2	0.0013	not detected	0.008
	Grapes	8	7	0.0499	not detected	0.166
	Jam	8	3	0.0016	not detected	0.005
	Muesli	8	1	0.0002	not detected	0.001
	Muffin	8	4	0.0010	not detected	0.003
	Raisins/sultanas	8	2	0.0051	not detected	0.027
	Strawberries	8	8	0.0779	0.005	0.363
	Wine, still red	8	4	0.0031	not detected	0.009
	Wine, still white	8	1	0.0004	not detected	0.003
DDD-2,4'	not detected in any foods of 2009 NZTDS					
DDE-2,4'	not detected in any foods of 2009 NZTDS					
DDT-2,4'	not detected in any foods of 2009 NZTDS					
DDD-4,4'	not detected in any foods of 2009 NZTDS					
DDE-4,4'	Bacon	8	5	0.0012	not detected	0.004
	Beef, mince	8	5	0.0042	not detected	0.016
	Butter	8	8	0.014	0.005	0.029
	Cheese	8	2	0.0012	not detected	0.005
	Cream	8	6	0.0087	not detected	0.024
	Egg	8	4	0.0017	not detected	0.004
	Fish in batter	8	1	0.0002	not detected	0.002
	Ice cream	8	2	0.0023	not detected	0.014
	Indian dish	8	1	0.0001	not detected	0.001
	Lamb/mutton	8	5	0.0027	not detected	0.006
	Lambs liver	8	2	0.0028	not detected	0.015

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Meat pie	8	1	0.0001	not detected	0.001
	Milk, 3.25% fat	8	1	0.0001	not detected	0.001
	Pizza	8	3	0.0006	not detected	0.002
	Pork chop	8	5	0.0056	not detected	0.016
	Sausages	8	5	0.0063	not detected	0.015
DDT-4,4’	not detected in any foods of 2009 NZTDS					
Deltamethrin	Biscuits, plain sweet	8	1	0.0029	not detected	0.023
	Bread, mixed grain	8	3	0.0085	not detected	0.035
	Bread, wheatmeal	8	4	0.0132	not detected	0.049
	Bread, white	8	3	0.0111	not detected	0.044
	Pasta, dried	8	2	0.0045	not detected	0.021
Demeton-S-methyl	not detected in any foods of 2009 NZTDS					
Diazinon	Apple	8	2	0.0005	not detected	0.003
	Biscuits, chocolate	8	1	0.0015	not detected	0.012
	Biscuits, plain sweet	8	1	0.0004	not detected	0.003
Dichlobenil	not detected in any foods of 2009 NZTDS					
Dichlofenthion	not detected in any foods of 2009 NZTDS					
Dichlofluanid	not detected in any foods of 2009 NZTDS					
Dichlorvos	Biscuits, chocolate	8	1	0.0003	not detected	0.002
	Muesli	8	1	0.0010	not detected	0.008
Dicloran	Bread, wheatmeal	8	1	0.0003	not detected	0.003
	Bread, white	8	1	0.0007	not detected	0.006
	Kumara	8	3	0.0087	not detected	0.063
	Strawberries	8	1	0.0081	not detected	0.065
	Tomato	8	1	0.0006	not detected	0.005
Dicofol	Bran flake cereal, mixed	8	1	0.0009	not detected	0.007
Dicrotophos	not detected in any foods of 2009 NZTDS					
Dieldrin	Courgette	8	1	0.0012	not detected	0.009
Difenoconazole	Celery	8	2	0.0170	not detected	0.125
	Chinese dish	8	1	0.0003	not detected	0.002
	Silverbeet	8	1	0.0115	not detected	0.092
Diflufenican	not detected in any foods of 2009 NZTDS					
Dimethenamid	not detected in any foods of 2009 NZTDS					
Dimethoate	Beans	8	1	0.0016	not detected	0.013
	Capsicum	8	4	0.0501	not detected	0.188
	Courgette	8	4	0.3834	not detected	1.177
	Melon	8	1	0.0213	not detected	0.171
	Tomato	8	1	0.0017	not detected	0.014
Dimethomorph	not detected in any foods of 2009 NZTDS					
Dimethylvinphos	not detected in any foods of 2009 NZTDS					
Dinocap	not detected in any foods of 2009 NZTDS					
Dioxabenzofos	not detected in any foods of 2009 NZTDS					
Diphenamid	not detected in any foods of 2009 NZTDS					

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Diphenylamine	Apple	8	5	0.0326	not detected	0.198
	Biscuits, plain sweet	8	1	0.0002	not detected	0.001
	Infant weaning food, custard/fruit dish	8	2	0.0016	not detected	0.009
	Infant weaning food, savoury	8	1	0.0008	not detected	0.006
	Lettuce	8	1	0.0005	not detected	0.004
	Milk, 0.5% fat	8	1	0.0014	not detected	0.012
	Potato crisps	8	2	0.0024	not detected	0.012
Disulfoton	not detected in any foods of 2009 NZTDS					
DTCs	Apple	8	6	0.1974	not detected	0.429
	Apricot, canned	8	2	0.0829	not detected	0.569
	Avocado	8	5	0.1112	not detected	0.279
	Beans	8	2	0.0070	not detected	0.035
	Beetroot, canned	8	1	0.0048	not detected	0.038
	Broccoli/cauliflower	8	7	0.0556	not detected	0.124
	Cabbage	8	8	0.3951	0.081	0.732
	Carrot	8	3	0.0253	not detected	0.074
	Celery	8	5	0.0669	not detected	0.322
	Corn, canned	8	1	0.0037	not detected	0.029
	Cucumber	8	3	0.0085	not detected	0.025
	Grapes	8	7	0.2348	not detected	0.422
	Infant weaning food, cereal based	8	2	0.0082	not detected	0.035
	Infant weaning food, custard/fruit dish	8	1	0.0284	not detected	0.227
	Infant weaning food, savoury	8	4	0.0186	not detected	0.064
	Kiwifruit	8	4	0.0184	not detected	0.069
	Kumara	8	1	0.0035	not detected	0.028
	Lettuce	8	4	0.1227	not detected	0.809
	Melon	8	3	0.0318	not detected	0.106
	Mushrooms	8	4	0.0133	not detected	0.038
	Nectarine	8	2	0.0125	not detected	0.073
	Onion	8	4	0.0139	not detected	0.035
	Orange	8	7	0.0855	not detected	0.191
	Peaches, canned	8	2	0.0059	not detected	0.025
	Pear	8	8	0.2596	0.040	0.612
	Peas	8	3	0.0181	not detected	0.053
	Potato crisps	8	1	0.0050	not detected	0.040
	Potatoes, peeled	8	4	0.0932	not detected	0.347
	Potatoes, with skin	8	5	0.3177	not detected	0.921
	Prunes	8	1	0.0072	not detected	0.058
	Pumpkin	8	5	0.0321	not detected	0.163

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Raisins/sultanas	8	3	0.0378	not detected	0.173
	Silverbeet	8	4	0.0803	not detected	0.380
	Strawberries	8	4	0.0166	not detected	0.037
	Taro	8	4	0.0370	not detected	0.143
	Tomato	8	4	0.0811	not detected	0.509
	Tomato sauce	8	3	0.0255	not detected	0.077
	Tomatoes in juice	8	1	0.0028	not detected	0.022
Diuron	Carrot	8	4	0.0015	not detected	0.005
	Cheese	8	1	0.0005	not detected	0.004
	Potato, hot chips	8	4	0.0019	not detected	0.004
Edifenphos	not detected in any foods of 2009 NZTDS					
Endosulfan 1	Tomato	8	1	0.0011	not detected	0.009
Endosulfan II	Courgette	8	1	0.0002	not detected	0.002
	Pear	8	1	0.0002	not detected	0.001
	Strawberries	8	1	0.0004	not detected	0.003
	Tomato	8	2	0.0051	not detected	0.038
Endosulfan sulphate	Chinese dish	8	1	0.0004	not detected	0.003
	Courgette	8	4	0.0059	not detected	0.023
	Cucumber	8	1	0.0009	not detected	0.007
	Tomato	8	2	0.0012	not detected	0.007
Endrin	not detected in any foods of 2009 NZTDS					
Endrin-aldehyde	not detected in any foods of 2009 NZTDS					
Endrin-Ketone	not detected in any foods of 2009 NZTDS					
EPN	Fish fingers	8	1	0.0004	not detected	0.003
Epoxiconazole	not detected in any foods of 2009 NZTDS					
EPTC	not detected in any foods of 2009 NZTDS					
Esfenvalerate	not detected in any foods of 2009 NZTDS					
Esprocarb	not detected in any foods of 2009 NZTDS					
Ethion	Indian dish	8	3	0.0007	not detected	0.002
	Mussels	8	1	0.0002	not detected	0.002
	Noodles, instant	8	1	0.0002	not detected	0.002
	Snacks, flavoured	8	1	0.0002	not detected	0.001
Ethofumesate	not detected in any foods of 2009 NZTDS					
Ethoprophos	not detected in any foods of 2009 NZTDS					
Ethoxyquin	not detected in any foods of 2009 NZTDS					
Etridiazole	not detected in any foods of 2009 NZTDS					
Etrimfos	not detected in any foods of 2009 NZTDS					
Famphur	not detected in any foods of 2009 NZTDS					
Fenamiphos	not detected in any foods of 2009 NZTDS					
Fenarimol	Cucumber	8	1	0.0003	not detected	0.002
Fenchlorphos	Chicken takeaway	8	1	0.0002	not detected	0.001
Fenitrothion	Biscuits, plain sweet	8	1	0.0015	not detected	0.012
	Bran flake cereal, mixed	8	1	0.0014	not detected	0.011

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Bread, mixed grain	8	1	0.0016	not detected	0.013
	Bread, wheatmeal	8	1	0.0058	not detected	0.046
	Hamburger, plain	8	4	0.0225	not detected	0.064
	Meat pie	8	1	0.0011	not detected	0.009
	Muesli	8	2	0.0120	not detected	0.052
	Muffin	8	8	0.0109	0.008	0.018
	Oats, rolled	8	2	0.0091	not detected	0.063
	Pasta, dried	8	2	0.0026	not detected	0.017
	Pizza	8	1	0.0005	not detected	0.004
Fenobucarb	not detected in any foods of 2009 NZTDS					
Fenoxaprop-ethyl	not detected in any foods of 2009 NZTDS					
Fenpiclonil	not detected in any foods of 2009 NZTDS					
Fenpropathrin	Grapes	8	3	0.0055	not detected	0.025
Fenpropimorph	not detected in any foods of 2009 NZTDS					
Fensulfothion	not detected in any foods of 2009 NZTDS					
Fenthion	not detected in any foods of 2009 NZTDS					
Fenvalerate	not detected in any foods of 2009 NZTDS					
Flamprop-methyl	Potato, hot chips	8	1	0.0004	not detected	0.003
Fluazifop-butyl	not detected in any foods of 2009 NZTDS					
Flucythrinate	not detected in any foods of 2009 NZTDS					
Fludioxonil	Bran flake cereal, mixed	8	1	0.0002	not detected	0.002
	Muffin	8	3	0.0020	not detected	0.007
	Nectarine	8	4	0.1673	not detected	0.556
	Pear	8	1	0.0040	not detected	0.032
	Raisins/sultanas	8	1	0.0010	not detected	0.008
	Strawberries	8	5	0.0533	not detected	0.192
Fluometuron	not detected in any foods of 2009 NZTDS					
Flusilazole	not detected in any foods of 2009 NZTDS					
Flutriafol	not detected in any foods of 2009 NZTDS					
Fluvalinate	Cucumber	8	2	0.0058	not detected	0.028
Folpet	not detected in any foods of 2009 NZTDS					
Fonofos	not detected in any foods of 2009 NZTDS					
Furalaxyl	not detected in any foods of 2009 NZTDS					
Furathiocarb	Chicken takeaway	8	1	0.0016	not detected	0.013
Halfenprox	not detected in any foods of 2009 NZTDS					
Haloxyfop-methyl	Pork chop	8	1	0.0020	not detected	0.016
Heptachlor	not detected in any foods of 2009 NZTDS					
Heptachlor-epoxide	not detected in any foods of 2009 NZTDS					
Heptenophos	not detected in any foods of 2009 NZTDS					
Hexachlorobenzene	not detected in any foods of 2009 NZTDS					
Hexaconazole	not detected in any foods of 2009 NZTDS					
Hexazinone	not detected in any foods of 2009 NZTDS					
Hexythiazox	not detected in any foods of 2009 NZTDS					

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Imazalil	Infant weaning food, custard/fruit dish	8	1	0.0017	not detected	0.014
	Orange	8	7	0.1699	not detected	0.412
	Sausages	8	1	0.0007	not detected	0.005
	Tomato	8	1	0.0101	not detected	0.081
Indoxacarb	Grapes	8	1	0.0025	not detected	0.020
	Silverbeet	8	1	0.0023	not detected	0.018
Iodofenphos	not detected in any foods of 2009 NZTDS					
Iprobenfos	not detected in any foods of 2009 NZTDS					
Iprodione	Apricot, canned	8	2	0.0072	not detected	0.047
	Cucumber	8	1	0.0024	not detected	0.019
	Infant weaning food, custard/fruit dish	8	1	0.0024	not detected	0.019
	Jam	8	2	0.0113	not detected	0.066
	Muesli	8	2	0.0087	not detected	0.057
	Nectarine	8	4	0.1336	not detected	0.489
	Peaches, canned	8	2	0.0037	not detected	0.019
	Pear	8	2	0.0128	not detected	0.071
	Raisins/sultanas	8	2	0.0181	not detected	0.121
	Strawberries	8	5	0.0896	not detected	0.273
	Tomato	8	2	0.0289	not detected	0.171
	Wine, still white	8	4	0.0759	not detected	0.221
Isazophos	not detected in any foods of 2009 NZTDS					
Isofenphos	not detected in any foods of 2009 NZTDS					
Isopropcarb	Infant weaning food, custard/fruit dish	8	2	0.0005	not detected	0.002
Kresoxim-methyl	not detected in any foods of 2009 NZTDS					
Leptophos	not detected in any foods of 2009 NZTDS					
Lindane (gamma-BHC)	not detected in any foods of 2009 NZTDS					
Linuron	Carrot	8	4	0.0039	not detected	0.012
Malathion	Biscuits, chocolate	8	2	0.0006	not detected	0.004
	Biscuits, cracker	8	1	0.0018	not detected	0.014
	Biscuits, plain sweet	8	4	0.0101	not detected	0.068
	Bread, mixed grain	8	2	0.0013	not detected	0.008
	Bread, wheatmeal	8	2	0.0016	not detected	0.009
	Bread, white	8	2	0.0005	not detected	0.003
	Muesli	8	1	0.0033	not detected	0.026
	Snacks, flavoured	8	1	0.0008	not detected	0.006
	Wheat biscuit cereals	8	1	0.0007	not detected	0.006
Mepronil	not detected in any foods of 2009 NZTDS					
Metalaxyl	Cucumber	8	6	0.0165	not detected	0.058
	Potatoes, with skin	8	1	0.0004	not detected	0.003
	Strawberries	8	2	0.0886	not detected	0.394

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Methacrifos	not detected in any foods of 2009 NZTDS					
Methamidiphos	Capsicum	8	4	0.0448	not detected	0.208
	Cucumber	8	2	0.0290	not detected	0.162
	Tomatoes in juice	8	1	0.0141	not detected	0.113
	Silverbeet	8	1	0.0096	not detected	0.077
Methidathion	Biscuits, cracker	8	1	0.0006	not detected	0.005
Methiocarb	Celery	8	1	0.0019	not detected	0.015
	Grapes	8	1	0.0009	not detected	0.007
Methoxychlor	not detected in any foods of 2009 NZTDS					
Metolachlor	not detected in any foods of 2009 NZTDS					
Metribuzin	not detected in any foods of 2009 NZTDS					
Mevinphos	not detected in any foods of 2009 NZTDS					
Molinate	not detected in any foods of 2009 NZTDS					
Monocrotophos	not detected in any foods of 2009 NZTDS					
Myclobutanil	Apple	8	2	0.0003	not detected	0.002
	Chicken takeaway	8	1	0.0003	not detected	0.002
	Grapes	8	3	0.0024	not detected	0.015
	Strawberries	8	4	0.0036	not detected	0.012
Naled	not detected in any foods of 2009 NZTDS					
Napropamide	not detected in any foods of 2009 NZTDS					
Nitrofen	not detected in any foods of 2009 NZTDS					
Nitrothal-isopropyl	not detected in any foods of 2009 NZTDS					
Norflurazon	not detected in any foods of 2009 NZTDS					
Omethoate	Courgette	8	4	0.1038	not detected	0.300
Oxadiazon	not detected in any foods of 2009 NZTDS					
Oxadixyl	not detected in any foods of 2009 NZTDS					
Oxychlordane	not detected in any foods of 2009 NZTDS					
Oxyfluorfen	not detected in any foods of 2009 NZTDS					
Paclobutrazol	not detected in any foods of 2009 NZTDS					
Parathion-ethyl	not detected in any foods of 2009 NZTDS					
Parathion-methyl	not detected in any foods of 2009 NZTDS					
Penconazole	Chicken takeaway	8	1	0.0002	not detected	0.001
	Pear	8	1	0.0003	not detected	0.002
Pendimethalin	not detected in any foods of 2009 NZTDS					
Permethrin	Apple	8	1	0.0009	not detected	0.007
Phenthoate	Muesli	8	1	0.0003	not detected	0.003
Phorate	not detected in any foods of 2009 NZTDS					
Phosalone	not detected in any foods of 2009 NZTDS					
Phosmet	not detected in any foods of 2009 NZTDS					
Phosphamidon	not detected in any foods of 2009 NZTDS					
Piperonyl butoxide	Biscuits, chocolate	8	4	0.0118	not detected	0.053
	Biscuits, cracker	8	5	0.0167	not detected	0.088
	Biscuits, plain sweet	8	6	0.0879	not detected	0.207

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Bran flake cereal, mixed	8	2	0.0047	not detected	0.026
	Bread, mixed grain	8	4	0.0332	not detected	0.136
	Bread, wheatmeal	8	4	0.0571	not detected	0.224
	Bread, white	8	4	0.0486	not detected	0.163
	Cake	8	4	0.0114	not detected	0.031
	Chicken takeaway	8	4	0.0012	not detected	0.003
	Chinese dish	8	4	0.0006	not detected	0.001
	Chocolate, plain milk	8	2	0.0018	not detected	0.010
	Cornflakes	8	1	0.0012	not detected	0.010
	Fish fingers	8	4	0.0094	not detected	0.025
	Fish in batter	8	4	0.0038	not detected	0.014
	Fish, fresh	8	1	0.0004	not detected	0.004
	Grapes	8	1	0.0002	not detected	0.001
	Hamburger, plain	8	3	0.0020	not detected	0.007
	Indian dish	8	2	0.0009	not detected	0.004
	Kiwifruit	8	1	0.0002	not detected	0.002
	Lettuce	8	1	0.0012	not detected	0.009
	Meat pie	8	4	0.0042	not detected	0.016
	Muesli	8	5	0.0174	not detected	0.058
	Muffin	8	5	0.0118	not detected	0.049
	Mussels	8	1	0.0015	not detected	0.012
	Pasta, dried	8	6	0.0577	not detected	0.163
	Peanut butter	8	1	0.0016	not detected	0.013
	Pizza	8	5	0.0080	not detected	0.030
	Potato crisps	8	1	0.0002	not detected	0.002
	Potato, hot chips	8	2	0.0011	not detected	0.007
	Prunes	8	1	0.0003	not detected	0.002
	Raisins/sultanas	8	4	0.0418	not detected	0.258
	Sausages	8	2	0.0014	not detected	0.008
	Snack bars	8	4	0.0102	not detected	0.038
	Snacks, flavoured	8	2	0.0027	not detected	0.015
	Spaghetti in sauce, canned	8	4	0.0112	not detected	0.054
Pirimicarb	Celery	8	1	0.0003	not detected	0.002
	Courgette	8	2	0.0013	not detected	0.007
	Lettuce	8	1	0.0112	not detected	0.090
Pirimiphos-methyl	Biscuits, chocolate	8	6	0.0259	not detected	0.065
	Biscuits, cracker	8	5	0.0320	not detected	0.125
	Biscuits, plain sweet	8	5	0.0457	not detected	0.131
	Bran flake cereal, mixed	8	3	0.0027	not detected	0.010
	Bread, mixed grain	8	8	0.0759	0.024	0.165
	Bread, wheatmeal	8	8	0.0682	0.003	0.232
	Bread, white	8	8	0.0342	0.002	0.078
	Cake	8	5	0.0027	not detected	0.007

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Celery	8	1	0.0008	not detected	0.006
	Chicken takeaway	8	1	0.0002	not detected	0.002
	Chinese dish	8	1	0.0005	not detected	0.004
	Cornflakes	8	1	0.0006	not detected	0.005
	Fish fingers	8	8	0.0161	0.008	0.031
	Fish in batter	8	3	0.0025	not detected	0.012
	Hamburger, plain	8	8	0.0125	0.002	0.034
	Meat pie	8	7	0.0093	not detected	0.027
	Muesli	8	4	0.0094	not detected	0.058
	Muffin	8	8	0.0074	0.002	0.024
	Noodles, instant	8	2	0.0018	not detected	0.011
	Oats, rolled	8	2	0.0009	not detected	0.005
	Pasta, dried	8	1	0.0004	not detected	0.003
	Pizza	8	5	0.0126	not detected	0.058
	Sausages	8	8	0.0199	0.009	0.032
	Snack bars	8	5	0.0025	not detected	0.007
	Snacks, flavoured	8	3	0.0076	not detected	0.024
	Spaghetti in sauce, canned	8	1	0.0004	not detected	0.003
	Tomato	8	2	0.0042	not detected	0.026
	Wheat biscuit cereals	8	1	0.0048	not detected	0.038
Prochloraz	not detected in any foods of 2009 NZTDS					
Procymidone	Bran flake cereal, mixed	8	4	0.0196	not detected	0.043
	Cabbage	8	2	0.0006	not detected	0.004
	Celery	8	1	0.0043	not detected	0.034
	Chinese dish	8	2	0.0056	not detected	0.043
	Cucumber	8	1	0.0008	not detected	0.007
	Lettuce	8	2	0.0004	not detected	0.002
	Muesli	8	4	0.0030	not detected	0.012
	Muffin	8	2	0.0005	not detected	0.002
	Nectarine	8	2	0.0186	not detected	0.137
	Raisins/sultanas	8	6	0.0292	not detected	0.076
	Snack bars	8	4	0.0039	not detected	0.015
	Tomatoes in juice	8	1	0.0003	not detected	0.002
Profenofos	not detected in any foods of 2009 NZTDS					
Prometryn	not detected in any foods of 2009 NZTDS					
Propachlor	not detected in any foods of 2009 NZTDS					
Propanil	not detected in any foods of 2009 NZTDS					
Propaphos	Nectarine	8	1	0.0007	not detected	0.006
Propargite	Bran flake cereal, mixed	8	1	0.0004	not detected	0.003
	Raisins/sultanas	8	2	0.0059	not detected	0.028
	Snack bars	8	1	0.0005	not detected	0.004
Propazine	not detected in any foods of 2009 NZTDS					
Propetamphos	not detected in any foods of 2009 NZTDS					

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Propham	Apple	8	1	0.0052	not detected	0.042
	Fish in batter	8	3	0.0219	not detected	0.101
	Potato crisps	8	4	0.1590	not detected	0.741
	Potatoes, peeled	8	3	0.0996	not detected	0.459
	Potatoes, with skin	8	5	0.0930	not detected	0.356
Propiconazole	Chicken takeaway	8	1	0.0007	not detected	0.005
	Rice, white	8	1	0.0019	not detected	0.015
Propoxur	not detected in any foods of 2009 NZTDS					
Propyzamide	not detected in any foods of 2009 NZTDS					
Prothiofos	Grapes	8	2	0.0016	not detected	0.008
Pyraclofos	not detected in any foods of 2009 NZTDS					
Pyrazophos	not detected in any foods of 2009 NZTDS					
Pyrazoxyfen	not detected in any foods of 2009 NZTDS					
Pyrethrin	not detected in any foods of 2009 NZTDS					
Pyrifenox	not detected in any foods of 2009 NZTDS					
Pyrimethanil	Bran flake cereal, mixed	8	3	0.0028	not detected	0.010
	Chicken takeaway	8	4	0.0007	not detected	0.002
	Chinese dish	8	2	0.0005	not detected	0.002
	Cucumber	8	2	0.0042	not detected	0.018
	Grapes	8	4	0.0138	not detected	0.061
	Hamburger, plain	8	1	0.0003	not detected	0.002
	Muesli	8	5	0.0039	not detected	0.013
	Muffin	8	1	0.0002	not detected	0.002
	Pear	8	2	0.0141	not detected	0.096
	Pizza	8	1	0.0001	not detected	0.001
	Raisins/sultanas	8	5	0.0133	not detected	0.053
	Snack bars	8	4	0.0024	not detected	0.007
	Strawberries	8	5	0.3282	not detected	1.566
	Tomato	8	1	0.0003	not detected	0.002
	Wine, still red	8	1	0.0004	not detected	0.004
	Wine, still white	8	1	0.0008	not detected	0.006
Pyriproxyfen	not detected in any foods of 2009 NZTDS					
Quinalphos	not detected in any foods of 2009 NZTDS					
Quintozene	Celery	8	1	0.0022	not detected	0.017
Quizalofop-ethyl	not detected in any foods of 2009 NZTDS					
Simazine	not detected in any foods of 2009 NZTDS					
Simetryn	not detected in any foods of 2009 NZTDS					
Sulfentrazone	not detected in any foods of 2009 NZTDS					
Sulfotep	not detected in any foods of 2009 NZTDS					
Tebuconazole	Nectarine	8	4	0.0049	not detected	0.018
Tebufenpyrad	Pear	8	1	0.0026	not detected	0.021
Tefluthrin	not detected in any foods of 2009 NZTDS					
Terbacil	not detected in any foods of 2009 NZTDS					

Agricultural compound residue	2009 NZTDS Food	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Terbufos	not detected in any foods of 2009 NZTDS					
Terbumeton	not detected in any foods of 2009 NZTDS					
Terbuthylazine	not detected in any foods of 2009 NZTDS					
Terbuthylazine-desethyl	not detected in any foods of 2009 NZTDS					
Terbutryn	not detected in any foods of 2009 NZTDS					
Tetrachlorvinphos	not detected in any foods of 2009 NZTDS					
Tetradifon	not detected in any foods of 2009 NZTDS					
Thenylchlor	not detected in any foods of 2009 NZTDS					
Thiobencarb	not detected in any foods of 2009 NZTDS					
Thiometon	Melon	8	1	0.0075	not detected	0.060
Tolclofos-methyl	not detected in any foods of 2009 NZTDS					
Tolylfluanid	Cucumber	8	1	0.0003	not detected	0.002
	Pear	8	1	0.0005	not detected	0.004
	Strawberries	8	4	0.0829	not detected	0.222
Triadimefon	Coffee beans, ground	8	2	0.0034	not detected	0.014
Tri-allate	not detected in any foods of 2009 NZTDS					
Triazophos	not detected in any foods of 2009 NZTDS					
Trifloxystrobin	Grapes	8	4	0.0072	not detected	0.020
	Strawberries	8	1	0.0003	not detected	0.002
Trifluralin	not detected in any foods of 2009 NZTDS					
Vinclozolin	not detected in any foods of 2009 NZTDS					

APPENDIX 6: FOODS OF THE 2009 NZTDS, AND AGRICULTURAL COMPOUND RESIDUES DETECTED

In this appendix, all foods in the 2009 NZTDS are listed alphabetically, with agricultural compound residues detected and their associated concentrations. Reporting is on the same basis as explained in Appendix 5.

There is one major difference, however, in that in Appendix 5, all agricultural compounds screened for in the 2009 NZTDS are listed in alphabetical order, along with the foods in which they were found, and associated concentrations.

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	Captan	8	1	0.0041	not detected	0.033
	Diazinon	8	2	0.0005	not detected	0.003
	Diphenylamine	8	5	0.0326	not detected	0.198
	DTCs	8	6	0.1974	not detected	0.429
	Myclobutanil	8	2	0.0003	not detected	0.002
	Permethrin	8	1	0.0009	not detected	0.007
	Propham	8	1	0.0052	not detected	0.042
Apple-based juice		8	0	no agricultural compound residues detected		
Apricot, canned	DTCs	8	2	0.0829	not detected	0.569
	Iprodione	8	2	0.0072	not detected	0.047
Avocado	DTCs	8	5	0.1112	not detected	0.279
Bacon	DDE - 4,4’	8	5	0.0012	not detected	0.004
Banana		8	0	no agricultural compound residues detected		
Beans	Dimethoate	8	1	0.0016	not detected	0.013
	DTCs	8	2	0.0070	not detected	0.035
Beans, baked, canned		8	0	no agricultural compound residues detected		
Beef, mince	DDE - 4,4’	8	5	0.0042	not detected	0.016
Beef, rump		8	0	no agricultural compound residues detected		
Beer		8	0	no agricultural compound residues detected		
Beetroot, canned	DTCs	8	1	0.0048	not detected	0.038
Biscuits, chocolate	Chlorpyriphos-methyl	8	1	0.0012	not detected	0.010
	Diazinon	8	1	0.0015	not detected	0.012
	Dichlorvos	8	1	0.0003	not detected	0.002
	Malathion	8	2	0.0006	not detected	0.004
	Piperonyl butoxide	8	4	0.0118	not detected	0.053
	Pirimiphos-methyl	8	6	0.0259	not detected	0.065
Biscuits, cracker	Chlorpyriphos-methyl	8	3	0.0098	not detected	0.037
	Malathion	8	1	0.0018	not detected	0.014
	Methidathion	8	1	0.0006	not detected	0.005
	Piperonyl butoxide	8	5	0.0167	not detected	0.088
	Pirimiphos-methyl	8	5	0.0320	not detected	0.125

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Biscuits, plain sweet	Chlorpyriphos-methyl	8	2	0.0190	not detected	0.084
	Deltamethrin	8	1	0.0029	not detected	0.023
	Diazinon	8	1	0.0004	not detected	0.003
	Diphenylamine	8	1	0.0002	not detected	0.001
	Fenitrothion	8	1	0.0015	not detected	0.012
	Malathion	8	4	0.0101	not detected	0.068
	Piperonyl butoxide	8	6	0.0879	not detected	0.207
	Pirimiphos-methyl	8	5	0.0457	not detected	0.131
Bran flake cereal, mixed	Chlorpyriphos	8	4	0.0025	not detected	0.010
	Chlorpyriphos-methyl	8	1	0.0047	not detected	0.037
	Cypermethrin	8	1	0.0015	not detected	0.012
	Cyprodonil	8	2	0.0013	not detected	0.008
	Dicofol	8	1	0.0009	not detected	0.007
	Fenitrothion	8	1	0.0014	not detected	0.011
	Fludioxonil	8	1	0.0002	not detected	0.002
	Piperonyl butoxide	8	2	0.0047	not detected	0.026
	Pirimiphos-methyl	8	3	0.0027	not detected	0.010
	Procymidone	8	4	0.0196	not detected	0.043
	Propargite	8	1	0.0004	not detected	0.003
	Pyrimethanil	8	3	0.0028	not detected	0.010
Bread, mixed grain	Chlorpyriphos	8	1	0.0003	not detected	0.002
	Deltamethrin	8	3	0.0085	not detected	0.035
	Fenitrothion	8	1	0.0016	not detected	0.013
	Malathion	8	2	0.0013	not detected	0.008
	Piperonyl butoxide	8	4	0.0332	not detected	0.136
	Pirimiphos-methyl	8	8	0.0759	0.024	0.165
Bread, wheatmeal	Chlorpyriphos	8	2	0.0006	not detected	0.002
	Deltamethrin	8	4	0.0132	not detected	0.049
	Dicloran	8	1	0.0003	not detected	0.003
	Fenitrothion	8	1	0.0058	not detected	0.046
	Malathion	8	2	0.0016	not detected	0.009
	Piperonyl butoxide	8	4	0.0571	not detected	0.224
	Pirimiphos-methyl	8	8	0.0682	0.003	0.232
Bread, white	Chlorpyriphos	8	2	0.0009	not detected	0.005
	Deltamethrin	8	3	0.0111	not detected	0.044
	Dicloran	8	1	0.0007	not detected	0.006
	Malathion	8	2	0.0005	not detected	0.003
	Piperonyl butoxide	8	4	0.0486	not detected	0.163
	Pirimiphos-methyl	8	8	0.0342	0.002	0.078

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Broccoli/cauliflower	DTCs	8	7	0.0556	not detected	0.124
Butter	DDE - 4,4’	8	8	0.0140	0.005	0.029
Cabbage	DTCs	8	8	0.3951	0.081	0.732
	Procymidone	8	2	0.0006	not detected	0.004
Caffeinated beverage		8	0	no agricultural compound residues detected		
Cake	Piperonyl butoxide	8	4	0.0114	not detected	0.031
	Pirimiphos-methyl	8	5	0.0027	not detected	0.007
Capsicum	Azoxystrobin	8	1	0.0061	not detected	0.049
	Bifenthrin	8	3	0.0032	not detected	0.011
	Buprofezin	8	2	0.0021	not detected	0.011
	Dimethoate	8	4	0.0501	not detected	0.188
	Methamidiphos	8	4	0.0448	not detected	0.208
Carbonated drink		8	0	no agricultural compound residues detected		
Carrot	DTCs	8	3	0.0253	not detected	0.074
	Diuron	8	4	0.0015	not detected	0.005
	Linuron	8	4	0.0039	not detected	0.012
Celery	Acephate	8	1	0.0135	not detected	0.108
	Chlorothalonil	8	4	0.0111	not detected	0.065
	Difenoconazole	8	2	0.0170	not detected	0.125
	DTCs	8	5	0.0669	not detected	0.322
	Methiocarb	8	1	0.0019	not detected	0.015
	Pirimicarb	8	1	0.0003	not detected	0.002
	Pirimiphos-methyl	8	1	0.0008	not detected	0.006
	Procymidone	8	1	0.0043	not detected	0.034
	Quintozene	8	1	0.0022	not detected	0.017
Cheese	DDE - 4,4’	8	2	0.0012	not detected	0.005
	Diuron	8	1	0.0005	not detected	0.004
Chicken		8	0	no agricultural compound residues detected		
Chicken takeaway	Chlorpyriphos-methyl	8	1	0.0002	not detected	0.001
	Cyanophos	8	1	0.0002	not detected	0.002
	Fenchlorphos	8	1	0.0002	not detected	0.001
	Furathiocarb	8	1	0.0016	not detected	0.013
	Myclobutanil	8	1	0.0003	not detected	0.002
	Penconazole	8	1	0.0002	not detected	0.001
	Piperonyl butoxide	8	4	0.0012	not detected	0.003
	Pirimiphos-methyl	8	1	0.0002	not detected	0.002
	Propiconazole	8	1	0.0007	not detected	0.005
	Pyrimethanil	8	4	0.0007	not detected	0.002
Chinese dish	Difenoconazole	8	1	0.0003	not detected	0.002
	Endosulfan sulphate	8	1	0.0004	not detected	0.003

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Piperonyl butoxide	8	4	0.0006	not detected	0.001
	Pirimiphos-methyl	8	1	0.0005	not detected	0.004
	Procymidone	8	2	0.0056	not detected	0.043
	Pyrimethanil	8	2	0.0005	not detected	0.002
Chocolate beverage		8	0	no agricultural compound residues detected		
Chocolate, plain milk	Piperonyl butoxide	8	2	0.0018	not detected	0.010
Coffee beans, ground	Triadimefon	8	2	0.0034	not detected	0.014
Coffee, instant		8	0	no agricultural compound residues detected		
Confectionery		8	0	no agricultural compound residues detected		
Corn, canned	DTCs	8	1	0.0037	not detected	0.029
Corned beef		8	0	no agricultural compound residues detected		
Cornflakes	Piperonyl butoxide	8	1	0.0012	not detected	0.010
	Pirimiphos-methyl	8	1	0.0006	not detected	0.005
Courgette	Bifenthrin	8	2	0.0006	not detected	0.003
	Dieldrin	8	1	0.0012	not detected	0.009
	Dimethoate	8	4	0.3834	not detected	1.177
	Endosulfan II	8	1	0.0002	not detected	0.002
	Endosulfan sulphate	8	4	0.0059	not detected	0.023
	Omethoate	8	4	0.1038	not detected	0.300
	Pirimicarb	8	2	0.0013	not detected	0.007
Cream	DDE - 4,4’	8	6	0.0087	not detected	0.024
Cucumber	Buprofezin	8	1	0.0003	not detected	0.002
	Chlorothalonil	8	3	0.0027	not detected	0.009
	Cyproconazole	8	1	0.0006	not detected	0.005
	DTCs	8	3	0.0085	not detected	0.025
	Endosulfan sulphate	8	1	0.0009	not detected	0.007
	Fenarimol	8	1	0.0003	not detected	0.002
	Fluvalinate	8	2	0.0058	not detected	0.028
	Iprodione	8	1	0.0024	not detected	0.019
	Metalaxyl	8	6	0.0165	not detected	0.058
	Methamidiphos	8	2	0.0290	not detected	0.162
	Procymidone	8	1	0.0008	not detected	0.007
	Pyrimethanil	8	2	0.0042	not detected	0.018
	Tolylfluanid	8	1	0.0003	not detected	0.002
Dairy dessert		8	0	no agricultural compound residues detected		
Egg	DDE - 4,4’	8	4	0.0017	not detected	0.004
Fish fingers	EPN	8	1	0.0004	not detected	0.003
	Piperonyl butoxide	8	4	0.0094	not detected	0.025
	Pirimiphos-methyl	8	8	0.0161	0.008	0.031

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Fish in batter	DDE - 4,4’	8	1	0.0002	not detected	0.002
	Piperonyl butoxide	8	4	0.0038	not detected	0.014
	Pirimiphos-methyl	8	3	0.0025	not detected	0.012
	Propham	8	3	0.0219	not detected	0.101
Fish, canned		8	0	no agricultural compound residues detected		
Fish, fresh	Piperonyl butoxide	8	1	0.0004	not detected	0.004
Fruit drink, powdered		8	0	no agricultural compound residues detected		
Grapes	Buprofezin	8	5	0.0089	not detected	0.027
	Chlorpyriphos	8	3	0.0047	not detected	0.018
	Cyprodonil	8	7	0.0499	not detected	0.166
	DTCs	8	7	0.2348	not detected	0.422
	Fenpropathrin	8	3	0.0055	not detected	0.025
	Indoxacarb	8	1	0.0025	not detected	0.020
	Methiocarb	8	1	0.0009	not detected	0.007
	Myclobutanil	8	3	0.0024	not detected	0.015
	Piperonyl butoxide	8	1	0.0002	not detected	0.001
	Prothiofos	8	2	0.0016	not detected	0.008
	Pyrimethanil	8	4	0.0138	not detected	0.061
	Trifloxystrobin	8	4	0.0072	not detected	0.020
Ham		8	0	no agricultural compound residues detected		
Hamburger, plain	Chlorpyriphos-methyl	8	3	0.0018	not detected	0.008
	Fenitrothion	8	4	0.0225	not detected	0.064
	Piperonyl butoxide	8	3	0.0020	not detected	0.007
	Pirimiphos-methyl	8	8	0.0125	0.002	0.034
	Pyrimethanil	8	1	0.0003	not detected	0.002
Honey		8	0	no agricultural compound residues detected		
Ice cream	DDE - 4,4’	8	2	0.0023	not detected	0.014
Indian dish	Chlorpyriphos	8	1	0.0030	not detected	0.024
	DDE - 4,4’	8	1	0.0001	not detected	0.001
	Ethion	8	3	0.0007	not detected	0.002
	Piperonyl butoxide	8	2	0.0009	not detected	0.004
Infant and Follow-on formula		8	0	no agricultural compound residues detected		
Infant weaning food, cereal based	DTCs	8	2	0.0082	not detected	0.035
Infant weaning food, custard/fruit dish	Diphenylamine	8	2	0.0016	not detected	0.009
	DTCs	8	1	0.0284	not detected	0.227
	Imazalil	8	1	0.0017	not detected	0.014
	Iprodione	8	1	0.0024	not detected	0.019
	Isopropcarb	8	2	0.0005	not detected	0.002

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Infant weaning food, savoury	Diphenylamine	8	1	0.0008	not detected	0.006
	DTCs	8	4	0.0186	not detected	0.064
Jam	Carbaryl	8	2	0.0134	not detected	0.075
	Cyprodonil	8	3	0.0016	not detected	0.005
	Iprodione	8	2	0.0113	not detected	0.066
Kiwifruit	Chlorpyriphos	8	1	0.0006	not detected	0.005
	DTCs	8	4	0.0184	not detected	0.069
	Piperonyl butoxide	8	1	0.0002	not detected	0.002
Kumara	Dicloran	8	3	0.0087	not detected	0.063
	DTCs	8	1	0.0035	not detected	0.028
Lamb/mutton	DDE - 4,4’	8	5	0.0027	not detected	0.006
Lambs liver	DDE - 4,4’	8	2	0.0028	not detected	0.015
Lettuce	Diphenylamine	8	1	0.0005	not detected	0.004
	DTCs	8	4	0.1227	not detected	0.809
	Piperonyl butoxide	8	1	0.0012	not detected	0.009
	Pirimicarb	8	1	0.0112	not detected	0.090
	Procymidone	8	2	0.0004	not detected	0.002
Margarine		8	0	no agricultural compound residues detected		
Meat pie	DDE - 4,4’	8	1	0.0001	not detected	0.001
	Fenitrothion	8	1	0.0011	not detected	0.009
	Piperonyl butoxide	8	4	0.0042	not detected	0.016
	Pirimiphos-methyl	8	7	0.0093	not detected	0.027
Melon	Dimethoate	8	1	0.0213	not detected	0.171
	DTCs	8	3	0.0318	not detected	0.106
	Thiometon	8	1	0.0075	not detected	0.060
Milk, 0.5% fat	Diphenylamine	8	1	0.0014	not detected	0.012
Milk, 3.25% fat	DDE - 4,4’	8	1	0.0001	not detected	0.001
Milk, flavoured		8	0	no agricultural compound residues detected		
Muesli	Chlorpyriphos	8	2	0.0007	not detected	0.003
	Chlorpyriphos-methyl	8	1	0.0008	not detected	0.007
	Cyprodonil	8	1	0.0002	not detected	0.001
	Dichlorvos	8	1	0.0010	not detected	0.008
	Fenitrothion	8	2	0.0120	not detected	0.052
	Iprodione	8	2	0.0087	not detected	0.057
	Malathion	8	1	0.0033	not detected	0.026
	Phenthoate	8	1	0.0003	not detected	0.003
	Piperonyl butoxide	8	5	0.0174	not detected	0.058
	Pirimiphos-methyl	8	4	0.0094	not detected	0.058
	Procymidone	8	4	0.0030	not detected	0.012
	Pyrimethanil	8	5	0.0039	not detected	0.013

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Muffin	Chlorpyriphos-methyl	8	4	0.0050	not detected	0.017
	Cyprodonil	8	4	0.0010	not detected	0.003
	Fenitrothion	8	8	0.0109	0.008	0.018
	Fludioxonil	8	3	0.0020	not detected	0.007
	Piperonyl butoxide	8	5	0.0118	not detected	0.049
	Pirimiphos-methyl	8	8	0.0074	0.002	0.024
	Procymidone	8	2	0.0005	not detected	0.002
	Pyrimethanil	8	1	0.0002	not detected	0.002
Mushrooms	DTCs	8	4	0.0133	not detected	0.038
Mussels	Ethion	8	1	0.0002	not detected	0.002
	Piperonyl butoxide	8	1	0.0015	not detected	0.012
Nectarine	Captan	8	1	0.0093	not detected	0.074
	Carbaryl	8	4	0.0471	not detected	0.340
	DTCs	8	2	0.0125	not detected	0.073
	Fludioxonil	8	4	0.1673	not detected	0.556
	Iprodione	8	4	0.1336	not detected	0.489
	Procymidone	8	2	0.0186	not detected	0.137
	Propaphos	8	1	0.0007	not detected	0.006
	Tebuconazole	8	4	0.0049	not detected	0.018
Noodles, instant	Ethion	8	1	0.0002	not detected	0.002
	Pirimiphos-methyl	8	2	0.0018	not detected	0.011
Oats, rolled	Chlorpyriphos-methyl	8	1	0.0018	not detected	0.014
	Fenitrothion	8	2	0.0091	not detected	0.063
	Pirimiphos-methyl	8	2	0.0009	not detected	0.005
Oil		8	0	no agricultural compound residues detected		
Onion	DTCs	8	4	0.0139	not detected	0.035
Orange	DTCs	8	7	0.0855	not detected	0.191
	Imazalil	8	7	0.1699	not detected	0.412
Orange juice		8	0	no agricultural compound residues detected		
Oysters		8	0	no agricultural compound residues detected		
Pasta, dried	Chlorpyriphos-methyl	8	2	0.0075	not detected	0.053
	Deltamethrin	8	2	0.0045	not detected	0.021
	Fenitrothion	8	2	0.0026	not detected	0.017
	Piperonyl butoxide	8	6	0.0577	not detected	0.163
	Pirimiphos-methyl	8	1	0.0004	not detected	0.003
Peaches, canned	Carbaryl	8	1	0.0040	not detected	0.032
	DTCs	8	2	0.0059	not detected	0.025
	Iprodione	8	2	0.0037	not detected	0.019
Peanuts		8	0	no agricultural compound residues detected		

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
Peanut butter	Piperonyl butoxide	8	1	0.0016	not detected	0.013
Pear	Captan	8	3	0.0194	not detected	0.082
	DTCs	8	8	0.2596	0.040	0.612
	Endosulfan II	8	1	0.0002	not detected	0.001
	Fludioxonil	8	1	0.0040	not detected	0.032
	Iprodione	8	2	0.0128	not detected	0.071
	Penconazole	8	1	0.0003	not detected	0.002
	Pyrimethanil	8	2	0.0141	not detected	0.096
	Tebufenpyrad	8	1	0.0026	not detected	0.021
	Tolylfluanid	8	1	0.0005	not detected	0.004
Peas	DTCs	8	3	0.0181	not detected	0.053
Pineapple		8	0	no agricultural compound residues detected		
Pizza	DDE - 4,4’	8	3	0.0006	not detected	0.002
	Fenitrothion	8	1	0.0005	not detected	0.004
	Piperonyl butoxide	8	5	0.0080	not detected	0.030
	Pirimiphos-methyl	8	5	0.0126	not detected	0.058
	Pyrimethanil	8	1	0.0001	not detected	0.001
Pork chop	DDE - 4,4’	8	5	0.0056	not detected	0.016
	Haloxyfop-methyl	8	1	0.0020	not detected	0.016
Potato crisps	Diphenylamine	8	2	0.0024	not detected	0.012
	DTCs	8	1	0.0050	not detected	0.040
	Piperonyl butoxide	8	1	0.0002	not detected	0.002
	Propham	8	4	0.1590	not detected	0.741
Potato, hot chips	Alachlor	8	3	0.0004	not detected	0.001
	Chlorpropham	8	4	0.0859	not detected	0.253
	Diuron	8	4	0.0019	not detected	0.004
	Flamprop-methyl	8	1	0.0004	not detected	0.003
	Piperonyl butoxide	8	2	0.0011	not detected	0.007
Potatoes, peeled	DTCs	8	4	0.0932	not detected	0.347
	Propham	8	3	0.0996	not detected	0.459
Potatoes, with skin	Azoxystrobin	8	1	0.0007	not detected	0.005
	DTCs	8	5	0.3177	not detected	0.921
	Metalaxyl	8	1	0.0004	not detected	0.003
	Propham	8	5	0.0930	not detected	0.356
Prunes	DTCs	8	1	0.0072	not detected	0.058
	Piperonyl butoxide	8	1	0.0003	not detected	0.002
Pumpkin	DTCs	8	5	0.0321	not detected	0.163
Raisins/sultanas	Chlorpyriphos	8	2	0.0018	not detected	0.008
	Cyprodonil	8	2	0.0051	not detected	0.027
	DTCs	8	3	0.0378	not detected	0.173
	Fludioxonil	8	1	0.0010	not detected	0.008

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Iprodione	8	2	0.0181	not detected	0.121
	Piperonyl butoxide	8	4	0.0418	not detected	0.258
	Procymidone	8	6	0.0292	not detected	0.076
	Propargite	8	2	0.0059	not detected	0.028
	Pyrimethanil	8	5	0.0133	not detected	0.053
Rice, white	Chlorpyriphos	8	1	0.0003	not detected	0.002
	Propiconazole	8	1	0.0019	not detected	0.015
Salad dressing		8	0	no agricultural compound residues detected		
Sausages	DDE - 4,4’	8	5	0.0063	not detected	0.015
	Imazalil	8	1	0.0007	not detected	0.005
	Piperonyl butoxide	8	2	0.0014	not detected	0.008
	Pirimiphos-methyl	8	8	0.0199	0.009	0.032
Silverbeet	Chlorpyriphos	8	1	0.0017	not detected	0.013
	Cyproconazole	8	1	0.0084	not detected	0.068
	Difenoconazole	8	1	0.0115	not detected	0.092
	DTCs	8	4	0.0803	not detected	0.380
	Indoxacarb	8	1	0.0023	not detected	0.018
	Methamidiphos	8	1	0.0096	not detected	0.077
Snack bars	Chlorpyriphos	8	1	0.0004	not detected	0.004
	Piperonyl butoxide	8	4	0.0102	not detected	0.038
	Pirimiphos-methyl	8	5	0.0025	not detected	0.007
	Procymidone	8	4	0.0039	not detected	0.015
	Propargite	8	1	0.0005	not detected	0.004
	Pyrimethanil	8	4	0.0024	not detected	0.007
Snacks, flavoured	Ethion	8	1	0.0002	not detected	0.001
	Malathion	8	1	0.0008	not detected	0.006
	Piperonyl butoxide	8	2	0.0027	not detected	0.015
	Pirimiphos-methyl	8	3	0.0076	not detected	0.024
Soy milk		8	0	no agricultural compound residues detected		
Soup, chicken		8	0	no agricultural compound residues detected		
Spaghetti in sauce, canned	Piperonyl butoxide	8	4	0.0112	not detected	0.054
	Pirimiphos-methyl	8	1	0.0004	not detected	0.003
Strawberries	Bitertanol	8	2	0.0097	not detected	0.040
	Captan	8	6	0.5196	not detected	1.278
	Carbaryl	8	2	0.0287	not detected	0.224
	Cyprodonil	8	8	0.0779	0.005	0.363
	Dicloran	8	1	0.0081	not detected	0.065
	DTCs	8	4	0.0166	not detected	0.037
	Endosulfan II	8	1	0.0004	not detected	0.003
	Fludioxonil	8	5	0.0533	not detected	0.192
	Iprodione	8	5	0.0896	not detected	0.273

2009 NZTDS Food	Agricultural compound detected	No. samples analysed	No. with residues	Mean (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)
	Metalaxyl	8	2	0.0886	not detected	0.394
	Myclobutanil	8	4	0.0036	not detected	0.012
	Pyrimethanil	8	5	0.3282	not detected	1.566
	Tolylfluanid	8	4	0.0829	not detected	0.222
	Trifloxystrobin	8	1	0.0003	not detected	0.002
Sugar		8	0	no agricultural compound residues detected		
Taro	DTCs	8	4	0.0370	not detected	0.143
Tea		8	0	no agricultural compound residues detected		
Tomato	Azaconazole	8	1	0.0093	not detected	0.074
	Chlorothalonil	8	1	0.0043	not detected	0.034
	Dicloran	8	1	0.0006	not detected	0.005
	Dimethoate	8	1	0.0017	not detected	0.014
	DTCs	8	4	0.0811	not detected	0.509
	Endosulfan 1	8	1	0.0011	not detected	0.009
	Endosulfan II	8	2	0.0051	not detected	0.038
	Endosulfan sulphate	8	2	0.0012	not detected	0.007
	Imazalil	8	1	0.0101	not detected	0.081
	Iprodione	8	2	0.0289	not detected	0.171
	Pirimiphos-methyl	8	2	0.0042	not detected	0.026
	Pyrimethanil	8	1	0.0003	not detected	0.002
Tomato sauce	DTCs	8	3	0.0255	not detected	0.077
Tomatoes in juice	DTCs	8	1	0.0028	not detected	0.022
	Methamidiphos	8	1	0.0141	not detected	0.113
	Procymidone	8	1	0.0003	not detected	0.002
Water, bottled		8	0	no agricultural compound residues detected		
Water, tap		8	0	no agricultural compound residues detected		
Wheat biscuit cereals	Malathion	8	1	0.0007	not detected	0.006
	Pirimiphos-methyl	8	1	0.0048	not detected	0.038
Wine, still red	Cyprodonil	8	4	0.0031	not detected	0.009
	Pyrimethanil	8	1	0.0004	not detected	0.004
Wine, still white	Cyprodonil	8	1	0.0004	not detected	0.003
	Iprodione	8	4	0.0759	not detected	0.221
	Pyrimethanil	8	1	0.0008	not detected	0.006
Yeast extract		6	0	no agricultural compound residues detected		
Yoghurt		8	0	no agricultural compound residues detected		

APPENDIX 7: SUMMARY OF ESTIMATED DIETARY EXPOSURES TO AGRICULTURAL COMPOUND RESIDUES BY AGE-GENDER COHORT AND AS A PERCENTAGE OF ADI IN THE 2009 NZTDS

Pesticide residue	ADI [A] (µg/kg bw/day)	Estimated dietary exposure for population age-gender cohort (µg/kg bw/day)							
		25+ yr males	25+ yr females	19–24 yr males	11–14 yr boys	11–14 yr girls	5–6 yr children	1–3 yr toddlers	6–12 month infants
Acephate	30	0.0004	0.0006	0.0004	0.0009	0.0005	0.0006	0.0011	0.0000
%ADI		0.001%	0.002%	0.001%	0.003%	0.002%	0.002%	0.004%	0.000%
Alachlor	0.5 [b]	0.0002	0.0001	0.0003	0.0004	0.0003	0.0004	0.0005	0.0003
%ADI		0.031%	0.018%	0.061%	0.074%	0.059%	0.078%	0.092%	0.057%
Azaconazole	25 [b]	0.0035	0.0040	0.0015	0.0030	0.0034	0.0023	0.0033	0.0029
%ADI		0.014%	0.016%	0.006%	0.012%	0.014%	0.009%	0.013%	0.012%
Azoxystrobin	200	0.0003	0.0004	0.0005	0.0007	0.0006	0.0008	0.0005	0.0002
%ADI		0.0002%	0.0002%	0.0002%	0.0004%	0.0003%	0.0004%	0.0003%	0.0001%
Bifenthrin	10	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0000
%ADI		0.0013%	0.0016%	0.0016%	0.0020%	0.0018%	0.0017%	0.0021%	0.0005%
Bitertanol	10	0.0004	0.0005	0.0002	0.0003	0.0006	0.0004	0.0011	0.0008
%ADI		0.004%	0.005%	0.002%	0.003%	0.006%	0.004%	0.011%	0.008%
Buprofezin	9	0.0004	0.0006	0.0004	0.0004	0.0005	0.0012	0.0011	0.0007
%ADI		0.004%	0.006%	0.004%	0.004%	0.005%	0.013%	0.012%	0.008%
Captan	100	0.030	0.036	0.018	0.023	0.041	0.048	0.074	0.061
%ADI		0.03%	0.04%	0.02%	0.02%	0.04%	0.05%	0.07%	0.06%
Carbaryl	8	0.013	0.016	0.005	0.008	0.008	0.022	0.013	0.024
%ADI		0.16%	0.20%	0.07%	0.10%	0.10%	0.28%	0.17%	0.30%
Chlorothalonil	20	0.0020	0.0025	0.0011	0.0023	0.0021	0.0017	0.0027	0.0017
%ADI		0.010%	0.012%	0.006%	0.011%	0.010%	0.008%	0.013%	0.008%
Chlorpropham	50	0.033	0.019	0.065	0.080	0.063	0.084	0.099	0.061
%ADI		0.07%	0.04%	0.13%	0.16%	0.13%	0.17%	0.20%	0.12%
Chlorpyriphos	10	0.0023	0.0022	0.0023	0.0036	0.0028	0.0054	0.0051	0.0044
%ADI		0.02%	0.02%	0.02%	0.04%	0.03%	0.05%	0.05%	0.04%
Chlorpyriphos-methyl	10	0.0064	0.0062	0.0084	0.0098	0.0089	0.0165	0.0321	0.0243
%ADI		0.06%	0.06%	0.08%	0.10%	0.09%	0.16%	0.32%	0.24%
Cyanophos	No ADI	0.00001	0.00001	0.00002	0.00003	0.00002	0.00003	0.00007	0.00005
Cypermethrin	20	0.00004	0.00005	0.00005	0.00008	0.00008	0.00007	0.00025	0.00024
%ADI		0.0002%	0.0002%	0.0003%	0.0004%	0.0004%	0.0003%	0.0012%	0.0012%
Cyproconazole	No ADI	0.00057	0.00064	0.00068	0.00048	0.00035	0.00067	0.00098	0.00108
Cyprodinil	30	0.0066	0.0083	0.0042	0.0040	0.0072	0.0108	0.0176	0.0135
%ADI		0.022%	0.028%	0.014%	0.013%	0.024%	0.036%	0.059%	0.045%
4,4’ -DDE (= total)	10	0.0099	0.0073	0.0112	0.0106	0.0073	0.0154	0.0214	0.0176
%ADI		0.10%	0.07%	0.11%	0.11%	0.07%	0.15%	0.21%	0.18%

Pesticide residue	ADI [A] (µg/kg bw/day)	Estimated dietary exposure for population age-gender cohort (µg/kg bw/day) 25+ yr males	25+ yr females	19–24 yr males	11–14 yr boys	11–14 yr girls	5–6 yr children	1–3 yr toddlers	6–12 month infants
Deltamethrin	10	0.020	0.016	0.018	0.036	0.025	0.056	0.042	0.037
%ADI		0.20%	0.16%	0.18%	0.36%	0.25%	0.56%	0.42%	0.37%
Diazinon	5	0.0005	0.0005	0.0004	0.0013	0.0012	0.0027	0.0023	0.0019
%ADI		0.011%	0.010%	0.009%	0.027%	0.025%	0.054%	0.046%	0.037%
Dichlorvos	4	0.00009	0.00012	0.00011	0.00015	0.00013	0.00020	0.00024	0.00009
%ADI		0.002%	0.003%	0.003%	0.004%	0.003%	0.005%	0.006%	0.002%
Dicloran	10	0.0020	0.0020	0.0014	0.0025	0.0027	0.0038	0.0044	0.0046
%ADI		0.020%	0.020%	0.014%	0.025%	0.027%	0.038%	0.044%	0.046%
Dicofol	2	0.00002	0.00003	0.00003	0.00005	0.00005	0.00004	0.00014	0.00014
%ADI		0.001%	0.001%	0.002%	0.002%	0.002%	0.002%	0.007%	0.007%
Dieldrin	0.1	0.00004	0.00005	0.00003	0.00006	0.00003	0.00005	0.00006	0.00009
%ADI		0.04%	0.05%	0.03%	0.06%	0.03%	0.05%	0.06%	0.09%
Difenoconazole, total	10	0.0012	0.0016	0.0014	0.0018	0.0012	0.0017	0.0027	0.0014
%ADI		0.012%	0.016%	0.014%	0.018%	0.012%	0.017%	0.027%	0.014%
Dimethoate, total	2	0.020	0.024	0.017	0.030	0.017	0.028	0.034	0.045
%ADI		1.0%	1.2%	0.8%	1.5%	0.8%	1.4%	1.7%	2.2%
Diphenylamine	80	0.026	0.026	0.019	0.043	0.044	0.107	0.065	0.075
%ADI		0.03%	0.03%	0.02%	0.05%	0.06%	0.13%	0.08%	0.09%
DTCs	3–30	0.551	0.571	0.498	0.813	0.781	1.547	1.101	1.189
%ADI		1.8–18%	1.9–19%	1.7–17%	2.7–27%	2.6–26%	5.2–52%	3.7–37%	4–40%
Diuron	7 [b]	0.0012	0.0009	0.0019	0.0023	0.0018	0.0028	0.0036	0.0027
%ADI		0.018%	0.013%	0.028%	0.033%	0.026%	0.040%	0.051%	0.038%
Endosulfan, total	6	0.0031	0.0036	0.0015	0.0028	0.0030	0.0022	0.0032	0.0030
%ADI		0.052%	0.061%	0.025%	0.047%	0.050%	0.037%	0.053%	0.051%
EPN	No ADI	0	0	0	0.0000006	0.0000009	0.0000012	0.0000012	0.0000009
Ethion	2	0.00018	0.00018	0.00019	0.00022	0.00024	0.00022	0.00021	0.00012
%ADI		0.009%	0.009%	0.010%	0.011%	0.012%	0.011%	0.011%	0.006%
Fenarimol	10	0.000008	0.000017	0.000010	0.000015	0.000007	0.000013	0.000023	0.000033
%ADI		0.0001%	0.0002%	0.0001%	0.0001%	0.0001%	0.0001%	0.0002%	0.0003%
Fenchlorphos	10	0.000004	0.000005	0.000014	0.000018	0.000012	0.000021	0.000041	0.000030
%ADI		0.00004%	0.00005%	0.00014%	0.00018%	0.00012%	0.00021%	0.00041%	0.00030%
Fenitrothion	6	0.0132	0.0122	0.0234	0.0178	0.0163	0.0209	0.0294	0.0225
%ADI		0.22%	0.20%	0.39%	0.30%	0.27%	0.35%	0.49%	0.37%
Fenpropathrin	30	0.00019	0.00028	0.00015	0.00015	0.00021	0.00067	0.00060	0.00043
%ADI		0.0006%	0.0009%	0.0005%	0.0005%	0.0007%	0.0022%	0.0020%	0.0014%
Flamprop-methyl	1 [b]	0.0002	0.0001	0.0003	0.0004	0.0003	0.0004	0.0005	0.0003
%ADI		0.017%	0.010%	0.032%	0.040%	0.031%	0.042%	0.049%	0.030%

Pesticide residue	ADI [A] (µg/kg bw/day)	Estimated dietary exposure for population age-gender cohort (µg/kg bw/day)							
		25+ yr males	25+ yr females	19–24 yr males	11–14 yr boys	11–14 yr girls	5–6 yr children	1–3 yr toddlers	6–12 month infants
Fludioxinil	400	0.040	0.052	0.016	0.025	0.024	0.072	0.036	0.073
%ADI		0.010%	0.013%	0.004%	0.006%	0.006%	0.018%	0.009%	0.018%
Fluvalinate	5 [a]	0.0002	0.0004	0.0002	0.0003	0.0002	0.0003	0.0005	0.0007
%ADI		0.004%	0.007%	0.004%	0.006%	0.003%	0.005%	0.010%	0.014%
Furathiocarb	3 [b]	0.00004	0.00005	0.00015	0.00019	0.00013	0.00022	0.00044	0.00032
%ADI		0.001%	0.002%	0.005%	0.006%	0.004%	0.007%	0.015%	0.011%
Haloxyfop-methyl	No ADI	0.00031	0.00031	0.00031	0.00031	0.00031	0.00031	0.00031	0.00031
Imazalil	30	0.043	0.067	0.061	0.101	0.162	0.321	0.247	0.154
%ADI		0.14%	0.22%	0.20%	0.34%	0.54%	1.07%	0.82%	0.51%
Indoxacarb	10	0.00024	0.00029	0.00025	0.00019	0.00019	0.00048	0.00052	0.00047
%ADI		0.002%	0.003%	0.002%	0.002%	0.002%	0.005%	0.005%	0.005%
Iprodione	60	0.067	0.092	0.036	0.034	0.036	0.074	0.062	0.094
%ADI		0.11%	0.15%	0.06%	0.06%	0.06%	0.12%	0.10%	0.16%
Isoprocarb	No ADI	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00064
Linuron	10 [b]	0.0010	0.0009	0.0009	0.0009	0.0008	0.0019	0.0025	0.0022
%ADI		0.010%	0.009%	0.009%	0.009%	0.008%	0.019%	0.025%	0.022%
Malathion	300	0.0025	0.0025	0.0023	0.0042	0.0034	0.0077	0.0139	0.0087
%ADI		0.0008%	0.0008%	0.0008%	0.0014%	0.0011%	0.0026%	0.0046%	0.0029%
Metalaxyl	80	0.0044	0.0057	0.0028	0.0035	0.0058	0.0052	0.0112	0.0091
%ADI		0.006%	0.007%	0.003%	0.004%	0.007%	0.006%	0.014%	0.011%
Methamidiphos	4	0.0053	0.0062	0.0068	0.0065	0.0047	0.0063	0.0094	0.0091
%ADI		0.13%	0.16%	0.17%	0.16%	0.12%	0.16%	0.23%	0.23%
Methidathion	1	0.00004	0.00004	0.00002	0.00005	0.00005	0.00012	0.00019	0.00023
%ADI		0.004%	0.004%	0.002%	0.005%	0.005%	0.012%	0.019%	0.023%
Methiocarb	20	0.00008	0.00012	0.00008	0.00015	0.00011	0.00020	0.00026	0.00007
%ADI		0.0004%	0.0006%	0.0004%	0.0007%	0.0006%	0.0010%	0.0013%	0.0004%
Myclobutanil	30	0.0005	0.0005	0.0003	0.0006	0.0007	0.0015	0.0013	0.0012
%ADI		0.002%	0.002%	0.001%	0.002%	0.002%	0.005%	0.004%	0.004%
Penconazole	30	0.00003	0.00006	0.00006	0.00006	0.00007	0.00012	0.00015	0.00014
%ADI		0.0001%	0.0002%	0.0002%	0.0002%	0.0002%	0.0004%	0.0005%	0.0005%
Permethrin, total	50	0.0007	0.0007	0.0005	0.0011	0.0012	0.0029	0.0017	0.0019
%ADI		0.001%	0.001%	0.001%	0.002%	0.002%	0.006%	0.003%	0.004%
Phenthoate	3	0.00003	0.00003	0.00003	0.00002	0.00002	0.00002	0.00003	0.00000
%ADI		0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.000%
Piperonyl butoxide	200	0.123	0.103	0.132	0.210	0.158	0.333	0.353	0.292
%ADI		0.06%	0.05%	0.07%	0.11%	0.08%	0.17%	0.18%	0.15%

Pesticide residue	ADI [a] (µg/kg bw/day)	Estimated dietary exposure for population age-gender cohort (µg/kg bw/day) 25+ yr males	25+ yr females	19–24 yr males	11–14 yr boys	11–14 yr girls	5–6 yr children	1–3 yr toddlers	6–12 month infants
Pirimicarb	20	0.0022	0.0024	0.0021	0.0029	0.0020	0.0011	0.0010	0.0001
%ADI		0.011%	0.012%	0.010%	0.015%	0.010%	0.006%	0.005%	0.001%
Pirimiphos-methyl	30	0.106	0.094	0.101	0.172	0.133	0.286	0.257	0.197
%ADI		0.35%	0.31%	0.34%	0.57%	0.44%	0.95%	0.86%	0.66%
Procymidone	100	0.0075	0.0089	0.0049	0.0071	0.0064	0.0132	0.0239	0.0266
%ADI		0.008%	0.009%	0.005%	0.007%	0.006%	0.013%	0.024%	0.027%
Propaphos	No ADI	0.0002	0.0002	0.0001	0.0001	0.0001	0.0003	0.0001	0.0003
Propargite	10	0.0003	0.0002	0.0002	0.0003	0.0003	0.0007	0.0034	0.0032
%ADI		0.003%	0.002%	0.002%	0.003%	0.003%	0.007%	0.034%	0.032%
Propham	No ADI	0.1522	0.1067	0.1355	0.1902	0.1723	0.3107	0.2080	0.1826
Propiconazole, total	70	0.0007	0.0008	0.0009	0.0010	0.0005	0.0013	0.0007	0.0006
%ADI		0.0011%	0.0011%	0.0013%	0.0014%	0.0008%	0.0019%	0.0011%	0.0008%
Prothiophos	0.1 [b]	0.00006	0.00008	0.00004	0.00004	0.00006	0.00020	0.00018	0.00013
%ADI		0.06%	0.08%	0.04%	0.04%	0.06%	0.20%	0.18%	0.13%
Pyrimethanil	200	0.0182	0.0225	0.0118	0.0133	0.0244	0.0249	0.0523	0.0413
%ADI		0.009%	0.011%	0.006%	0.007%	0.012%	0.012%	0.026%	0.021%
Quintozene	10	0.00006	0.00009	0.00006	0.00014	0.00009	0.00010	0.00018	0.00000
%ADI		0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.002%	0.000%
Tebuconazole	30	0.0011	0.0014	0.0004	0.0007	0.0006	0.0020	0.0008	0.0019
%ADI		0.004%	0.005%	0.001%	0.002%	0.002%	0.007%	0.003%	0.006%
Tebufenpyrad	2 [b]	0.0003	0.0005	0.0004	0.0004	0.0005	0.0010	0.0010	0.0010
%ADI		0.015%	0.027%	0.020%	0.021%	0.025%	0.048%	0.050%	0.051%
Thiometon	3	0.0002	0.0003	0.0002	0.0002	0.0003	0.0009	0.0012	0.0018
%ADI		0.007%	0.010%	0.007%	0.007%	0.010%	0.031%	0.041%	0.059%
Tolylfluanid	80	0.0037	0.0044	0.0020	0.0023	0.0050	0.0040	0.0093	0.0068
%ADI		0.005%	0.005%	0.002%	0.003%	0.006%	0.005%	0.012%	0.009%
Triadimefon	30	0.0056	0.0042	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000
%ADI		0.0188%	0.0139%	0.0041%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Trifloxystrobin	40	0.0003	0.0004	0.0002	0.0002	0.0003	0.0009	0.0008	0.0006
%ADI		0.0007%	0.0010%	0.0005%	0.0005%	0.0007%	0.0022%	0.0021%	0.0015%

Notes

a ADIs are those established by the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) (IPCS, 2009).

b Australian ADI used as no ADI established by JMPR (ADHA, 2010).

APPENDIX 8: ELEMENTS ANALYSED IN THE 2009 NZTDS AND THEIR LIMITS OF DETECTION (LOD) IN PARTS PER MILLION (MG/KG)

A summary of the methods used for the contaminant and nutrient elements in the 2009 NZTDS have been detailed previously in section 2.3.2.

The LODs for the elements in the 2009 NZTDS are derived from the standard deviation of blanks from analytical runs corrected for final digest volume and sample weight taken according to international protocol (Keith *et al.,* 1983), and consequently, these varied over the course of the project. The LODs, which are also dependent on the element, the fat and the water content of the food, are tabulated below.

Element	LOD (mg/kg) and Matrix			
	Water	Liquid or low-fat foods	High moisture foods	High-fat or dry solid foods
Arsenic (As)	0.001	0.001	0.002–0.005	0.010
Cadmium (Cd)	0.00005	0.0002	0.0004	0.0020
Iodine (I)	0.001	0.001	0.002–0.005	0.010
Lead (Pb)	0.0001	0.001	0.002–0.005	0.010
Mercury (Hg) (Total)	0.00008–0.0001	0.001	0.002–0.005	0.010
Methylmercury (MeHg)			0.004 (fish/seafood)	
Selenium (Se)	0.001	0.002	0.004	0.010–0.020
Sodium (Na)	1.0	5	10–20	50

APPENDIX 9: CONTAMINANT ELEMENTS – ARSENIC (TOTAL), CADMIUM, LEAD, MERCURY (TOTAL) AND METHYLMERCURY IN THE 2009 NZTDS

Contaminant concentrations reported are on a "sample as consumed and as received basis", that is, at normal moisture content after preparation for consumption.

In recording the minimum and maximum concentrations for each food, normal international convention has been followed for "not detected" results, namely the result is reported as "less than the LOD" (that is, 0.0213 mg/kg means not detected, down to al LOD of 0.0213 mg/kg). The respective LODs for the contaminant elements in different matrices are detailed in Appendix 8.

Mean concentrations are an intermediate in the calculation of the estimated dietary exposure, so have reported to four decimal places.

Appendix 9.1: Arsenic content (mg/kg) in foods of the 2009 NZTDS

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND=LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	8	7	0.0012	< 0.002	0.003
Apple-based juice	8	0	0.0041	0.002	0.008
Apricot, canned	8	8	0.0010	< 0.002	< 0.002
Avocado	8	6	0.0019	< 0.002	0.006
Bacon	8	0	0.0559	0.004	0.111
Banana	8	8	0.0010	< 0.002	< 0.002
Beans	8	8	0.0010	< 0.002	< 0.002
Beans, baked, canned	8	8	0.0010	< 0.002	< 0.002
Beef, corned	8	1	0.0053	< 0.002	0.009
Beef, mince	8	1	0.0046	< 0.002	0.008
Beef, rump	8	1	0.0051	< 0.002	0.008
Beer	8	3	0.0018	< 0.001	0.005
Beetroot, canned	8	7	0.0013	< 0.002	0.004
Biscuits, chocolate	8	5	0.0088	< 0.010	0.016
Biscuits, cracker	8	3	0.0120	< 0.010	0.019
Biscuits, plain sweet	8	4	0.0091	< 0.010	0.017
Bran flake cereal, mixed	8	0	0.0296	0.017	0.051
Bread, mixed grain	8	3	0.0073	< 0.005	0.015
Bread, wheatmeal	8	1	0.0093	< 0.005	0.025
Bread, white	8	2	0.0085	< 0.005	0.018
Broccoli/cauliflower	8	8	0.0010	< 0.002	< 0.002
Butter	8	8	0.0050	< 0.010	< 0.010
Cabbage	8	8	0.0010	< 0.002	< 0.002
Caffeinated beverage	8	8	0.0005	< 0.001	< 0.001
Cake	8	0	0.0081	0.004	0.013

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND=LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Capsicum	8	8	0.0010	< 0.002	< 0.002
Carbonated drink	8	8	0.0005	< 0.001	< 0.001
Carrot	8	8	0.0010	< 0.002	< 0.002
Celery	8	8	0.0010	< 0.002	< 0.002
Cheese	8	8	0.0050	< 0.010	< 0.010
Chicken	8	1	0.0058	< 0.002	0.011
Chicken takeaway	8	1	0.0042	< 0.002	0.006
Chinese dish	8	2	0.0055	< 0.002	0.013
Chocolate beverage	8	7	0.0006	< 0.001	0.002
Chocolate, plain milk	8	8	0.0050	< 0.010	< 0.010
Coffee beans, ground	8	7	0.0006	< 0.001	0.002
Coffee, instant	8	8	0.0005	< 0.001	< 0.001
Confectionery	8	6	0.0071	< 0.010	0.016
Corn, canned	8	6	0.0018	< 0.002	0.005
Cornflakes	8	6	0.0065	< 0.010	0.012
Courgette	8	7	0.0014	< 0.002	0.004
Cream	8	8	0.0010	< 0.002	< 0.002
Cucumber	8	0	0.0060	0.003	0.009
Dairy dessert	8	5	0.0017	< 0.002	0.004
Egg	8	0	0.0045	0.002	0.006
Fish fingers	8	0	1.0215	0.496	1.882
Fish in batter	8	0	2.6643	0.313	5.809
Fish, canned	8	0	0.6226	0.324	1.131
Fish, fresh	8	0	3.9859	2.073	6.313
Fruit drink	8	8	0.0005	< 0.001	< 0.001
Grapes	8	4	0.0022	< 0.002	0.004
Ham	8	0	0.0084	0.005	0.012
Hamburger, plain	8	2	0.0061	< 0.002	0.012
Honey	8	8	0.0050	< 0.010	< 0.010
Ice cream	8	5	0.0038	< 0.002	0.010
Indian dish	8	0	0.0148	0.004	0.023
Infant and Follow-on formula	8	8	0.0005	< 0.001	< 0.001
Infant weaning food, cereal based	8	2	0.0116	< 0.002	0.022
Infant weaning food, custard/ fruit dish	8	0	0.0071	0.004	0.012
Infant weaning food, savoury	8	4	0.0024	< 0.002	0.005
Jam	8	8	0.0050	< 0.010	< 0.010
Kiwifruit	8	8	0.0010	< 0.002	< 0.002
Kumara	8	8	0.0010	< 0.002	< 0.002

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND=LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Lamb/mutton	8	8	0.0010	< 0.002	< 0.002
Lambs liver	8	3	0.0036	< 0.002	0.008
Lettuce	8	8	0.0010	< 0.002	< 0.002
Margarine	8	8	0.0050	< 0.010	< 0.010
Meat pie	8	1	0.0041	< 0.002	0.007
Melon	8	8	0.0010	< 0.002	< 0.002
Milk, 0.5% fat	8	8	0.0005	< 0.001	< 0.001
Milk, 3.25% fat	8	8	0.0005	< 0.001	< 0.001
Milk, flavoured	8	8	0.0005	< 0.001	< 0.001
Muesli	8	5	0.0096	< 0.010	0.022
Muffin	8	1	0.0095	< 0.010	0.013
Mushrooms	8	0	0.1945	0.056	0.389
Mussels	8	0	2.2217	1.693	3.422
Nectarine	8	5	0.0035	< 0.002	0.009
Noodles, instant	8	5	0.0017	< 0.002	0.005
Oats, rolled	8	6	0.0019	< 0.002	0.006
Oil	8	8	0.0050	< 0.010	< 0.010
Onion	8	8	0.0010	< 0.002	< 0.002
Orange	8	6	0.0019	< 0.002	0.005
Orange juice	8	8	0.0005	< 0.001	< 0.001
Oysters	8	0	2.3859	1.627	3.216
Pasta, dried	8	6	0.0017	< 0.002	0.005
Peaches, canned	8	8	0.0010	< 0.002	< 0.002
Peanut butter	8	5	0.0059	< 0.002	0.019
Peanuts, whole	8	4	0.0051	< 0.002	0.012
Pear	8	1	0.0036	< 0.002	0.006
Peas	8	8	0.0010	< 0.002	< 0.002
Pineapple, canned	8	8	0.0010	< 0.002	< 0.002
Pizza	8	1	0.0094	< 0.002	0.014
Pork chop	8	2	0.0043	< 0.002	0.010
Potato crisps	8	8	0.0010	< 0.002	< 0.002
Potato, hot chips	8	6	0.0017	< 0.002	0.006
Potatoes, peeled	8	8	0.0010	< 0.002	< 0.002
Potatoes, with skin	8	8	0.0010	< 0.002	< 0.002
Prunes	8	4	0.0040	< 0.002	0.012
Pumpkin	8	7	0.0015	< 0.002	0.005
Raisins/sultanas	8	0	0.0243	0.017	0.032
Rice, white	8	0	0.0334	0.014	0.050
Salad dressing	8	5	0.0075	< 0.010	0.014

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND=LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Sausages	8	5	0.0023	< 0.002	0.005
Silverbeet	8	5	0.0020	< 0.002	0.006
Snack bars	8	0	0.0177	0.010	0.029
Snacks, flavoured	8	7	0.0059	< 0.010	0.012
Soup, chicken	8	6	0.0013	< 0.002	0.002
Soy milk	8	1	0.0015	< 0.001	0.002
Spaghetti in sauce, canned	8	8	0.0010	< 0.002	< 0.002
Strawberries	8	3	0.0025	< 0.002	0.005
Sugar	8	8	0.0050	< 0.010	< 0.010
Taro	8	7	0.0012	< 0.002	0.003
Tea	8	8	0.0005	< 0.001	< 0.001
Tomato	8	7	0.0013	< 0.002	0.003
Tomato sauce	8	7	0.0012	< 0.002	0.003
Tomatoes in juice	8	8	0.0010	< 0.002	< 0.002
Water, bottled	8	8	0.0005	< 0.001	< 0.001
Water, tap	8	6	0.0011	< 0.001	0.003
Wheat biscuit cereals	8	0	0.0291	0.019	0.039
Wine, still red	8	0	0.0038	0.001	0.009
Wine, still white	8	0	0.0047	0.002	0.010
Yeast extract	6	0	0.1424	0.119	0.165
Yoghurt	8	8	0.0010	< 0.002	< 0.002

Appendix 9.2: Cadmium content (mg/kg) of 2009 NZTDS foods

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	8	4	0.0003	< 0.0004	0.0006
Apple-based juice	8	1	0.0003	< 0.0002	0.0008
Apricot, canned	8	0	0.0020	0.0012	0.0028
Avocado	8	0	0.0206	0.0111	0.0286
Bacon	8	1	0.0009	< 0.0004	0.0016
Banana	8	3	0.0009	< 0.0004	0.0015
Beans	8	0	0.0016	0.0005	0.0040
Beans, baked, canned	8	0	0.0040	0.0024	0.0079
Beef, corned	8	0	0.0020	0.0011	0.0036
Beef, mince	8	6	0.0003	< 0.0004	0.0005
Beef, rump	8	4	0.0005	< 0.0004	0.0009
Beer	8	6	0.0002	< 0.0002	0.0006
Beetroot, canned	8	0	0.0112	0.0055	0.0157
Biscuits, chocolate	8	0	0.0220	0.0126	0.0286

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Biscuits, cracker	8	0	0.0140	0.0073	0.0196
Biscuits, plain sweet	8	0	0.0091	0.0023	0.0136
Bran flake cereal, mixed	8	0	0.0235	0.0046	0.0480
Bread, mixed grain	8	0	0.0167	0.0088	0.0279
Bread, wheatmeal	8	0	0.0155	0.0058	0.0301
Bread, white	8	0	0.0121	0.0052	0.0233
Broccoli/cauliflower	8	0	0.0061	0.0035	0.0103
Butter	8	8	0.0010	< 0.0020	< 0.0020
Cabbage	8	0	0.0032	0.0017	0.0048
Caffeinated beverage	8	4	0.0005	< 0.0002	0.0013
Cake	8	0	0.0049	0.0037	0.0063
Capsicum	8	1	0.0019	< 0.0004	0.0049
Carbonated drink	8	5	0.0004	< 0.0002	0.0011
Carrot	8	0	0.0264	0.0088	0.0387
Celery	8	0	0.0203	0.0137	0.0336
Cheese	8	8	0.0010	< 0.0020	< 0.0020
Chicken	8	3	0.0004	< 0.0004	0.0006
Chicken takeaway	8	0	0.0048	0.0035	0.0063
Chinese dish	8	0	0.0052	0.0029	0.0068
Chocolate beverage	8	0	0.0046	0.0011	0.0123
Chocolate, plain milk	8	0	0.0391	0.0126	0.0855
Coffee beans, ground	8	8	0.0001	< 0.0002	< 0.0002
Coffee, instant	8	5	0.0002	< 0.0002	0.0005
Confectionery	8	7	0.0025	< 0.0020	0.0128
Corn, canned	8	0	0.0016	0.0007	0.0037
Cornflakes	8	7	0.0022	< 0.0020	0.0102
Courgette	8	1	0.0018	< 0.0004	0.0046
Cream	8	8	0.0002	< 0.0004	< 0.0004
Cucumber	8	8	0.0002	< 0.0004	< 0.0004
Dairy dessert	8	2	0.0033	< 0.0004	0.0080
Egg	8	5	0.0003	< 0.0004	0.0008
Fish fingers	8	0	0.0113	0.0036	0.0265
Fish in batter	8	0	0.0075	0.0021	0.0181
Fish, canned	8	0	0.0083	0.0023	0.0213
Fish, fresh	8	0	0.0021	0.0010	0.0051
Fruit drink	8	8	0.0001	< 0.0002	< 0.0002
Grapes	8	2	0.0016	< 0.0004	0.0097
Ham	8	0	0.0033	0.0019	0.0049
Hamburger, plain	8	0	0.0082	0.0051	0.0131

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Honey	8	7	0.0012	< 0.0020	0.0029
Ice cream	8	5	0.0017	< 0.0004	0.0077
Indian dish	8	0	0.0075	0.0047	0.0092
Infant and Follow-on formula	8	5	0.0002	< 0.0002	0.0004
Infant weaning food, cereal based	8	0	0.0016	0.0007	0.0035
Infant weaning food, custard/ fruit dish	8	1	0.0008	< 0.0004	0.0017
Infant weaning food, savoury	8	0	0.0058	0.0026	0.0104
Jam	8	4	0.0021	< 0.0020	0.0046
Kiwifruit	8	2	0.0005	< 0.0004	0.0009
Kumara	8	0	0.0030	0.0022	0.0042
Lamb/mutton	8	1	0.0007	< 0.0004	0.0014
Lambs liver	8	0	0.1032	0.0328	0.2389
Lettuce	8	0	0.0135	0.0015	0.0399
Margarine	8	8	0.0010	< 0.0020	< 0.0020
Meat pie	8	0	0.0042	0.0027	0.0080
Melon	8	0	0.0054	0.0009	0.0185
Milk, 0.5% fat	8	7	0.0031	< 0.0002	0.0238
Milk, 3.25% fat	8	7	0.0001	< 0.0002	0.0003
Milk, flavoured	8	0	0.0009	0.0003	0.0020
Muesli	8	0	0.0188	0.0087	0.0289
Muffin	8	0	0.0081	0.0031	0.0133
Mushrooms	8	0	0.0061	0.0044	0.0083
Mussels	8	0	0.1942	0.0987	0.3579
Nectarine	8	0	0.0012	0.0004	0.0029
Noodles, instant	8	0	0.0033	0.0019	0.0054
Oats, rolled	8	0	0.0039	0.0019	0.0083
Oil	8	8	0.0010	< 0.0020	< 0.0020
Onion	8	0	0.0127	0.0038	0.0314
Orange	8	7	0.0002	< 0.0004	0.0004
Orange juice	8	8	0.0001	< 0.0002	< 0.0002
Oysters	8	0	1.3334	0.1946	3.8986
Pasta, dried	8	0	0.0064	0.0022	0.0138
Peaches, canned	8	0	0.0020	0.0008	0.0039
Peanut butter	8	0	0.0538	0.0201	0.0911
Peanuts, whole	8	0	0.1038	0.0225	0.2114
Pear	8	0	0.0030	0.0015	0.0060
Peas	8	0	0.0029	0.0009	0.0051
Pineapple, canned	8	1	0.0007	< 0.0004	0.0012

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Pizza	8	0	0.0077	0.0051	0.0123
Pork chop	8	3	0.0009	< 0.0004	0.0033
Potato crisps	8	0	0.1294	0.0745	0.2438
Potato, hot chips	8	0	0.0345	0.0275	0.0407
Potatoes, peeled	8	0	0.0266	0.0121	0.0463
Potatoes, with skin	8	0	0.0404	0.0215	0.0722
Prunes	8	3	0.0012	< 0.0004	0.0026
Pumpkin	8	0	0.0081	0.0026	0.0168
Raisins/sultanas	8	3	0.0012	< 0.0004	0.0027
Rice, white	8	0	0.0034	0.0009	0.0079
Salad dressing	8	2	0.0025	< 0.0020	0.0052
Sausages	8	0	0.0038	0.0024	0.0054
Silverbeet	8	0	0.0203	0.0077	0.0366
Snack bars	8	0	0.0082	0.0055	0.0146
Snacks, flavoured	8	2	0.0100	< 0.0020	0.0371
Soup, chicken	8	5	0.0004	< 0.0004	0.0008
Soy milk	8	0	0.0041	0.0016	0.0073
Spaghetti in sauce, canned	8	0	0.0091	0.0069	0.0129
Strawberries	8	0	0.0042	0.0006	0.0146
Sugar	8	7	0.0015	< 0.0020	0.0053
Taro	8	0	0.0173	0.0053	0.0492
Tea	8	5	0.0002	< 0.0002	0.0004
Tomato	8	4	0.0007	< 0.0004	0.0029
Tomato sauce	8	0	0.0155	0.0107	0.0196
Tomatoes in juice	8	0	0.0115	0.0078	0.0170
Water, bottled	8	6	0.0001	< 0.00005	0.0004
Water, tap	8	3	0.0005	< 0.00005	0.0027
Wheat biscuit cereals	8	0	0.0112	0.0061	0.0178
Wine, still red	8	2	0.0008	< 0.0002	0.0025
Wine, still white	8	0	0.0007	0.0003	0.0023
Yeast extract	6	0	0.0117	0.0094	0.0191
Yoghurt	8	2	0.0007	< 0.0004	0.0028

Appendix 9.3: Lead content (mg/kg) of 2009 NZTDS foods

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	8	8	0.0010	< 0.002	< 0.002
Apple-based juice	8	0	0.0033	0.002	0.007
Apricot, canned	8	0	0.0188	0.015	0.025
Avocado	8	8	0.0010	< 0.002	< 0.002
Bacon	8	0	0.0045	0.003	0.008
Banana	8	6	0.0015	< 0.002	0.003
Beans	8	3	0.0039	< 0.002	0.010
Beans, baked, canned	8	4	0.0019	< 0.002	0.004
Beef, corned	8	1	0.0042	< 0.002	0.007
Beef, mince	8	3	0.0042	< 0.002	0.012
Beef, rump	8	2	0.0035	< 0.002	0.008
Beer	8	2	0.0018	< 0.001	0.005
Beetroot, canned	8	3	0.0027	< 0.002	0.005
Biscuits, chocolate	8	3	0.0105	< 0.010	0.015
Biscuits, cracker	8	6	0.0081	< 0.010	0.024
Biscuits, plain sweet	8	8	0.0050	< 0.010	< 0.010
Bran flake cereal, mixed	8	3	0.0485	< 0.010	0.221
Bread, mixed grain	8	5	0.0122	< 0.005	0.059
Bread, wheatmeal	8	4	0.0231	< 0.005	0.142
Bread, white	8	4	0.0121	< 0.005	0.052
Broccoli/cauliflower	8	1	0.0053	< 0.002	0.010
Butter	8	7	0.0088	< 0.010	0.035
Cabbage	8	7	0.0012	< 0.002	0.002
Caffeinated beverage	8	1	0.0027	< 0.001	0.005
Cake	8	4	0.0073	< 0.010	0.012
Capsicum	8	4	0.0025	< 0.002	0.009
Carbonated drink	8	3	0.0012	< 0.001	0.003
Carrot	8	3	0.0038	< 0.002	0.012
Celery	8	5	0.0017	< 0.002	0.004
Cheese	8	6	0.0070	< 0.010	0.013
Chicken	8	1	0.0033	< 0.002	0.005
Chicken takeaway	8	3	0.0178	< 0.002	0.054
Chinese dish	8	3	0.0033	< 0.002	0.009
Chocolate beverage	8	0	0.0029	0.001	0.004
Chocolate, plain milk	8	3	0.0267	< 0.010	0.095
Coffee beans, ground	8	3	0.0017	< 0.001	0.004
Coffee, instant	8	0	0.0019	0.002	0.002
Confectionery	8	6	0.0080	< 0.010	0.018
Corn, canned	8	8	0.0010	< 0.002	< 0.002
Cornflakes	8	8	0.0050	< 0.010	< 0.010
Courgette	8	4	0.0037	< 0.002	0.014

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Cream	8	8	0.0010	< 0.002	< 0.002
Cucumber	8	7	0.0012	< 0.002	0.002
Dairy dessert	8	4	0.0023	< 0.002	0.004
Egg	8	7	0.0011	< 0.002	0.002
Fish fingers	8	2	0.0030	< 0.002	0.005
Fish in batter	8	2	0.0079	< 0.002	0.025
Fish, canned	8	3	0.0030	< 0.002	0.006
Fish, fresh	8	2	0.0033	< 0.002	0.006
Fruit drink	8	2	0.0017	< 0.001	0.003
Grapes	8	3	0.0024	< 0.002	0.004
Ham	8	1	0.0047	< 0.002	0.010
Hamburger, plain	8	1	0.0053	< 0.002	0.015
Honey	8	4	0.0095	< 0.010	0.022
Ice cream	8	8	0.0010	< 0.002	< 0.002
Indian dish	8	0	0.0106	0.006	0.020
Infant and Follow-on formula	8	5	0.0009	< 0.001	0.002
Infant weaning food, cereal based	8	4	0.0038	< 0.002	0.013
Infant weaning food, custard/ fruit dish	8	4	0.0024	< 0.002	0.007
Infant weaning food, savoury	8	3	0.0033	< 0.002	0.009
Jam	8	7	0.0060	< 0.010	0.013
Kiwifruit	8	4	0.0019	< 0.002	0.004
Kumara	8	3	0.0022	< 0.002	0.004
Lamb/mutton	8	4	0.0022	< 0.002	0.004
Lambs liver	8	0	0.0286	0.011	0.053
Lettuce	8	7	0.0016	< 0.002	0.006
Margarine	8	8	0.0050	< 0.010	< 0.010
Meat pie	8	2	0.0053	< 0.002	0.019
Melon	8	8	0.0010	< 0.002	< 0.002
Milk, 0.5% fat	8	8	0.0005	< 0.001	< 0.001
Milk, 3.25% fat	8	8	0.0005	< 0.001	< 0.001
Milk, flavoured	8	6	0.0007	< 0.001	0.001
Muesli	8	4	0.0191	< 0.010	0.076
Muffin	8	0	0.0161	0.006	0.053
Mushrooms	8	5	0.0024	< 0.002	0.008
Mussels	8	0	0.1031	0.078	0.138
Nectarine	8	7	0.0013	< 0.002	0.003
Noodles, instant	8	0	0.0062	0.003	0.011
Oats, rolled	8	6	0.0031	< 0.002	0.014
Oil	8	8	0.0050	< 0.010	< 0.010
Onion	8	2	0.0032	< 0.002	0.006
Orange	8	6	0.0019	< 0.002	0.005

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Orange juice	8	3	0.0014	< 0.001	0.003
Oysters	8	0	0.0515	0.036	0.081
Pasta, dried	8	8	0.0010	< 0.002	< 0.002
Peaches, canned	8	0	0.0365	0.017	0.061
Peanut butter	8	8	0.0010	< 0.002	< 0.002
Peanuts, whole	8	8	0.0010	< 0.002	< 0.002
Pear	8	4	0.0018	< 0.002	0.003
Peas	8	1	0.0048	< 0.002	0.011
Pineapple, canned	8	0	0.0159	0.006	0.026
Pizza	8	0	0.0248	0.003	0.165
Pork chop	8	4	0.0022	< 0.002	0.005
Potato crisps	8	7	0.0012	< 0.002	0.002
Potato, hot chips	8	2	0.0029	< 0.002	0.005
Potatoes, peeled	8	7	0.0012	< 0.002	0.003
Potatoes, with skin	8	2	0.0029	< 0.002	0.005
Prunes	8	3	0.0256	< 0.002	0.093
Pumpkin	8	4	0.0033	< 0.002	0.012
Raisins/sultanas	8	0	0.0227	0.014	0.041
Rice, white	8	4	0.0021	< 0.002	0.005
Salad dressing	8	6	0.0073	< 0.010	0.017
Sausages	8	0	0.0047	0.002	0.008
Silverbeet	8	0	0.0075	0.003	0.012
Snack bars	8	4	0.0168	< 0.010	0.051
Snacks, flavoured	8	7	0.0099	< 0.010	0.044
Soup, chicken	8	0	0.0041	0.002	0.006
Soy milk	8	1	0.0015	< 0.001	0.003
Spaghetti in sauce, canned	8	2	0.0064	< 0.002	0.017
Strawberries	8	2	0.0040	< 0.002	0.014
Sugar	8	8	0.0050	< 0.010	< 0.010
Taro	8	6	0.0020	< 0.002	0.007
Tea	8	5	0.0008	< 0.001	0.001
Tomato	8	6	0.0013	< 0.002	0.002
Tomato sauce	8	3	0.0029	< 0.002	0.007
Tomatoes in juice	8	0	0.0100	0.004	0.040
Water, bottled	8	8	0.0001	< 0.0001	< 0.0001
Water, tap	8	4	0.0002	< 0.0001	0.001
Wheat biscuit cereals	8	6	0.0076	< 0.010	0.017
Wine, still red	8	0	0.0051	0.002	0.009
Wine, still white	8	0	0.0098	0.008	0.014
Yeast extract	6	3	0.0089	< 0.010	0.015
Yoghurt	8	3	0.0021	< 0.002	0.004

Appendix 9.4: Mercury (total) content (mg/kg) of 2009 NZTDS foods

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	8	8	0.0010	< 0.002	< 0.002
Apple-based juice	8	8	0.0005	< 0.001	< 0.001
Apricot, canned	8	8	0.0010	< 0.002	< 0.002
Avocado	8	8	0.0010	< 0.002	< 0.002
Bacon	8	8	0.0010	< 0.002	< 0.002
Banana	8	8	0.0010	< 0.002	< 0.002
Beans	8	8	0.0010	< 0.002	< 0.002
Beans, baked, canned	8	8	0.0010	< 0.002	< 0.002
Beef, corned	8	8	0.0010	< 0.002	< 0.002
Beef, mince	8	8	0.0010	< 0.002	< 0.002
Beef, rump	8	8	0.0010	< 0.002	< 0.002
Beer	8	8	0.0005	< 0.001	< 0.001
Beetroot, canned	8	8	0.0010	< 0.002	< 0.002
Biscuits, chocolate	NA	NA	0.0010	< 0.002	< 0.002
Biscuits, cracker	NA	NA	0.0010	< 0.002	< 0.002
Biscuits, plain sweet	NA	NA	0.0010	< 0.002	< 0.002
Bran flake cereal, mixed	NA	NA	0.0010	< 0.002	< 0.002
Bread, mixed grain	NA	NA	0.0010	< 0.002	< 0.002
Bread, wheatmeal	NA	NA	0.0010	< 0.002	< 0.002
Bread, white	NA	NA	0.0010	< 0.002	< 0.002
Broccoli/cauliflower	8	8	0.0010	< 0.002	< 0.002
Butter	NA	NA	0.0010	< 0.002	< 0.002
Cabbage	8	8	0.0010	< 0.002	< 0.002
Caffeinated beverage	8	8	0.0005	< 0.001	< 0.001
Cake	NA	NA	0.0010	< 0.002	< 0.002
Capsicum	8	8	0.0010	< 0.002	< 0.002
Carbonated drink	8	8	0.0005	< 0.001	< 0.001
Carrot	8	8	0.0010	< 0.002	< 0.002
Celery	8	8	0.0010	< 0.002	< 0.002
Cheese	NA	NA	0.0010	< 0.002	< 0.002
Chicken	8	8	0.0010	< 0.002	< 0.002
Chicken takeaway	8	8	0.0010	< 0.002	< 0.002
Chinese dish	8	8	0.0010	< 0.002	< 0.002
Chocolate beverage	8	8	0.0005	< 0.001	< 0.001
Chocolate, plain milk	NA	NA	0.0010	< 0.002	< 0.002
Coffee beans, ground	8	8	0.0005	< 0.001	< 0.001
Coffee, instant	8	8	0.0005	< 0.001	< 0.001
Confectionery	NA	NA	0.0010	< 0.002	< 0.002
Corn, canned	8	8	0.0010	< 0.002	< 0.002
Cornflakes	NA	NA	0.0010	< 0.002	< 0.002
Courgette	8	8	0.0010	< 0.002	< 0.002

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Cream	8	8	0.0010	< 0.002	< 0.002
Cucumber	8	8	0.0010	< 0.002	< 0.002
Dairy dessert	8	8	0.0010	< 0.002	< 0.002
Egg	8	6	0.0021	< 0.002	0.006
Fish fingers	8	0	0.0634	0.029	0.127
Fish in batter	8	0	0.2655	0.042	0.476
Fish, canned	8	0	0.0338	0.016	0.108
Fish, fresh	8	0	0.1376	0.053	0.297
Fruit drink	8	8	0.0005	< 0.001	< 0.001
Grapes	8	8	0.0010	< 0.002	< 0.002
Ham	8	8	0.0010	< 0.002	< 0.002
Hamburger, plain	8	8	0.0010	< 0.002	< 0.002
Honey	NA	NA	0.0010	< 0.002	< 0.002
Ice cream	NA	NA	0.0010	< 0.002	< 0.002
Indian dish	8	8	0.0010	< 0.002	< 0.002
Infant and Follow-on formula	8	8	0.0005	< 0.001	< 0.001
Infant weaning food, cereal based	8	8	0.0010	< 0.002	< 0.002
Infant weaning food, custard/ fruit dish	8	8	0.0010	< 0.002	< 0.002
Infant weaning food, savoury	8	8	0.0010	< 0.002	< 0.002
Jam	NA	NA	0.0010	< 0.002	< 0.002
Kiwifruit	8	8	0.0010	< 0.002	< 0.002
Kumara	8	8	0.0010	< 0.002	< 0.002
Lamb/mutton	8	8	0.0010	< 0.002	< 0.002
Lambs liver	8	2	0.0041	< 0.002	0.009
Lettuce	8	8	0.0010	< 0.002	< 0.002
Margarine	NA	NA	0.0010	< 0.002	< 0.002
Meat pie	8	8	0.0010	< 0.002	< 0.002
Melon	8	8	0.0010	< 0.002	< 0.002
Milk, 0.5% fat	8	8	0.0005	< 0.001	< 0.001
Milk, 3.25% fat	8	8	0.0005	< 0.001	< 0.001
Milk, flavoured	8	8	0.0005	< 0.001	< 0.001
Muesli	NA	NA	0.0010	< 0.002	< 0.002
Muffin	NA	NA	0.0010	< 0.002	< 0.002
Mushrooms	8	8	0.0010	< 0.002	< 0.002
Mussels	8	0	0.0169	0.012	0.029
Nectarine	8	8	0.0010	< 0.002	< 0.002
Noodles, instant	8	8	0.0010	< 0.002	< 0.002
Oats, rolled	8	8	0.0010	< 0.002	< 0.002
Oil	NA	NA	0.0010	< 0.002	< 0.002
Onion	8	8	0.0010	< 0.002	< 0.002
Orange	8	8	0.0010	< 0.002	< 0.002
Orange juice	8	8	0.0005	< 0.001	< 0.001

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Oysters	8	0	0.0260	0.016	0.054
Pasta, dried	8	8	0.0010	< 0.002	< 0.002
Peaches, canned	8	8	0.0010	< 0.002	< 0.002
Peanut butter	NA	NA	0.0010	< 0.002	< 0.002
Peanuts, whole	NA	NA	0.0010	< 0.002	< 0.002
Pear	8	8	0.0010	< 0.002	< 0.002
Peas	8	8	0.0010	< 0.002	< 0.002
Pineapple, canned	8	8	0.0010	< 0.002	< 0.002
Pizza	8	8	0.0010	< 0.002	< 0.002
Pork chop	8	2	0.0033	< 0.002	0.009
Potato crisps	8	8	0.0010	< 0.002	< 0.002
Potato, hot chips	8	8	0.0010	< 0.002	< 0.002
Potatoes, peeled	8	8	0.0010	< 0.002	< 0.002
Potatoes, with skin	8	8	0.0010	< 0.002	< 0.002
Prunes	8	8	0.0010	< 0.002	< 0.002
Pumpkin	8	8	0.0010	< 0.002	< 0.002
Raisins/sultanas	8	8	0.0010	< 0.002	< 0.002
Rice, white	8	8	0.0010	< 0.002	< 0.002
Salad dressing	NA	NA	0.0010	< 0.002	< 0.002
Sausages	8	8	0.0010	< 0.002	< 0.002
Silverbeet	8	7	0.0012	< 0.002	0.003
Snack bars	NA	NA	0.0010	< 0.002	< 0.002
Snacks, flavoured	NA	NA	0.0010	< 0.002	< 0.002
Soup, chicken	8	8	0.0010	< 0.002	< 0.002
Soy milk	8	8	0.0005	< 0.001	< 0.001
Spaghetti in sauce, canned	NA	NA	0.0010	< 0.002	< 0.002
Strawberries	8	8	0.0010	< 0.002	< 0.002
Sugar	NA	NA	0.0010	< 0.002	< 0.002
Taro	8	8	0.0010	< 0.002	< 0.002
Tea	8	8	0.0005	< 0.001	< 0.001
Tomato	8	8	0.0010	< 0.002	< 0.002
Tomato sauce	8	8	0.0010	< 0.002	< 0.002
Tomatoes in juice	8	8	0.0010	< 0.002	< 0.002
Water, bottled	8	8	0.00004	< 0.00008	< 0.00008
Water, tap	8	8	0.00004	< 0.00008	< 0.00008
Wheat biscuit cereals	NA	NA	0.0010	< 0.002	< 0.002
Wine, still red	8	8	0.0005	< 0.001	< 0.001
Wine, still white	8	8	0.0005	< 0.001	< 0.001
Yeast extract	NA	NA	0.0010	< 0.002	< 0.002
Yoghurt	8	8	0.0010	< 0.002	< 0.002

Note

NA = not analysed, because LOD in these matrices inadequate to yield a meaningful LOD/2 value. Such foods have been assigned a mean value based on previous NZTDS or other New Zealand data (Vannoort *et al.*, 2000).

Appendix 9.5: Methylmercury content (mg/kg) of 2009 NZTDS foods

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Fish fingers	8	0	0.0425	0.030	0.086
Fish in batter	8	0	0.1950	0.031	0.312
Fish, canned	8	0	0.0228	0.004	0.085
Fish, fresh	8	0	0.0893	0.044	0.183
Mussels	6	0	0.0071	0.005	0.011
Oysters	8	0	0.0101	0.006	0.016

In the 2009 NZTDS, methylmercury was only analysed in fish and shellfish.

APPENDIX 10: SUMMARY OF ESTIMATED DIETARY EXPOSURES (µG/KG BW/WEEK)* TO CONTAMINANT ELEMENTS IN THE 2009 NZTDS

Elements	International Standard (µg/kg bw/wk)*	25+ yr males	25+ yr females	19–24 yr young males	11–14 yr boys	11–14 yr girls	5–6 yr children	1–3 yr toddlers	6–12 month infants
Arsenic (total)		11.3–11.5[b]–1.7	8.7– 8.9–9.1	10.3–10.4 –10.6	10.4– 10.6–10.8	5.5–5.6–5.8	10.7–11.0–11.4	12.8–13.3–13.7	11.2–11.7–12.2
Arsenic (inorganic) [a]	W [a]	1.9–2.0 – 2.1	1.6–1.7–1.8	1.7–1.8–1.9	1.9–2.0–2.1	1.2–1.3–1.4	2.4–2.5–2.6	3.0–3.1–3.2	3.0–3.1–3.2
Cadmium (diet including oysters)	25 [c]	6.7–6.8–6.9	5.4–5.5–5.6	6.8–6.9–7.0	7.6–7.7–7.8	6.4– 6.5–6.5	11.3–11.5–11.6	10.7–10.9–11.1	2.0–2.1–2.1
% of PTMI		27%	22%	27%	31%	26%	46%	44%	36%
Cadmium (diet excluding oysters)	25 [c]	5.0–5.1–5.2	4.2–4.2–4.3	5.7–5.8–5.9	7.6–7.7–7.8	6.4–6.5–6.5	11.3–11.5–11.6	10.7–10.9–11.1	8.8–9.0–9.2
% of PTMI		20%	17%	23%	31%	26%	46%	44%	36%
Lead	W [d]	0.8–0.9–1.1	0.7–0.8–1.0	0.8–1.0–1.1	0.9–1.0–1.2	0.7– 0.9–1.0	1.4–1.7–2.0	1.6–2.0–2.4	1.7– 2.1–2.5
Mercury (total), all NZTDS foods		0.50–0.69–0.88	0.40–0.57–0.75	0.54–0.73–0.92	0.50–0.69–0.87	0.27–0.43–0.59	0.66–0.98–1.3	0.75–1.18–1.6	0.64–1.15–1.7
Mercury (total), diet excluding fish and shellfish	4 [e]	0.01–0.20–0.39	0.01–0.18–0.35	0.01–0.20–0.39	0.01–0.20–0.39	0.01–0.17–0.33	0.01–0.33–0.75	0.01–0.44–0.86	0.01–0.52–1.1
% of PTWI (inorganic mercury)		5%	4.5%	5%	5%	4.3%	8.3%	11%	13%
Methylmercury (fish and shellfish only)	1.6 [f]	0.33–0.33–0.33	0.27–0.27–0.2	0.37–0.37–0.37	0.34–0.34–0.34	0.19–0.19–0.19	0.46–0.46–0.46	0.52–0.52–0.52	0.45–0.45–0.45
% of PTWI Methylmercury (fish and shellfish only)		21%	17%	23%	21%	12%	29%	33%	28%

Notes

* All estimated dietary exposures in table are on weekly basis, except cadmium, which is on monthly basis, as WHO prefer longer reference timeframe for Cd (see c below).

a Conservative estimate assuming 10% of total As in fish is inorganic, all other foods 100% inorganic arsenic. Previous PTWI of 15 µg/kg bw/week inorganic arsenic withdrawn, and $BMDL_{0.5}$ estimated to be 3 µg/kg bw/week (WHO, 2010a).

b All lower, mid and upper bound estimates in this table are based on assigning zero, LOD/2 and LOD, respectively, to non-detects.

c New standard for cadmium is PTMI 25 µg/kg bw/**month**, reflecting need for longer-term reference timeframe than weekly (WHO, 2010b).

d Withdrawn, previous PTWI for lead of 25 µg/kg bw/week, has been withdrawn (WHO, 2010b).

e PTWI is for inorganic mercury (WHO, 2010a).

f PTWI for methylmercury (WHO, 2007).

APPENDIX 11: NUTRIENT ELEMENTS – IODINE, SELENIUM AND SODIUM IN THE 2009 NZTDS

Nutrient concentrations reported are on a "sample as consumed and as received basis", that is, at normal moisture content after preparation for consumption.

In recording the minimum and maximum concentrations for each food, normal international convention has been followed for "not detected" results, namely the result is reported as "less than the LOD" (that is, 0.0213 mg/kg means not detected, down to an LOD of 0.0213 mg/kg). The respective LODs for the nutrient elements in different matrices are detailed in Appendix 8.

Mean concentrations would normally be rounded, but the mean is an intermediate in the calculation of the estimated dietary exposure, so rounding has been left to the final calculated figure.

Appendix 11.1: Iodine content (mg/kg) of 2009 NZTDS foods

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	8	7	0.0014	< 0.002	0.004
Apple-based juice	8	2	0.0070	< 0.001	0.042
Apricot, canned	8	0	0.0199	0.011	0.027
Avocado	8	7	0.0013	< 0.002	0.004
Bacon	8	0	0.0121	0.009	0.016
Banana	8	7	0.0011	< 0.002	0.002
Beans	8	2	0.0026	< 0.002	0.005
Beans, baked, canned	8	0	0.0078	0.003	0.023
Beef, corned	8	0	0.1403	0.017	0.401
Beef, mince	8	0	0.0071	0.004	0.010
Beef, rump	8	0	0.0056	0.003	0.011
Beer	8	0	0.0063	0.002	0.024
Beetroot, canned	8	0	0.0255	0.014	0.033
Biscuits, chocolate	8	0	0.0944	0.041	0.191
Biscuits, cracker	8	3	0.0632	< 0.010	0.345
Biscuits, plain sweet	8	3	0.0350	< 0.010	0.114
Bran flake cereal, mixed	8	5	0.0103	< 0.010	0.027
Bread, mixed grain	8	3	0.0165	< 0.005	0.084
Bread, wheatmeal	8	7	0.0125	< 0.005	0.083
Bread, white	8	8	0.0025	< 0.005	< 0.005
Broccoli/cauliflower	8	6	0.0013	< 0.002	0.002
Butter	8	0	0.0162	0.012	0.020
Cabbage	8	6	0.0050	< 0.002	0.022
Caffeinated beverage	8	3	0.0043	< 0.001	0.021
Cake	8	0	0.1089	0.092	0.130
Capsicum	8	5	0.0315	< 0.002	0.180
Carbonated drink	8	3	0.0033	< 0.001	0.013

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Carrot	8	2	0.0060	< 0.002	0.017
Celery	8	2	0.0145	< 0.002	0.072
Cheese	8	0	0.0614	0.052	0.087
Chicken	8	0	0.0073	0.006	0.009
Chicken takeaway	8	0	0.0347	0.011	0.084
Chinese dish	8	0	0.1012	0.002	0.298
Chocolate beverage	8	2	0.0086	< 0.001	0.025
Chocolate, plain milk	8	0	0.2085	0.090	0.497
Coffee beans, ground	8	8	0.0005	< 0.001	< 0.001
Coffee, instant	8	7	0.0009	< 0.001	0.003
Confectionery	8	7	0.0117	< 0.010	0.059
Corn, canned	8	0	0.0103	0.006	0.021
Cornflakes	8	8	0.0050	< 0.010	< 0.010
Courgette	8	4	0.0020	< 0.002	0.005
Cream	8	0	0.0529	0.032	0.096
Cucumber	8	8	0.0010	< 0.002	< 0.002
Dairy dessert	8	0	0.0440	0.034	0.051
Egg	8	0	0.4655	0.318	0.648
Fish fingers	8	0	0.0563	0.032	0.103
Fish in batter	8	0	0.1305	0.066	0.310
Fish, canned	8	0	0.1801	0.063	0.395
Fish, fresh	8	0	0.2367	0.144	0.384
Fruit drink	8	8	0.0005	< 0.001	< 0.001
Grapes	8	4	0.0019	< 0.002	0.004
Ham	8	0	0.0488	0.026	0.143
Hamburger, plain	8	0	0.0429	0.008	0.113
Honey	8	8	0.0050	< 0.010	< 0.010
Ice cream	8	0	0.0582	0.044	0.108
Indian dish	8	0	0.0705	0.013	0.140
Infant and Follow-on formula	8	0	0.1334	0.087	0.185
Infant weaning food, cereal based	8	2	0.0066	< 0.002	0.020
Infant weaning food, custard/ fruit dish	8	0	0.0418	0.007	0.074
Infant weaning food, savoury	8	1	0.0140	< 0.002	0.058
Jam	8	8	0.0050	< 0.010	< 0.010
Kiwifruit	8	8	0.0010	< 0.002	< 0.002
Kumara	8	5	0.0023	< 0.002	0.006
Lamb/mutton	8	0	0.0106	0.004	0.025
Lambs liver	8	0	0.0651	0.017	0.259
Lettuce	8	3	0.0022	< 0.002	0.005
Margarine	8	7	0.0057	< 0.010	0.011
Meat pie	8	0	0.0761	0.004	0.257

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Melon	8	7	0.0012	< 0.002	0.003
Milk, 0.5% fat	8	0	0.1027	0.032	0.192
Milk, 3.25% fat	8	0	0.0944	0.039	0.157
Milk, flavoured	8	0	0.0784	0.038	0.139
Muesli	8	4	0.0164	< 0.010	0.074
Muffin	8	0	0.0680	0.042	0.117
Mushrooms	8	6	0.0014	< 0.002	0.003
Mussels	8	0	1.2700	0.722	1.880
Nectarine	8	7	0.0016	< 0.002	0.006
Noodles, instant	8	0	0.0359	0.003	0.233
Oats, rolled	8	8	0.0010	< 0.002	< 0.002
Oil	8	8	0.0050	< 0.010	< 0.010
Onion	8	1	0.0074	< 0.002	0.012
Orange	8	5	0.0023	< 0.002	0.006
Orange juice	8	1	0.0037	< 0.001	0.009
Oysters	8	0	1.2981	0.967	1.739
Pasta, dried	8	3	0.0440	< 0.002	0.099
Peaches, canned	8	1	0.0140	< 0.002	0.022
Peanut butter	8	2	0.1198	< 0.002	0.423
Peanuts, whole	8	1	0.0110	< 0.002	0.017
Pear	8	8	0.0010	< 0.002	< 0.002
Peas	8	7	0.0012	< 0.002	0.003
Pineapple, canned	8	1	0.0217	< 0.002	0.039
Pizza	8	0	0.0486	0.024	0.074
Pork chop	8	0	0.0072	0.005	0.009
Potato crisps	8	3	0.0190	< 0.002	0.066
Potato, hot chips	8	4	0.0043	< 0.002	0.009
Potatoes, peeled	8	7	0.0013	< 0.002	0.003
Potatoes, with skin	8	4	0.0061	< 0.002	0.026
Prunes	8	4	0.0051	< 0.002	0.015
Pumpkin	8	7	0.0012	< 0.002	0.002
Raisins/sultanas	8	0	0.0228	0.018	0.030
Rice, white	8	7	0.0012	< 0.002	0.003
Salad dressing	8	0	0.0448	0.024	0.083
Sausages	8	0	0.0832	0.021	0.165
Silverbeet	8	0	0.0160	0.003	0.056
Snack bars	8	0	0.0324	0.015	0.049
Snacks, flavoured	8	0	0.0420	0.010	0.128
Soup, chicken	8	0	0.0252	0.006	0.069
Soy milk	8	0	0.0139	0.005	0.035
Spaghetti in sauce, canned	8	1	0.0106	< 0.002	0.022
Strawberries	8	6	0.0017	< 0.002	0.005

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Sugar	8	8	0.0050	< 0.010	< 0.010
Taro	8	4	0.0019	< 0.002	0.004
Tea	8	8	0.0005	< 0.001	< 0.001
Tomato	8	8	0.0010	< 0.002	< 0.002
Tomato sauce	8	0	0.0111	0.003	0.021
Tomatoes in juice	8	1	0.0040	< 0.002	0.012
Water, bottled	8	6	0.0007	< 0.001	0.001
Water, tap	8	4	0.0030	< 0.001	0.008
Wheat biscuit cereals	8	8	0.0050	< 0.010	< 0.010
Wine, still red	8	0	0.0080	0.004	0.014
Wine, still white	8	0	0.0018	0.001	0.004
Yeast extract	6	0	0.0443	0.026	0.070
Yoghurt	8	0	0.0559	0.021	0.104

Appendix 11.2: Selenium content (mg/kg) of 2009 NZTDS foods

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	8	8	0.0020	< 0.004	< 0.004
Apple-based juice	8	8	0.0010	< 0.002	< 0.002
Apricot, canned	8	8	0.0020	< 0.004	< 0.004
Avocado	8	7	0.0037	< 0.004	0.016
Bacon	8	0	0.1404	0.096	0.200
Banana	8	5	0.0107	< 0.004	0.046
Beans	8	7	0.0034	< 0.004	0.013
Beans, baked, canned	8	0	0.0222	0.011	0.035
Beef, corned	8	0	0.0592	0.046	0.082
Beef, mince	8	0	0.0613	0.023	0.105
Beef, rump	8	0	0.0958	0.034	0.140
Beer	8	7	0.0020	< 0.002	0.009
Beetroot, canned	8	7	0.0024	< 0.004	0.005
Biscuits, chocolate	8	4	0.0192	< 0.020	0.039
Biscuits, cracker	8	1	0.0692	< 0.020	0.143
Biscuits, plain sweet	8	2	0.0415	< 0.020	0.073
Bran flake cereal, mixed	8	0	0.0960	0.043	0.237
Bread, mixed grain	8	0	0.0506	0.016	0.111
Bread, wheatmeal	8	1	0.0629	< 0.010	0.130
Bread, white	8	1	0.0688	< 0.010	0.138
Broccoli/cauliflower	8	6	0.0049	< 0.004	0.023
Butter	NA	NA	0.0100	< 0.020	< 0.020
Cabbage	8	4	0.0073	< 0.004	0.034
Caffeinated beverage	8	8	0.0010	< 0.002	< 0.002
Cake	8	0	0.0778	0.062	0.095

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Capsicum	8	8	0.0020	< 0.004	< 0.004
Carbonated drink	8	8	0.0010	< 0.002	< 0.002
Carrot	8	6	0.0043	< 0.004	0.015
Celery	8	8	0.0020	< 0.004	< 0.004
Cheese	8	0	0.0844	0.080	0.089
Chicken	8	0	0.3397	0.156	0.517
Chicken takeaway	8	0	0.0947	0.067	0.180
Chinese dish	8	0	0.0458	0.020	0.075
Chocolate beverage	8	6	0.0013	< 0.002	0.002
Chocolate, plain milk	8	4	0.0169	< 0.020	0.028
Coffee, beans, ground	8	8	0.0010	< 0.002	< 0.002
Coffee, instant	8	8	0.0010	< 0.002	< 0.002
Confectionery	8	8	0.0100	< 0.020	< 0.020
Corn, canned	8	4	0.0051	< 0.004	0.018
Cornflakes	8	2	0.0314	< 0.020	0.065
Courgette	8	6	0.0043	< 0.004	0.018
Cream	8	0	0.0074	0.006	0.009
Cucumber	8	8	0.0020	< 0.004	< 0.004
Dairy dessert	8	0	0.0078	0.005	0.011
Egg	8	0	0.2397	0.219	0.263
Fish fingers	8	0	0.2848	0.226	0.393
Fish in batter	8	0	0.2822	0.141	0.448
Fish, canned	8	0	0.4352	0.259	0.763
Fish, fresh	8	0	0.4648	0.359	0.570
Fruit drink	8	8	0.0010	< 0.002	< 0.002
Grapes	8	8	0.0020	< 0.004	< 0.004
Ham	8	0	0.1793	0.125	0.221
Hamburger, plain	8	0	0.0472	0.018	0.074
Honey	8	8	0.0100	< 0.020	< 0.020
Ice cream	8	5	0.0054	< 0.004	0.013
Indian dish	8	0	0.0525	0.027	0.085
Infant and Follow-on formula	8	0	0.0199	0.012	0.026
Infant weaning food, cereal based	8	3	0.0074	< 0.004	0.018
Infant weaning food, custard/ fruit dish	8	4	0.0034	< 0.004	0.005
Infant weaning food, savoury	8	5	0.0050	< 0.004	0.019
Jam	8	8	0.0100	< 0.020	< 0.020
Kiwifruit	8	6	0.0038	< 0.004	0.010
Kumara	8	8	0.0020	< 0.004	< 0.004
Lamb/mutton	8	0	0.0578	0.032	0.120
Lambs liver	8	0	0.1720	0.070	0.281
Lettuce	8	8	0.0020	< 0.004	< 0.004

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Margarine	NA	NA	0.0059	< 0.0118	< 0.0118
Meat pie	8	0	0.0421	0.028	0.065
Melon	8	8	0.0020	< 0.004	< 0.004
Milk, 0.5% fat	8	0	0.0080	0.005	0.012
Milk, 3.25% fat	8	0	0.0061	0.004	0.009
Milk, flavoured	8	0	0.0075	0.004	0.013
Muesli	8	0	0.0802	0.022	0.251
Muffin	8	0	0.0660	0.045	0.093
Mushrooms	8	0	0.1727	0.119	0.284
Mussels	8	0	0.4360	0.338	0.551
Nectarine	8	8	0.0020	< 0.004	< 0.004
Noodles, instant	8	1	0.0288	< 0.004	0.072
Oats, rolled	8	4	0.0097	< 0.004	0.026
Oil	NA	NA	0.0010	< 0.002	< 0.002
Onion	8	5	0.0047	< 0.004	0.012
Orange	8	8	0.0020	< 0.004	< 0.004
Orange juice	8	8	0.0010	< 0.002	< 0.002
Oysters	8	0	0.4529	0.311	0.589
Pasta, dried	8	0	0.0501	0.034	0.068
Peaches, canned	8	8	0.0020	< 0.004	< 0.004
Peanut butter	8	0	0.0597	0.048	0.086
Peanuts, whole	8	0	0.0833	0.043	0.216
Pear	8	8	0.0020	< 0.004	< 0.004
Peas	8	5	0.0031	< 0.004	0.005
Pineapple, canned	8	8	0.0020	< 0.004	< 0.004
Pizza	8	0	0.0852	0.059	0.105
Pork chop	8	0	0.1665	0.129	0.206
Potato crisps	8	6	0.0118	< 0.004	0.052
Potato, hot chips	8	6	0.0059	< 0.004	0.030
Potatoes, peeled	8	7	0.0027	< 0.004	0.007
Potatoes, with skin	8	7	0.0030	< 0.004	0.010
Prunes	8	8	0.0020	< 0.004	< 0.004
Pumpkin	8	8	0.0020	< 0.004	< 0.004
Raisins/sultanas	8	8	0.0020	< 0.004	< 0.004
Rice, white	8	6	0.0033	< 0.004	0.008
Salad dressing	NA	NA	0.0010	< 0.002	< 0.002
Sausages	8	0	0.0641	0.041	0.097
Silverbeet	8	7	0.0045	< 0.004	0.022
Snack bars	8	1	0.0349	< 0.020	0.058
Snacks, flavoured	8	3	0.0255	< 0.020	0.066
Soup, chicken	8	4	0.0073	< 0.004	0.022
Soy milk	8	0	0.0112	0.003	0.028

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Spaghetti in sauce, canned	8	0	0.0069	0.004	0.011
Strawberries	8	4	0.0036	< 0.004	0.006
Sugar	8	8	0.0100	< 0.020	< 0.020
Taro	8	8	0.0020	< 0.004	< 0.004
Tea	8	8	0.0010	< 0.002	< 0.002
Tomato	8	8	0.0020	< 0.004	< 0.004
Tomato sauce	8	4	0.0074	< 0.004	0.026
Tomatoes in juice	8	4	0.0034	< 0.004	0.005
Water, bottled	8	8	0.0005	< 0.001	< 0.001
Water, tap	8	8	0.0005	< 0.001	< 0.001
Wheat biscuit cereals	8	0	0.1992	0.109	0.307
Wine, still red	8	8	0.0010	< 0.002	< 0.002
Wine, still white	8	8	0.0010	< 0.002	< 0.002
Yeast extract	6	1	0.1191	< 0.020	0.240
Yoghurt	8	5	0.0042	< 0.004	0.011

NA = not analysed, because LOD in these matrices inadequate to yield a meaningful LOD/2 value. Such foods have been assigned a mean value based on previous NZTDS or other New Zealand data (Vannoort *et al.*, 2000).

Appendix 11.3: Sodium content (mg/kg) of 2009 NZTDS foods

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Apple	8	4	9	< 10	14
Apple-based juice	8	0	26	11	65
Apricot, canned	8	0	96	20	138
Avocado	8	1	124	< 10	204
Bacon	8	0	16911	13685	20945
Banana	8	8	5	< 10	< 10
Beans	8	8	5	< 10	< 10
Beans, baked, canned	8	0	4347	3802	4636
Beef, corned	8	0	8838	7343	10185
Beef, mince	8	0	735	659	818
Beef, rump	8	0	609	501	739
Beer	8	0	26	18	46
Beetroot, canned	8	0	2299	1856	2950
Biscuits, chocolate	8	0	1660	1473	1921
Biscuits, cracker	8	0	6378	4788	8445
Biscuits, plain sweet	8	0	3345	2872	3807
Bran flake cereal, mixed	8	0	3338	2051	6563
Bread, mixed grain	8	0	4247	3772	4563
Bread, wheatmeal	8	0	4333	3882	4641
Bread, white	8	0	4542	4240	4898

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Broccoli/cauliflower	8	0	61	29	137
Butter	8	0	5377	4863	6093
Cabbage	8	0	65	31	152
Caffeinated beverage	8	0	584	143	963
Cake	8	0	3507	3151	4310
Capsicum	8	5	8	< 10	13
Carbonated drink	8	0	53	14	101
Carrot	8	0	400	283	634
Celery	8	0	459	233	654
Cheese	8	0	6747	6406	7226
Chicken	8	0	1297	998	1782
Chicken takeaway	8	0	6608	6000	7092
Chinese dish	8	0	3845	3191	4249
Chocolate beverage	8	2	39	< 5	117
Chocolate, plain milk	8	0	814	633	1325
Coffee, beans, ground	8	8	3	< 5	< 5
Coffee, instant	8	5	5	< 5	11
Confectionery	8	0	644	202	1118
Corn, canned	8	0	1717	1012	2514
Cornflakes	8	0	6598	5721	7973
Courgette	8	8	5	< 10	< 10
Cream	8	1	196	< 10	242
Cucumber	8	0	22	12	51
Dairy dessert	8	0	439	340	542
Egg	8	0	1418	1353	1462
Fish fingers	8	0	4020	3343	5075
Fish in batter	8	0	2589	1937	3218
Fish, canned	8	0	3657	2519	4112
Fish, fresh	8	0	926	792	1031
Fruit drink	8	0	146	54	245
Grapes	8	0	25	12	47
Ham	8	0	11114	8933	12460
Hamburger, plain	8	0	4353	3060	4888
Honey	8	6	32	< 50	55
Ice cream	8	0	431	347	585
Indian dish	8	0	2993	2249	4088
Infant and Follow-on formula	8	0	234	170	334
Infant weaning food, cereal based	8	4	30	< 10	94
Infant weaning food, custard/ fruit dish	8	0	134	64	185
Infant weaning food, savoury	8	1	155	< 10	264
Jam	8	6	81	< 50	356

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Kiwifruit	8	0	19	15	23
Kumara	8	0	208	118	353
Lamb/mutton	8	0	958	820	1170
Lambs liver	8	0	896	794	1040
Lettuce	8	1	20	< 10	39
Margarine	8	0	5560	3505	7476
Meat pie	8	0	4131	3316	4949
Melon	8	0	64	24	113
Milk, 0.5% fat	8	0	372	326	421
Milk, 3.25% fat	8	0	352	306	396
Milk, flavoured	8	0	338	308	362
Muesli	8	1	261	< 50	622
Muffin	8	0	3739	3135	4573
Mushrooms	8	0	45	36	52
Mussels	8	0	3927	2647	4987
Nectarine	8	8	5	< 10	< 10
Noodles, instant	8	0	3620	2536	4509
Oats, rolled	8	8	5	< 10	< 10
Oil	8	8	25	< 50	< 50
Onion	8	0	22	12	46
Orange	8	5	9	< 10	25
Orange juice	8	2	9	< 5	14
Oysters	8	0	3915	3259	4479
Pasta, dried	8	5	26	< 10	76
Peaches, canned	8	1	42	< 10	116
Peanut butter	8	0	4508	2271	6370
Peanuts, whole	8	4	2122	< 10	6069
Pear	8	7	6	< 10	17
Peas	8	3	10	< 10	15
Pineapple, canned	8	4	21	< 10	58
Pizza	8	0	5243	4587	6171
Pork chop	8	0	909	571	1175
Potato crisps	8	0	4066	3096	4785
Potato, hot chips	8	0	2133	10	3282
Potatoes, peeled	8	8	5	< 10	< 10
Potatoes, with skin	8	3	10	< 10	16
Prunes	8	5	12	< 10	40
Pumpkin	8	8	5	< 10	< 10
Raisins/sultanas	8	0	126	66	207
Rice, white	8	6	8	< 10	21
Salad dressing	8	0	7656	5887	9622
Sausages	8	0	7036	6362	7724

Food	Number of samples analysed	Number of samples < LOD	Mean (mg/kg) (ND = LOD/2)	Minimum (mg/kg)	Maximum (mg/kg)
Silverbeet	8	0	645	428	1319
Snack bars	8	0	1857	266	2896
Snacks, flavoured	8	0	6980	3100	10861
Soup, chicken	8	0	3254	2257	4225
Soy milk	8	0	607	388	917
Spaghetti in sauce, canned	8	0	3908	2949	4661
Strawberries	8	8	5	< 10	< 10
Sugar	8	8	25	< 50	< 50
Taro	8	8	5	< 10	< 10
Tea	8	8	3	< 5	< 5
Tomato	8	4	9	< 10	19
Tomato sauce	8	0	8332	6813	10395
Tomatoes in juice	8	0	649	57	1807
Water, bottled	8	0	10	8	14
Water, tap	8	0	9	5	13
Wheat biscuit cereals	8	0	3009	2768	3336
Wine, still red	8	0	32	18	60
Wine, still white	8	0	20	15	28
Yeast extract	6	0	33227	31825	35000
Yoghurt	8	0	404	48	627

APPENDIX 12: DAILY INTAKES OF NUTRIENT ELEMENTS FOR EACH AGE-GENDER COHORT IN THE 2009 NZTDS

Nutrient elements	25+ yr males	25+ yr females	19–24 yr young males	11–14 yr [c] boys	11–14 yr [c] girls	5–6 yr [d] children	1–3 yr toddlers	6–12 month [e] infants
Iodine intake (µg/day)	84–<u>86</u>–88 [a]	62–<u>63</u>–65	88–<u>89</u>–91	60–<u>61</u>–62	49–<u>50</u>–51	42–<u>43</u>–44	48–<u>48</u>–49	66–<u>66</u>–67
EAR (µg/day) [b]	100	100	100	75	75	65	65	110 (AI, not EAR)
UL (µg/day) [b]	1100	1100	1100	600	600	300	200	B/F
Selenium intake (µg/day)	75–<u>78</u>–82	54–<u>56</u>–59	79–<u>82</u>–85	68– <u>70</u>–72	49–<u>51</u>–53	39–<u>41</u>–42	25–<u>26</u>–27	21–<u>21</u>–22
EAR (µg/day) [b]	60	50	60	40	40	25	20	15 (AI, not EAR)
UL (µg/day) [b]	400	400	400	280	280	150	90	60
Sodium intake (mg/day)	2901	2049	3405	2862	2318	1866	1306	805
AI (mg/day) [b]	460–920	460–920	460–920	400–800	400–800	300–600	200–400	170
UL (mg/day) [b]	2300	2300	2300	2000	2000	1400	1000	unable to be set

Notes

a All lower, <u>mid</u> and upper bound estimates in this table are based on assigning zero, <u>LOD/2</u> and LOD, respectively, to non-detects.
b Nutrient Reference Values for Australia and New Zealand (NHMRC, 2006); EAR = Estimated Average Requirement; UL = Upper Level of Intake; AI = Adequate Intake.
c Nutrient reference values for 11–14 year children extrapolated from values for 9–13 year children.
d Nutrient reference values for 5–6 year children extrapolated from values for 4–8 year children.
e Nutrient reference values for 6–12 month infants extrapolated from values for 7–12 month infants.

APPENDIX 13: GLOSSARY OF TERMS, ABBREVIATIONS AND ACRONYMS

ADI *Acceptable Daily Intake* is the daily intake of a chemical which, during the entire lifetime of the consumer, appears to be without appreciable risk to health. ADIs are set using the information obtained from toxicological studies, including data from chronic studies on various laboratory animals. From these studies, the highest dose level that produces no observable adverse effect (NOAEL) in the most sensitive test species is established. The NOAEL is divided by a safety factor, taking into account the difference between test animals and humans, and the difference between individuals, to give the ADI expressed in terms of mg agricultural compound/kg bw/day. Safety factors for agricultural compounds are usually in the range 100 to 1000, depending on the reliability and interpretation of the toxicological data available. Safety factors lower than 100, down as low as 10, may be used if good human epidemiological data are available, but this is rarely the case. These toxicological evaluations of agricultural compounds are undertaken internationally by the Joint FAO/WHO Meeting on Pesticide Residues (JMPR). The JMPR sets WHO ADIs, which are normally adopted by New Zealand. In the absence of these, the most recent ADIs promulgated by JMPR are included in Appendix 7, and have been expressed on µg/kg bw/day basis for ease of reading. Where an ADI has not been set by JMPR, then the Australian ADI has also been used, as set by the Australian Department of Health and Aging, Office of Chemical Safety and Environmental Health (ADHA, 2010).

agricultural compound*

For the purposes of this study, agricultural compound is a generic term for any substance intended for preventing, destroying, attracting, repelling, or controlling any pest, including unwanted species of plants or animals during the production, storage, transportation, distribution, and processing of food, agricultural commodities, or animal feed. The term includes pesticides, fungicides, insecticides, herbicides, and veterinary medicines administered to animals for the control of, for example, ectoparasites. It includes substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transportation, or disinfestations of raw primary produce.

*In previous NZTDSs, the term used for these compounds was pesticides.

agricultural compound* residue

Any specified substance in food, agricultural commodities, or animal feed resulting from the use of an agricultural compound (from known, unknown or unavoidable sources). Includes any derivatives of an agricultural compound, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance.

*In previous NZTDSs, the term used for these compounds was pesticides.

AI *Adequate Intake* – Where evidence was insufficient or too conflicting to establish an EAR, an adequate intake (AI) range was set, either on experimental evidence or by adopting the most recent available median intake and assuming that the Australian/New Zealand populations were not deficient for that particular nutrient (NHMRC, 2006).

ALARA *As Low As Reasonably Achievable.*

arithmetic mean

Simple average calculated by summing all values in the data set and dividing by the number of values in the data set.

ATDS *Australian Total Diet Study.*

analyte A substance detected by chemical analyses.

$BMDL_{0.5}$

Benchmark Dose Limit – corresponding to lower limit of a one-sided 95% confidence interval on the BMD. The BMD approach provides a more quantitative alternative in the dose-response assessment to the NOAEL process for non-cancer health effects.

bw *Body weight.*

CNS *National Children's Nutrition Survey of New Zealand,* undertaken in 2002.

composite

A sample produced by combining portions of each of a number of constituent samples. In this report, composite refers to the product of equal portions of constituent samples.

dL *decilitre.*

DTC *Dithiocarbamate.*

EAR *Estimated Average Requirement:* EARs were developed by a working party of New Zealand and Australian nutrition experts (NHMRC, 2006). EARs define the daily levels of intake estimated to meet the known nutrient needs of half the healthy people, and are based on the process and recommendations of the United States/Canadian Dietary Reference Intakes with regard to any unique aspects of populations in New Zealand and Australia, and new evidence and recommendations from European countries and/or organisations.

ESR *Institute of Environmental Science & Research Limited.*

FAO *Food and Agriculture Organization.*

g *grams.*

GAP *Good agricultural practice.*

GEMS *Global Environmental Monitoring System.*

JECFA *The Joint FAO/WHO Expert Committee on Food Additives.*

JMPR *The Joint FAO/WHO Meeting on Pesticide Residues.*

kg *kilograms.*

LOD *Limit of Detection* – is defined as the minimum concentration of the analyte in a dietary sample that can just be detected under a pre-established set of analysis conditions. An LOD can be calculated from 3 times standard deviation (SD) of the blank; the LOD in food must be corrected for weight of food sampled and final volume of digest (Keith *et al.*, 1983). For the purposes of the 2009 NZTDS, concentrations above the LOD have been reported and used in determining mean concentrations, which are then used for dietary exposure estimates.

LOQ *Limit of Quantitation* – is the minimum concentration of analyte in a dietary sample that can be determined quantitatively with acceptable accuracy and consistency. The LOQ is also referred to as the "limit of reporting" in the international literature (FAO/UNEP/WHO, 1985). LOQ can be calculated from 10 times standard deviation (SD) of the blank; the LOQ in food items must be corrected for the weight of food sampled and final volume of digest (Keith *et al.*, 1983). The LOQ is also referred to as the "limit of reporting" (LOR) in the international literature.

lower bound (LB) intake estimate

Dietary intakes are estimates obtained by multiplying the mean concentration of the analyte in a food by the amount of each food consumed. The intake from each food is then summed across all foods in the diet to yield a total dietary intake. A problem arises when the concentration of analyte in the food is "not detected", since the true concentration could be anywhere from zero up to the LOD. For nutrients in New Zealand, such as iodine and selenium, insufficiency of intake is likely to be more of a health issue than excessive intake. In this regard, intake calculations have also been undertaken which assign the value of zero to "not detected" concentration data, and these thus provide a lower bound (LB) intake estimate.

MeHg *methylmercury.*

mg/kg *milligrams per kilogram,* equivalent to parts per million.

µg/kg *micrograms per kilogram,* equivalent to parts per billion

MJ *megajoule*.

mls *millilitres.*

MoH *Ministry of Health* (New Zealand).

NNS *National Nutrition Survey of New Zealand,* undertaken in 1997.

NOAEL *No Observable Adverse Effect Level.*

not detected

Means the analytical result is below the LOD.

NRV *Nutrient Reference Value* of Australia and New Zealand (NHMRC, 2006).

NZFSA *New Zealand Food Safety Authority*, amalgamated into the New Zealand Ministry of Agriculture and Forestry from 1 July 2010.

NZTDS *New Zealand Total Diet Study.*

50th percentile

The 50th percentile corresponds to the value that divides a set of ordered results into two halves. It is also known as the median.

90th percentile

The 90th percentile corresponds to the value that has 90% of ordered results below it. It only has 10% of results above it.

PTMI *Provisional Tolerable Monthly Intake.*

PTWI *Provisional Tolerable Weekly Intake* – is the end-point used by JECFA for food contaminants such as heavy metals with cumulative properties. Its value represents permissible human weekly exposure to those contaminants unavoidably associated with consumption of otherwise wholesome and nutritious foods (WHO, 1987b).

Q1, Q2, etc

Quarter 1, quarter 2, etc. Sampling periods for the 2009 NZTDS.

RDIs

Recommended Dietary Intakes are the average daily nutrient intake levels sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and gender group (NHMRC, 2006).

TDS *Total Diet Study.*

UL *Upper Level of Intake* – the highest average daily nutrient intake level likely to pose no adverse health effects in almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects increases (NHMRC, 2006).

upper bound (UB) intake estimate

Dietary intakes are estimates obtained by multiplying the mean concentration of the analyte in a food by the amount of each food consumed. The intake from each food is then summed across all foods in the diet to yield a total dietary intake. A problem arises when the concentration of analyte in the food is "not detected", since the true concentration could be anywhere from zero up to the LOD. From a toxicological point of view, it is best to err on the side of caution, and this is achieved by assigning all "not detected" results an upper bound value equal to the LOD. Such intakes are thus called upper bound (UB) intake estimates.

US EPA *United States Environmental Protection Agency.*

US FDA *United States Food and Drug Administration.*

WHO *World Health Organization.*

yr *year.*

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