24th Australian Total Diet Study

FOOD STANDARDS Australia New Zealand

Te Mana Kounga Kai – Ahitereiria me Aotearoa

Phase 2

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Foreword

Food Standards Australia New Zealand (FSANZ) is an independent Australian Government agency committed to ensuring that the people of Australia and New Zealand have a safe food supply that protects and supports their health. FSANZ is responsible for developing food standards, including establishing limits for the levels of certain chemicals in foods.

FSANZ conducts a number of surveys to measure the levels of chemicals in food, and estimates the dietary exposure of the Australian population to these chemicals to determine whether there are any public health concerns. The most comprehensive analytical food survey conducted in Australia for this purpose is the Australian Total Diet Study (ATDS). The study has traditionally focused on agricultural and veterinary chemicals, but over time has included other chemicals of interest, such as additives and nutrients.

The 24th ATDS was conducted in two stages—phase 1 covered acrylamide, aluminium and perchlorate; while phase 2, presented in this report, focused on various food packaging chemicals.

I would like to thank the staff of FSANZ and other agencies who have contributed to another successful ATDS outcome. I am pleased to present phase 2 of the 24th ATDS as part of FSANZ's commitment to monitoring the Australian food supply and ensuring that it continues to be one of the safest in the world.

Ms Philippa Smith AM

CHAIR

Table of contents

Tables and figures

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Abbreviations

4-BZP	4-benzoylbiphenyl
4-MBP	4-methylbenzophenone
ATDS	Australian Total Diet Study
BMD	benchmark dose
BBP	butylbenzyl phthalate
BP	benzophenone
BPA	bisphenol A
bw	body weight
DBP	dibutyl phthalate
DDP	didecyl phthalate
DEABP	4,4’-bis(diethylamino) benzophenone
DEHA	di-(2-ethylhexyl) adipate
DEHP	diethylhexyl phthalate
DEP	diethyl phthalate
DETX	2,4-diethyl-9H-thioxanthen-9-one
DHpP	diheptyl phthalate
DHxP	dihexyl phthalate
DIBP	diisobutyl phthalate
DIDP	diisodecyl phthalate
DINP	diisononyl phthalate
DIPP	diisopropyl phthalate
DMP	dimethyl phthalate
DMPAP	2,2-dimethoxy-2-phenylacetophenone
DNOP	di-n-octyl phthalate
DPP	dipentyl phthalate
EC	European Commission
EDAB	ethyl 4-(dimethylamino)benzoate
EFSA	European Food Safety Authority
EHDAB	2-ethylhexyl-4-(dimethylamino) benzoate
ESBO	epoxidised soybean oil
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration (of US)
FSANZ	Food Standards Australia New Zealand
GC	gas chromatography
HBGV	health-based guidance value

HMPP	2-hydroxy-2-methylpropiophenone
IRG184	*Irgacure184* or 1-hydroxycyclohexyl phenyl ketone, methanone
ITX (2- & 4-)	isopropyl-9H-thioxanthen-9-one, mix of 2-and 4-isomers
kg	kilogram
JEFCA	Joint FAO/WHO Expert Committee on Food Additives
LC	liquid chromatography
LOAEL	lowest observed adverse effect level
LOD	limit of detection
LOR	limit of reporting
mg	milligram (one thousandth of a gram)
mg/kg	milligrams per kilogram (parts per million)
MOE	margin of exposure
MS	mass spectrometry
NMI	National Measurement Institute
NNS	National Nutrition Survey
NOAEL	no observed adverse effect level
ppb	parts per billion (equivalent to one microgram per kilogram)
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulphonic acid
ppm	parts per million (equivalent to one milligram per kilogram)
PVC	polyvinyl chloride
RASFF	Rapid Alert System for Food and Feed
SML	specific migration limit
TDI	tolerable daily intake
TMDE	Theoretical Maximum Daily Exposure
TTC	threshold of toxicological concern
µg/kg	micrograms/kilogram (parts per billion)
UK	United Kingdom
US	United States of America
WHO	World Health Organization

Note: Definitions for some of these terms can be found in Appendix 13 - Glossary

Executive Summary

Phase 2 of the 24th Australian Total Diet Study (ATDS) was a screening study that investigated levels of 30 food packaging chemicals in the Australian food supply. It was conducted to inform the need for further targeted studies on packaging chemicals that will better define dietary exposure and potential public health and safety risks.

The results confirm that overall Australian consumers are exposed to low levels of packaging chemicals through food consumption, and provide reassurance that concentrations of these chemicals in food represent a negligible to low risk to public health and safety.

A total of 81 typically consumed foods and beverages were tested for packaging chemicals including bisphenol A (BPA), epoxidised soybean oil (ESBO), di-2-ethylhexyl adipate (DEHA), two perfluorinated compounds, 14 phthalates, and 11 chemicals used in printing inks. These chemicals have a range of uses in food packaging including as plasticisers (plastic softeners), lid-sealing agents, moisture/oil-resistant coatings and in labelling.

Most foods contained no detectable levels of the packaging chemicals analysed. However, low levels (parts per million or parts per billion) of BPA, ESBO, DEHA, perfluorooctane sulphonic acid, seven phthalates and four printing ink chemicals were detected in a small proportion of some foods. Concentrations of these chemicals were generally comparable to, or lower than, those reported in previous Australian surveys and international studies. The remaining 15 chemicals were not detected above the limit of reporting in any foods analysed in this study.

Typically, in a total diet study foods analysed are ‘mapped’ to a wider number of similar foods reported as consumed in national nutrition surveys to estimate dietary exposure. In this case, it was not possible to map analysed foods to similar foods that also had the same type of packaging, because details of the packaging of foods reported as consumed in the national nutrition surveys were not reported, with the exception of some canned food. The details of the packaging for the food samples included were also not recorded.

Therefore, a screening assessment of the detected chemicals was conducted to identify whether any were of potential health and safety concern that would require further investigation. This assessment involved a conservative calculation of the possible daily exposure based on the highest concentrations detected in foods, and comparison to internationally recognised safe levels. Where there were no internationally accepted health-based guidance values, a margin of exposure (MOE) approach was used.

The results showed that, in general, the estimated exposures to packaging chemicals detected in Australian foods and beverages were below internationally recognised safe levels and presented a negligible to low risk to the Australian population. However, for two phthalates, di(2-ethylhexyl) phthalate (DEHP) and diisononyl phthalate (DINP), the screening identified a need for more comprehensive analytical data to enable a more robust assessment of any potential health and safety risks.

DEHP and DINP were each detected in approximately a third of the foods tested for phthalates, across a variety of food groups. The European Union's (EU) specific migration limit (SML) for DEHP was exceeded in samples of bread and hamburger, and for both DEHP and DINP the theoretical daily exposure that was estimated exceeded the respective tolerable daily intake. While these theoretical exposure estimates were highly conservative, FSANZ is currently in the process of planning a follow–up analytical survey to allow a better estimate of dietary exposure to these two chemicals.

Results of the current study are consistent with those observed internationally which have shown the presence of phthalates (including DEHP) in a range of foods commonly consumed in the diet, with some conservative dietary exposure estimates in the range of relevant health-based guidance values (HBGV). Importantly, these studies also recognise that while diet is a source of phthalate exposure, other sources (for example, dust, indoor air, personal care products) would also need to be considered for a complete risk assessment.

In regard to BPA, all detections were below the internationally recognised SML. Canada, the EU, and some states and counties in the United States (US) have phased out the use of BPA in polycarbonate baby bottles, whereas a voluntary phase-out has been introduced in Australia. FSANZ notes these phase-outs have been instigated primarily in response to consumer concerns rather than being based on demonstration of a clear public health risk.

The information gathered in this study will feed into the review of the current regulatory framework of food contact packaging materials in Australia and New Zealand through Proposal P1034[1] – Chemical Migration from Packaging into Food. The overall purpose of proposal P1034 is to determine whether there is a need to make changes to the way in which food contact materials are managed in Australia and New Zealand. It recognises that countries with comparable food regulatory frameworks currently have significantly more specific mandatory requirements for food contact materials than Australia and New Zealand.The Proposal will consider chemicals migrating from packaging materials into food offered for retail sale. It will include all virgin and recycled packaging materials from which chemicals could migrate into food through direct contact with food, and other more indirect mechanisms.

1 Proposal P1034 http://www.foodstandards.gov.au/code/proposals/Pages/P1034ChemicalMigrationfromPackagingintoFood.aspx

1. Introduction

The ATDS provides a unique and comprehensive assessment of the Australian population's dietary exposure (intake) to food chemicals. It estimates dietary exposure to chemicals from foods in the Australian food supply prepared to a 'table ready state' (for example, lamb chops are grilled).

Formerly the Australian Market Basket Survey, the ATDS has been conducted approximately every two years since 1970. While the survey has traditionally focused on agricultural and veterinary chemicals and metal contaminants, its scope has expanded to include a broader range of substances of interest to FSANZ. These have included food additives (FSANZ 2005), nutrients (FSANZ 2008; FSANZ 2011) and acrylamide (FSANZ 2014a).

The 24th ATDS was conducted in two different phases. Phase 1 assessed acrylamide, aluminium and perchlorate and was published in April 2014 (FSANZ 2014a). Phase 2 investigated 30 chemicals that may be used in food packaging. Both phases were conducted with the participation of all Australian states and territories.

This ATDS provides a general indication of the levels of packaging chemicals in foods and beverages available in Australia. It will inform the need for further targeted studies on packaging chemicals that will better define dietary exposure and potential public health and safety risks. The scope does not extend to investigating specific types of packaging from which chemicals may migrate.

1.1 Why is FSANZ investigating levels of packaging chemicals in food?

There continues to be ongoing concern from consumers, industry, the media, politicians and some international regulators about the unintended leaching of food packaging chemicals into foods and their potential health effects. These concerns have been raised by detections of individual packaging chemicals in foods and associated public attention over the past 30 years.

Packaging chemicals can migrate into foods through direct contact from food packaging materials, such as plastic or paperboard and gaskets used to seal jars and bottles. Indirect exposure may also occur; for example migration from outer packaging through plastic inner bags. It is recognised that many of the chemicals used in packaging are also common constituents of food processing equipment. Therefore, chemicals may migrate into food due to direct contact with equipment such as conveyer belts, plastic tubing, gloves, or inks on printed paperboard. Because some of the chemicals selected are widely used in other industries, exposure could also come from a range of environmental sources. Human biomarker studies to determine the combined exposure to packaging chemicals through ingestion, inhalation and absorption could be considered in future assessments.

FSANZ has previously conducted two targeted surveys on the presence of food packaging chemicals in Australian food and beverages. The chemicals analysed were BPA (FSANZ 2010a), ESBO, phthalates, perfluorinated compounds, acrylonitrile, semicarbazide and vinyl chloride (FSANZ 2010b). BPA and ESBO were detected at low levels in a small proportion of foods analysed in these surveys, however no public health and safety risks were identified. None of the other chemicals were detected in the tested foods.

This ATDS complements these surveys and builds the evidence base for food packaging chemicals in Australian foods by including more packaging chemicals and a wider range of foods and beverages. The information gained will contribute important information for the current FSANZ proposal P1034 – Chemical Migration from Packaging into Food. The overall purpose of proposal P1034 is to determine whether there is a need to make changes to the way in which food packaging materials are managed in Australia and New Zealand.

Current requirements in the Australia New Zealand Food Standards Code (the Code; FSANZ 2014b) are non-directive and place the responsibility for the safety of food contact materials with the manufacturers and retailers. Countries and regions with comparable food regulatory frameworks (eg. US, EU, and Canada), have significantly more specific mandatory requirements for food contact materials. These are further outlined in Section 2.

The Proposal will consider chemicals migrating from packaging materials into food offered for retail sale (including food sold for catering purposes). It will include all virgin and recycled packaging materials from which chemicals could migrate into food through direct contact with food, and other more indirect mechanisms. Further information on FSANZ's approach to assessing whether there are unmanaged public health and safety risks relating to chemical migration from packaging into food can be found in FSANZ's consultation paper-Proposal 1034 available at: http://www.foodstandards.gov.au/code/proposals/Pages/P1034ChemicalMigrationfromPackagingintoFood.aspx.

2. Food packaging material regulation

International systems regulating food packaging chemicals include one or more of the following: general safety requirements, mandatory positive lists, voluntary lists, preclearance requirements, no-objection letters and licensing and/or registration requirements. The physical, chemical and sanitary integrity of food packaging is covered by general safety requirements. The overall tenet aims to prevent the transfer of harmful substances to human health or cause unacceptable changes in composition, taste or odour of food.

Whilst most countries have general safety requirements for packaging, there are no international guidelines provided by World Health Organisation (WHO) and Food and Agriculture Organisation of the United Nations (FAO) in Codex Alimentarius regarding acceptable maximum level or acceptable daily intake of packaging chemicals in food. For example, the FAO/WHO (2010) report on toxicological and health aspects of BPA does not provide guidance values. Therefore there is no common approach to regulation of food packaging chemicals. However, the more rigorous and prescriptive US and EU requirements form the basis for all international legislation for food packaging chemicals.

An overview of requirements in Australia, the US and EU is set out below.

2.1 Australia New Zealand Food Standards Code

The two key standards in the Code relating to food packaging materials are *Standard 1.4.3–Articles and Materials in Contact with Food and Standard 1.4.1–Contaminants and Natural Toxicants*.

Standard 1.4.3 contains general food safety requirements of materials in contact with food, permitting use of these materials provided they do not cause bodily harm, distress or discomfort. The current version incorporates an editorial note that refers to the *Australian Standard for Plastic Materials for Food Contact Use, AS2070-–1999,* which provides a voluntary guide to industry for the production of plastic materials, processing aids, additives, colourants, printing inks and coatings for food contact use[2]. In turn, the Australian Standard refers to regulations in the US and the EU-see below for further details on these international regulations.

Standard 1.4.1 of the Code includes maximum allowable levels for some substances in food packaging that can migrate into food, including for vinyl chloride, acrylonitrile and tin.

Standard 3.2.2–*Food Safety Practices and General Requirements* (clause 9) in the Code also applies to food packaging: it has specific requirements for food businesses to ensure that when packaging food, only packaging material that is fit for its intended use and is not likely to cause food contamination is used.

2 The editorial note is proposed for deletion in Proposal P1025 Code Revision http://www.foodstandards.gov.au/code/proposals/Pages/proposalp1025coderev5755.aspx

Codes of Practice (such as the Confederation of European Paper Industries and The European Printing Ink Association guideline) and voluntary standards may also be used by food packaging businesses, including the Australian Standard–Plastics materials for food contact use (AS 2070-1999), which references the US and EU regulations.

2.2 US regulations

In the US, food packaging chemicals are regulated under the *Federal Food, Drug and Cosmetic Act*. The Act requires that all food contact materials are determined safe for their intended use before they are permitted for sale in the country. Food contact substances are subject to pre-approval to be used as food additives through a notification program, which involves a safety assessment of the substance. The US regulation includes positive lists of substances permitted for use as components of food contact materials including coatings, adhesives, polymers and production aids (USFDA 2014). There are no US regulations specifying levels of food contact materials in food.

2.3 EU regulations

In the EU, the European Commission's Framework Regulation (EC) No 1935/2004 (Europa 2004) is the basic legislation that applies to all food contact materials including food packaging. It sets out that these materials shall be safe, and not change the properties of food in unacceptable ways. Several packaging materials including plastics have additional, specific measures, but for the majority, including paper and board, printing inks and coatings, there are no specific EU-wide measures in place.

Plastic packaging is governed by Plastics Regulation (EU) No. 10/2011 (European Commission 2011), which includes a positive list of substances permitted to be used in plastic packaging. This regulation also sets a SML for certain chemicals including several phthalates in food. The SML is the maximum permitted amount of a given substance released from packaging into food. SMLs are established by the EU for regulation purposes and are intended to be an overestimate of the migration in food. SMLs are established from toxicological risk assessments and are calculated using an assumption that 1 kg of packaged food with 60 cm^2 of exposed surface area is consumed per day by a person of 60 kg bodyweight.

EU SMLs that have been established for chemicals analysed in this study are presented in results tables in Chapter 5.

2.4 Overseas monitoring for the presence of packaging chemicals in food

In Europe, routine monitoring of food packaging chemicals is undertaken and reporting occurs through the Rapid Alert System for Food and Feed (RASFF). These notifications usually report on risks identified in food packaging chemicals (as well as food and feed) that are placed on the market in the notifying country or detained at an EU point of entry at the border with an EU neighbouring country. The notifying country reports on the risks it has identified, the product and its traceability and the measures it has taken. In 2012, there were 104 food packaging chemical notifications made[3], 31 of which were alerts (i.e. where a food packaging chemical presents a serious risk is on the market and when rapid action is, or might be, required in an importing country).

Diet studies on the presence of food packaging chemicals in the food supply in other countries have focused primarily on the presence of phthalates in food and RASFF notifications have identified regular exceedances of DEHP in food. Other international studies indicate that phthalates in the diet, and DEHP in particular, contribute to overall exposure to these chemicals from all sources. A range of total diet studies in other countries, including in the UK (Bradley et al. 2013a), Denmark (Petersen and Breindahl 2000), China (Guo et al. 2012) and the US (Schecter et al. 2013) have shown the presence of phthalates in foods commonly found in the diet.

Studies carried out in the UK and Denmark were used by the European Food Safety Authority (EFSA 2005c) to undertake a risk assessment of DEHP. The EFSA Panel noted that exposure to DEHP from food consumption is in the range of the relevant HBGV, the established Tolerable Daily Intake (TDI), though it was noted that there are a number of other sources which contribute to the overall human exposure to DEHP. The UK Committee on Toxicity (UK COT 2011) concluded from an analysis of the dietary exposure to phthalates (Bradley, 2013a) that levels of phthalates detected in the total diet study do not indicate a risk to human health from dietary exposure alone. Other non-dietary sources of exposure would also need to be considered in a full risk assessment for phthalates. The results from diet studies in China and the US appear to corroborate this conclusion.

3 There are two kinds of RASFF notifications: market notifications and border rejections. A member of the network sends a market notification when a risk is found in a food or feed product placed on the market. A border rejection is sent when a product was refused entry into the Community. There are two types of market notifications: alert and information notifications. http://ec.europa.eu/6304C197-C474-4C34-A178-EBE8395FAECA/FinalDownload/DownloadId-359B2447862872989EA9ED24EF9E1C98/6304C197-C474-4C34-A178-EBE8395FAECA/food/food/rapidalert/docs/rasff_annual_report_2012_en.pdf .

3. Chemicals assessed

The 30 food packaging chemicals assessed in this study are listed in Table 1. Chemicals were selected for investigation after extensive consultation with internal and external stakeholders, reviews of Australian and international literature and of previous international incidents. Criteria evaluated included, for example, known use in food packaging materials and human health hazards. The availability of an appropriate analytical method and financial resources were also important considerations in planning the study.

Table 1. Chemicals investigated in phase 2 of the 24th ATDS

Chemical name	Abbreviation	CAS[1]
bisphenol A; 2,2-bis(4-hydroxyphenyl) propane	BPA	80-05-7
epoxidised soybean oil	ESBO	8013-07-8
Perfluorinated compounds:		
perfluorooctanoic acid	PFOA	335-67-1
perfluorooctane sulphonic acid	PFOS	2795-39-3
Phthalates and adipate:		
butyl benzyl phthalate	BBP	85-68-7
dibutyl phthalate	DBP	84-74-2
didecyl phthalate	DDP	84-77-5
di(2-ethylhexyl) adipate	DEHA	103-23-1
di(2-ethylhexyl) phthalate	DEHP	117-81-7
diethyl phthalate	DEP	84-66-2
diheptyl phthalate	DHpP	3648-21-3
dihexyl phthalate	DHxP	84-75-3
diisobutyl phthalate	DIBP	84-69-5
diisodecyl phthalate	DIDP	26761-40-0
diisononyl phthalate	DINP	68515-48-0
diisopropyl phthalate	DIPP	605-45-8

Chemical name	Abbreviation	CAS[1]
dimethyl phthalate	DMP	131-11-3
di-n-octyl phthalate	DNOP	117-84-0
dipentyl phthalate, di-n-pentyl phthalate	DPP	131-18-0
Printing ink chemicals:		
2-hydroxy-2-methylpropiophenone	HMPP	7473-98-5
Benzophenone	BP	119-61-9
ethyl 4-(dimethylamino)benzoate	EDAB	10287-53-3
1-hydroxycyclohexyl phenyl ketone	IRG184	947-19-3
4-methylbenzophenone	4-MBP	134-84-9
2,2-dimethoxy-2-phenylacetophenone	DMPAP	24650-42-8
2-ethylhexyl-4-(dimethylamino)benzoate	EHDAB	21245-02-3
isopropyl-9H-thioxanthen-9-one, mix of 2-and 4-isomers	ITX	75081-21-9
4-benzoylbiphenyl	4-BZP	2128-93-0
2,4-diethyl-9H-thioxanthen-9-one	DETX	82799-44-8
4,4'-bis(diethylamino) benzophenone	DEABP	90-93-7

[1] CAS = Chemical Abstracts Service (CAS) registry number

3.1 BPA

BPA is an industrial chemical used as a starting material in producing polycarbonate plastic and epoxy resins (EFSA 2013, FAO/WHO 2010). Polycarbonate is found in a variety of food contact materials such as drink bottles, food containers including microwave-safe containers, tableware, processing equipment and water pipes. Epoxy resins are used as a protective lining in canned or glass food and beverage containers. Major Australian retailers of polycarbonate plastic baby bottles are voluntarily phasing out the use of BPA[4].

4 FSANZ website http://www.foodstandards.gov.au/consumer/chemicals/bpa/pages/regulationandmonitor5377.aspx

Hazard summary

In 2006 EFSA established a TDI of 0.05 mg/kg bw for BPA from a no observed adverse effect level (NOAEL) of 5 mg/kg bw/day based on liver changes in mice and reduced bodyweight gain in rats (EFSA 2006a). New data and refined methodologies have recently led EFSA to reduce the TDI to 0.004 mg/kg bw/day (EFSA 2015). This lower TDI is temporary pending the outcome of a long-term study in rats currently being undertaken in the US, which is designed to address some remaining uncertainties about the potential effects of BPA (Schug et al 2013).

3.2 ESBO

ESBO is produced by the catalytic oxidation (epoxidation) of soybean oil. It is widely used as a plasticiser (softening agent) to improve the flexibility and softness of plastics, and in lid gaskets on glass jars and bottles to create an airtight seal. ESBO is also used in flexible polyvinyl chloride (PVC)-based cling films and in lacquers on food cans. It has been reported that ESBO can migrate into foods during the packaging and sterilisation process, particularly when the food is warm and under high pressure (EFSA 2004).

Hazard summary

In 1999 the European Commission Scientific Committee for Food established a TDI of 1 mg/kg bw for ESBO. This value, which has been adopted by EFSA, was derived from a NOAEL of 140 mg/kg bw/day for observed increases in liver and kidney weight in the absence of any histological changes in a two-year rat study (EFSA 2004, SIAM 2006).

3.3 Perfluorinated compounds

Perfluorooctane sulphonic acid (PFOS) and perfluorooctanoic acid (PFOA) were the two perfluorinated compounds assessed in this study. Perfluorinated compounds are widely used in a variety of products, including in food contact materials, to produce coatings that are resistant to oil, water or staining (such as grease-proof paper). Perfluorinated compounds are bioaccumulative in animals and humans, and persistent in the environment due to the strength of the carbon-fluorine bonds in their structure. They are also extremely durable under high temperatures and in contact with strong acids or bases (EFSA 2008).

Hazard summary

EFSA established a TDI of 0.15 μg/kg bw for PFOS based on a NOAEL of 0.03 mg/kg bw for changes in lipids and thyroid hormones observed in a monkey study (EFSA 2008). PFOA was assigned a TDI of 1.5 μg/kg bw based on a benchmark dose (BMD) analysis of increased liver weight in rats (EFSA 2008).

3.4 Phthalates and adipates

Fourteen phthalates and one adipate were assessed in this study (Table 1).

Phthalates are a group of diesters of 1,2-benzenedicarboxylic acid widely used as plasticisers. Phthalates are also used in various solvents, coatings and adhesives. The major uses of phthalates in food packaging and production materials are in PVC tubing, gaskets, cling wraps, printing inks, paper and cardboard packaging and laminated aluminium foil (Cao 2010). Phthalates can often be found in food contact plastics at levels of 20–50% weight/weight (Pedersen and Jensen 2010).

Adipates such as DEHA investigated in this study are also commonly used as plasticisers in flexible PVC plastics. In food packaging, DEHA is most commonly used in plastic cling wrap (Cao et al 2014).

Since phthalates and adipates are not chemically bound to the polymer, they can readily migrate from food packaging materials into foods (COT 2011). As such there is ongoing interest in the monitoring and control of their migration into foods, particularly into oils (Lacoste 2014; McCombie et al 2015).

Hazard summary

Some phthalates and adipates have been the subject of concern in regard to potential for reproductive and developmental effects. TDIs have been established for six of the 14 phthalates investigated in this study and for DEHA, as summarised in Table 2.

Table 2. TDIs for phthalates and DEHA

Chemical	TDI (mg/kg bw)	Endpoint	NOAEL (mg/kg bw/day)	Reference
DEP	5	Developmental effects in rats	1600	WHO (2003)
DBP	0.01	Developmental effects in rats	2 (LOAEL)	EFSA (2005a)
BBP	0.5	Testicular toxicity and reduced anogenital distance in rats	50	EFSA (2005b)
DEHA	0.3	Foetotoxicity in rats	30	SCF (2000)
DEHP	0.05	Testicular toxicity in rats	5	EFSA (2005c)
DINP	0.15	Liver and kidney effects in rats	15	EFSA (2005d)
DIDP	0.15	Liver effects in dogs	15	EFSA (2005e)

TDI – tolerable daily intake; NOAEL - no observed adverse effect level; LOAEL – lowest observed adverse effect level

NOAELs for two of the remaining eight phthalates were located in the published literature as shown in Table 3. These NOAELs are used in this report to compare with the Theoretical Maximum Daily Exposure (TMDE) calculated using maximum determined concentrations for each chemical (Chapter 6).

Table 3. Hazard information for phthalates with no TDI

Chemical	NOAEL (mg/kg bw/day)	Endpoint	Reference
DMP	1000	Reduced bodyweight gain in rats. There were no effects on developmental parameters (doses tested 200 to 4000 mg/kg bw/day)	Gray et al (2000), NICNAS (2008)
DPP	11	Reduced fetal testosterone production in rats	Hannas et al (2011)

TDI – tolerable daily intake; NOAEL – no observed adverse effect level

The remaining six phthalates (DDP, DHpP, DHxP, DIBP, DIPP and DNOP) belong to Cramer structural class I for which a threshold of toxicological concern (TTC[5]) level of 0.03 mg/kg bw/day applies (Kroes et al 2004).

3.5 Printing ink chemicals

Eleven printing ink chemicals were investigated in this study (Table 1).

Printed material in food packaging contains a variety of inks and associated chemicals used as curing agents, adhesives and lacquers. The printing ink chemicals investigated are photoinitiators and amine synergists, which are chemicals used to set or cure inks, adhesives and lacquers under ultraviolet light (European Printing Ink Association 2013; Jung et al 2009).

During and after the printing process these ink ingredients are not completely used up or removed, nor are they bound irreversibly to the packaging (EFSA 2009). As a result, migration of printing ink chemicals into food can occur in several ways; by permeation, set-off or in the gas phase. In the case of permeation, ink ingredients can migrate from the outside through the packaging material to the food inside if there is no functional barrier (e.g. foil lining). Set-off occurs when printed packaging material is stored in rolls or stacks before constructing final packaging units, and the printing chemicals transfer from the external side to the inner side of the packaging via direct contact. Migration at the gas phase occurs when volatile chemicals evaporate from the packaging, move through the inner bag if present and recondense in the food. For example, benzophenone (BP) and

5 The TTC approach assigns safe levels of human exposure to chemicals based on consideration of chemical structure (Kroes et al 2004, FAO/WHO 2011).

4-methoxybenzophenone (4-MBP) have been reported as migrating into foods in carton packages, even when inner linings are present (see EFSA 2009; Bradley et al 2013; Jung et al 2013 and references therein). The properties of the packaging material, the coatings applied and the food matrix within the packaging all affect the degree of migration.

Hazard summary

There are minimal toxicity data for many of the printing inks analysed. However for BP there were sufficient data for EFSA to establish a TDI of 0.03 mg/kg bw based on a BMD analysis of renal hyperplasia in male rats (EFSA 2009). The lower 95% confidence limits of the BMD for a 10% effect (BMDL10) were calculated to be 3.1 to 7.4 mg/kg bw/day. The lower value (3.1 mg/kg bw/day) was used by EFSA to derive the TDI for BP and was also used as the basis for calculation of the MOE[6] for 4-MBP, which was also investigated in the present study.

Repeat-dose toxicity data were located for an additional two printing ink chemicals. For HMPP, a NOAEL of 50 mg/kg bw/day was reported in a 90-day repeat-dose toxicity study in rats, with kidney effects observed at the lowest observed adverse effect level (LOAEL) of 150 mg/kg bw/day (ECHA 2013a). For IRG184, the NOAEL in a 90-day repeat-dose study in rats was 300 mg/kg bw/day. Reduced bodyweight gain was the only adverse effect reported at the next highest dose, 1000 mg/kg bw/day (ECHA 2013b).

The remaining printing ink chemicals belong to Cramer structural class III for which a TTC level of 0.0015 mg/kg bw/day applies (Kroes et al 2004).

6 In this report, the MOE is the ratio of the no observed adverse effect level (NOAEL) to the Theoretical Maximum Daily Exposure (TMDE) calculated using a modified budget method. The higher the MOE, the less likely there is a health or safety concern.

4. Conducting the survey

4.1 Overview

The ATDS is managed by FSANZ as part of the Implementation Subcommittee for Food Regulation Coordinated Food Survey Plan. This plan allows coordination of national survey activities across multiple jurisdictions.

FSANZ funded and coordinated the study with the assistance of Australian state and territory government food regulatory agencies. Each state and territory nominated a representative liaison officer to coordinate the collection of food samples, packaging and shipment of samples to the appointed laboratory for analysis.

4.2 Selection of foods

In total 81 foods and beverages were surveyed. The food sample list was developed based on foods sampled for phase 1 of the 24th ATDS, which focused on acrylamide.

The following criteria were also considered:

- known uses of food packaging chemicals; for example:
  - » BPA and ESBO have been used in can lining (EFSA 2004; EFSA 2013)
  - » ESBO and phthalates have been used in lid gaskets of jars and bottles (EFSA 2004; Cao 2010)
  - » perfluorinated compounds have been used in moisture/grease-proof packaging (Begley et al 2005; EFSA 2008)
  - » phthalates and/or DEHA have been used in paper and cardboard packaging and cling wrap (Cao 2010; Cao et al 2014)
- international reports of migration of food packaging chemicals into foods
- foods that are representative of current patterns of food and beverage consumption in Australia
- resource capabilities of the states and territories to collect samples
- cost associated with the purchase, shipping and analysis of samples.

Of the foods selected, 17 were analysed for BPA, 21 for ESBO, 48 for DEHA and phthalates, 60 for printing ink chemicals, and 50 for perfluorinated compounds. The sampled foods represent a broader range than those tested in previous FSANZ surveys of food packaging chemicals, and build the evidence base for these chemicals in food.

Further details of foods selected for particular chemical assessments are provided below and in Appendix 1.

4.3 Food sampling

Number and type of foods sampled

Both national and regional foods were sampled in the 24th ATDS. National foods are those produced locally but distributed nationally and would not be expected to exhibit any regional variation – including processed foods such as infant formulas and breakfast cereals. National foods were usually only collected in four jurisdictions (capital cities). Regional foods are those that may vary in food chemical concentrations depending on the location and season in which the food was produced – including meats, bread and milk. For these foods, 8–12 samples across jurisdictions were collected to capture regional variability.

Collecting food samples

Sampling took place in each state and territory over two sampling periods to capture seasonal variation: in May 2011 (autumn sampling) and August/September 2011 (winter sampling). FSANZ provided purchasing officers with detailed instructions on the foods to be sampled, including highest-selling brands to include, specific products to buy, particular flavours or fat-content versions to include, shopping outlets to purchase from, and quantities to purchase.

All states and territories took part in the survey. Each jurisdiction made three individual purchases of the food each time the food appeared on their sampling schedule. Due to the large number of samples collected, purchasing took place over several days. Foods were sampled from a range of different retail outlets representing the buying habits of the majority of the community, including supermarkets, corner stores, delicatessens, markets and takeaway shops. Food samples were collected in every jurisdiction, except for national foods, which as mentioned above were usually only collected in four jurisdictions. Information on the quantity, brand, batch number/expiry date and location of each purchase was recorded.

Foods in different packaging types included various types of plastics (rigid and flexible), metal cans, cardboard (carton board, corrugated board and folding cartons), paper and glass were included in the survey but specific information on each individual food sample's packaging was not recorded.

Foods included in the study for BPA

BPA was analysed in 17 of the 81 foods sampled including: baked beans; beer; canned tomatoes; coffee; infant foods; jam; juice; packaged vegetables (jarred and frozen); potatoes; powdered energy drinks; soup base; tea and yeast extract.

Foods included in the study for ESBO

ESBO was analysed in 21 of the 81 foods sampled including: baked beans; beer; canned tomatoes; coffee; infant foods and formula; jam; juice; olives; peanut butter; packaged vegetables (jarred and frozen); powdered energy drinks; soup base; tea and tomato sauce.

Foods included in the study for perfluorinated compounds

Perfluorinated compounds were analysed in 50 of the 81 foods sampled including: baked beans; canned tomatoes; dried fruit; frozen and takeaway meals; infant foods and formulas; jams; juice; meat products; milk; nuts; packaged vegetables (jarred and frozen); peanut butter; snack foods; sugar; tap water; tomato sauce; various cereal products (e.g. breads, breakfast cereals and bars) and yeast extract.

Foods included in the study for phthalates and DEHA

Fourteen phthalate esters and DEHA were analysed in 48 of the 81 foods sampled. Foods sampled included: baked beans; biscuits and cake; canned tomatoes; crisps and confectionery; egg noodles; frozen and takeaway meals; infant foods and formulas; jam; juice; meat products; milk; olives; packaged vegetables (jarred and frozen); peanut butter; sugar and various cereal products (e.g. breads, breakfast cereals and bars).

Foods included in the study for printing inks

Eleven printing ink chemicals were analysed in 60 of the 81 foods sampled. These foods included: baked beans; confectionery and snack foods; cakes and pikelets; dried fruit; frozen and takeaway meals; frozen vegetables; fruit pies; infant foods; meat products; milk; nuts; pasta; sugar and various cereal products (e.g. breads, breakfast cereals and bars).

4.4 Sample preparation and analysis

Samples were sent to the analytical laboratory as soon as practicable after purchase. When the analytical laboratory was located outside of the city/state conducting the sampling, all perishable samples (e.g. frozen goods) were sent overnight in a chilled or frozen state to the laboratory, reflecting how these products arrive in the home.

Before analysis, individual samples were prepared in the laboratory to a ready-to-eat state according to detailed instructions provided by FSANZ (Appendix 2 on food preparation). For example, chicken breast and lamb chops were grilled before analysis. Some of the foods surveyed, such as sugar and infant desserts, were in a table-ready form at the time of purchase and did not require additional preparation. Perishable foods were all prepared within 48 hours of purchasing. Frozen and shelf-stable foods were prepared within a week of purchase.

In general, three primary samples of each food from each jurisdiction were combined into a single composite for laboratory analysis (i.e. to produce one composite per jurisdiction). A total of 442 composite samples were analysed. There were 80 composites for BPA (17 foods), 84 composites for ESBO (21 foods), 304 composites for perfluorinated compounds (50 foods), 264 composites for phthalates and DEHA (48 foods), and 335 composites for printing inks (60 foods). In addition to composite food samples, individual tap water samples from the laboratory were also analysed.

The National Measurement Institute (NMI) received all samples, prepared the composite samples and coordinated analyses for the chemicals of interest by accredited laboratories. Foods were analysed by NMI (for the perfluorinated compounds), the Institute of Environmental Science and Research Ltd (for BPA, ESBO, DEHA and phthalates) and Advanced Analytical Australia (for printing ink chemicals) as per the methodology outlined in Table 4 below.

Table 4. Analytical methods used in the 24th ATDS

Chemical	Analytical method	LOR (mg/kg)
BPA	Samples were extracted with water/acetonitrile, derivatised with acetic anhydride and analysed by GC-MS[1]	3.7×10^{-3}
ESBO	Samples were extracted with hexane, transmethylated and derivatised to 1,3-dioxalanes and analysed by GC-MS[2]	0.3–4
perfluorinated compounds	Samples were extracted with methanol and analysed by LC-MS/MS[3]	2×10^{-7}– 0.006
phthalates and adipate	Samples were extracted with ethyl acetate and analysed by LC-MS/MS	0.3–4
printing inks	Samples were extracted with acetonitrile and analysed by GC-MS/MS[4]	0.05–1

BPA - bisphenol A; ESBO - epoxidised soybean oil; LOR - limit of reporting; GC - gas chromatography; MS - mass spectrometry; LC - liquid chromatography.

1. Accredited by International Accreditation New Zealand for baby food; Goodson et al 2002. 2. In-house method based on Weller et al 2007. 3. USEPA 2015. 4. Han et al 2011.

5. Detections of packaging chemicals in foods

5.1 Overview of detections in food

In total, 15 chemicals were detected in analysed foods at levels above the limit of reporting (LOR). The chemicals detected were BPA (found in eight out of 17 foods), ESBO (in four out of 21 foods), the perfluorinated compound PFOS (in two out of 50 foods), seven phthalates and the adipate DEHA (in 27 foods out of 48 foods), and four printing ink chemicals (in seven out of 60 foods).

Chemicals were detected at generally low levels (in the parts per million or parts per billion range), and in only a small proportion of composites analysed. Concentrations of the remaining 15 chemicals analysed were below the LOR.

A brief summary of the detections of each chemical and comparison to levels found in other domestic and international surveys is provided in Sections 5.2–5.7 below. Complete analytical results are presented in Appendices 3–8.

KEY RESULTS FOR DETECTIONS OF PACKAGING CHEMICALS IN THE 24TH ATDS

Low levels (parts per million or parts per billion) of BPA, ESBO, PFOS, DEHA, seven phthalates (DBP, DEHP, DEP, DHpP, DINP, DMP, DPP) and four printing ink chemicals (BP, EDAB, HMPP and IRG184) were detected above the limit of reporting in some foods.

In most cases these chemicals were only detected in a small proportion of the food samples tested for that chemical. The remaining 15 chemicals were not detected in any foods analysed in this study.

Concentrations of detected chemicals were generally comparable to, or lower than, those reported in previous Australian surveys and international studies.

In most instances chemicals were found at concentrations below EU SMLs where such limits have been established. However SMLs were exceeded in some foods for BP, DBP and DEHP.

5.2 BPA

BPA was detected at low levels in eight out of 17 foods tested, with the highest concentrations found in infant dinner, baked beans and canned tomatoes (see Table 5 and Appendix 3 Table A3.1). BPA was also detected in chargrilled vegetables in oil, coffee (takeaway espresso), jams, prune juice and soup base. For baked beans, canned tomatoes and soup base, all four of the four composites tested contained detectable levels of BPA.

Table 5. Results for BPA detections

Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
17	8	23 (19/80)	<LOR–0.074	0.6	Infant dinner; baked beans in tomato sauce; tomatoes, canned

1. The proportion of total samples analysed. In most cases, each sample analysed was a composite of three individual primary samples. 80 composites from 17 different foods were tested for BPA. For further details refer to the methodology in Chapter 4. Results do not include one laboratory water sample, in which BPA was not detected. LOR – limit of reporting; SML – specific migration limit.

These findings are consistent with a previous FSANZ survey (2010a) where BPA was also detected at low levels in baked beans, canned tomatoes, soup and infant dinner. Results are also comparable with reported BPA concentration ranges from international studies where such data were available (Appendix 3 Table A3.2).

The EU has set a SML of 0.6 mg/kg for BPA, meaning this is the maximum level of this substance that is permitted to migrate from packaging into food. The SML was not exceeded in any of the foods tested for BPA.

5.3 ESBO

ESBO was detected at low levels in four out of 21 foods tested, namely chargrilled vegetables in oil, infant dinner, infant soy formula and olives in oil (Table 6, Appendix 4 Table A4.1). Four out of four samples of soy-based infant formula contained measurable amounts of ESBO, as did three of four samples of chargrilled vegetables in oil. A previous FSANZ study (2010a) also reported detectable levels of ESBO in black olives and infant dinner.

Concentrations of ESBO detected in this study were well below those reported in similar foods from Europe and the previous FSANZ study (Table A4.2). The EU SML for ESBO (60 mg/kg for general foods, 30 mg/kg for infant foods) was not exceeded in any food sample tested in this study.

The products in which ESBO was detected are all likely to be packaged in jars – these findings are consistent with reports of ESBO migration from the sealing material used on jar lids, especially into fatty foods (EFSA 2006b).

Table 6. Results for ESBO detections

Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
21	4	13 (11/ 88)	<LOR–14	60 (general foods); 30 (infant foods)	Olives; vegetables, chargrilled in oil; infant formula, soy- based

1. The proportion of total samples analysed. In most cases, each sample analysed was a composite of three individual primary samples. 88 composites from 21 different foods were tested for ESBO. For further details refer to the methodology in Chapter 4. Results do not include one laboratory water sample, in which ESBO was not detected. LOR – limit of reporting; SML – specific migration limit.

5.4 Perfluorinated compounds

PFOS was detected at low levels (maximum 1 part per billion, 1 ppb) in two out of 50 foods tested for perfluorinated compounds, in fish fillets and beef sausages (Table 7, Appendix 5 Table A5.1). PFOA was not detected in any foods.

Neither of these chemicals were detected in any foods tested in the previous FSANZ (2010a) survey. However these studies did not include fish or sausage samples.

The concentration of PFOS detected in fish in this study was generally much lower than levels reported in international studies (Appendix 5 Table A5.2). Although there were no direct comparisons found for beef sausages, PFOS levels reported in ground beef in US (EFSA 2008) and Canadian studies (Tittlemier 2007) were similar to or higher than the 24th ATDS.

An EU SML for PFOS has not been established.

Table 7. Results for perfluorinated compound detections

Chemical	Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
PFOA	50	0	0	<LOR	none	-
PFOS	50	2	0.7 (2/304)	<LOR–0.001	none	Fish fillets – white fish, fresh; sausages, beef

1. The proportion of total samples analysed. In most cases, each sample analysed was a composite of three individual primary samples. 304 composites from 50 different foods were tested for PFOA and PFOS. For further details refer to the methodology in Chapter 4. Results do not include two laboratory water samples, in which neither PFOA nor PFOS were detected. LOR – limit of reporting; SML – specific migration limit.

5.5 Phthalates

One or more phthalates were detected in 27 out of 48 foods tested (Table 8, Appendix 6 Table A6.1–6.7). DEHP and DINP were each found in 15 of 48 foods, DEP was detected in five of 48 foods, DBP and DMP were each detected in two (different) foods, and DPP and DHpP were detected in one (different) food each. However, the overall proportion of detections of each phthalate was low, ranging from 0.4–11% of the 264 composite samples analysed (Table 8).

The highest mean concentrations of phthalates were detected in peanut butter, pizzas, hamburgers, lamb chops and savoury bread (see Appendix 6 for detailed results). Concentrations of individual phthalates exceeded the EU SML in seven cases (Table 8).

These included five cases with DEHP: one sample of savoury bread and four hamburger samples had levels above the EU SML of 1.5 mg/kg. For hamburgers, the highest DEHP concentration was 4.2 mg/kg and the mean was 1.77 mg/kg.

The concentration of DBP also exceeded the EU SML in one sample of wheat-based breakfast cereals and one sample of chargrilled vegetables in oil.

While DINP is on the EU positive list of substances allowed in food-contact plastics, it has no SML. The EU overall migration limit of 60 mg/kg for 1kg food packages was not exceeded for DINP in any foods analysed.

In a further seven cases, foods were found to contain a phthalate that is not on the EU (European Commission 2011) or US (USFDA 2014) positive lists (Table 8): DEP was detected in five different types of bread, DHpP was detected in hamburger and DPP was detected in lamb chops.

Table 8. Results for phthalate detections

Phthalate	Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
BBP	48	0	0	<LOR	30	-
DBP	48	2	0.8 (2/264)	<LOR–0.48	0.3	Breakfast cereals, single grain, wheat-based*; chargrilled vegetables in oil*
DDP	48	0	0	<LOR	none[2]	-
DEHP	48	15	11 (27/264)	<LOR–6.7	1.5	Bread, fancy, fresh (savoury)*; hamburger, from takeaway*; peanut butter
DEP	48	5	2 (5/264)	<LOR–1.6	none[2]	Breads: fancy, fresh, sweet; fancy, fresh, savoury; multigrain; white; wholemeal
DHpP	48	1	0.4 (1/264)	<LOR–0.56	none[3]	Hamburger, from takeaway*
DHxP	48	0	0	<LOR	none[2]	-
DIBP	48	0	0	<LOR	none[2]	-
DIDP	48	0	0	<LOR	none[4]	-
DINP	48	15	9 (24/264)	≤LOR–54	none[4]	Peanut butter; pizza, meat and vegetable topped; hamburger, from takeaway
DIPP	48	0	0	<LOR	none[3]	-

Phthalate	Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
DMP	48	2	0.8 (2/264)	<LOR–0.45	none[2]	Bread, fancy, fresh (sweet); sausages, beef
DNOP	48	0	0	<LOR	none[3]	-
DPP	48	1	0.4 (1/264)	<LOR–3.7	none[3]	Lamb chops, loin*

1. The proportion of total samples analysed. In most cases, each sample analysed was a composite of three individual primary samples. 264 composites from 48 different foods were tested for phthalates. For further details refer to the methodology in Chapter 4. Results do not include one laboratory water sample, in which none of the phthalates were detected.
2. Not on EU positive list (European Commission 2011) but on the US positive list (USFDA 2014), no SML.
3. Not on EU positive list (European Commission 2011) or US positive list (USFDA 2014).
4. On the EU positive list (European Commission 2011) with overall migration limit of 60 mg/kg of food.
   LOR – limit of reporting; SML – specific migration limit.* foods in which concentrations exceeded the SML, or the chemical detected was not on the EU (European Commission 2011) or US (USFDA 2014) permitted lists for food-contact plastics.

A comparison of phthalate concentrations reported here versus other published studies is presented in Table A6.8. Phthalates were not detected in the previous FSANZ survey; however the methodology and food groups analysed in this survey was different. In some cases, the measured concentrations of specific phthalates were higher than those reported in previous international studies (e.g. bread). However, direct comparisons are difficult due to differences in analytical methodology, different food products, limited sample sizes and a lack of information on packaging types.

5.6 DEHA

DEHA was detected in four foods (beef sausages, chocolate cake, hamburgers and lamb chops) in the 48 foods that were also tested for phthalates (Table 9, Appendix 7 Table A7.1). These foods are all high in fat content, consistent with the high fat solubility of DEHA and reports showing that it is most likely to migrate into fatty foods (EFSA 2005f). However, the EU SML set for DEHA (18 mg/kg; EFSA 2005f) was not exceeded in any of the food samples tested.

Table 9. Results for DEHA detections

Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
48	4	7 (15/264)	<LOR–4.1	18	Lamb chops, loin; cake, chocolate, iced; sausages, beef

1. Proportion of total samples analysed. In most cases, each sample analysed was a composite of three individual primary samples. 264 composites from 48 different foods were tested for DEHA. For further details refer to the methodology in Chapter 4. Results do not include one laboratory water sample, in which DEHA was not detected. LOR – limit of reporting; SML – specific migration limit.

A comparison of DEHA levels reported in this study with others is presented in Table A7.2. The concentrations of DEHA detected in sausages and chops were generally comparable to or lower than concentrations reported internationally (Table A7.2).

5.7 Printing inks

Four of the 11 printing ink chemicals tested were detected in foods: BP, IRG184, EDAB and HMPP (Table 10, Appendix 8 Table A8.1–8.4). One or more of these chemicals was detected in 13 out of 60 foods and beverages, including battered/crumbed chicken products, fish portions, beef sausages, lamb chops, flat bread, corn-based snack food, pancake mix and milks. IRG184 was found in five foods, BP in four foods, EDAB in three foods and HMPP in one food.

BP concentrations in three of the tested foods slightly exceeded the EU SML of 0.6 mg/kg (EFSA 2009): in corn-based snack foods (maximum concentration 1 mg/kg); supermarket-purchased fish portions (maximum concentration 1 mg/kg); and battered/crumbed chicken products (maximum concentration 0.8 mg/kg).

No EU SML has been established for EDAB, HMPP or IRG184.

Table 10. Results for printing ink chemical detections

Chemical	Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
BP	60	4	2 (7/335)	<LOR–1	0.6	Fish portions, frozen from supermarket (crumbed)*; chicken products, battered or crumbed*; snack foods, corn-based chips & taco shells*
4-BZP	60	0	0	<LOR	none	-
DEABP	60	0	0	<LOR	none	-
DETX	60	0	0	<LOR	none	-
DMPAP	60	0	0	<LOR	none	-
EDAB	60	3	1 (4/335)	≤LOR–0.08	none	Chicken products, battered or crumbed*; sausages, beef*; lamb chops, loin
EHDAB	60	0	0	<LOR	none	-
HMPP	60	1	0.2 (1/335)	<LOR–0.08	none	Sausages, beef*

Chemical	Total no. foods analysed	No. foods with positive detections	% Samples[1] with positive detections	Concentration range (mg/kg)	SML (mg/kg)	Foods with the highest concentrations
IRG184	60	5	2 (6/335)	<LOR–0.73	none	Chicken products, battered or crumbed (deep fried from takeaway)*; milk, fresh (full fat)*; bread, flat*; fish portions, frozen from supermarket (crumbed only)*; milk, UHT (full fat)*
ITX (2- & 4-)	60	0	0	<LOR	none	-
4-MBP	60	0	0	<LOR	none	-

1. Proportion of total samples analysed. In most cases, each sample analysed was a composite of three individual primary samples. 335 composites from 60 different foods were tested for printing ink chemicals. For further details refer to the methodology in Chapter 4. Results do not include two laboratory water samples, in which none of the printing ink chemicals were detected.

* foods in which concentrations exceeded the SML, or the chemical detected was not on the EU (European Commission 2011) or US (USFDA 2014) permitted list for food-contact plastics. LOR – limit of reporting; LOR – limit of reporting; SML – specific migration limit.

A comparison of the concentrations of printing ink chemicals detected in this study and other studies is presented in Table A8.5. Studies from New Zealand (Ministry of Primary Industries, unpublished) and the United Kingdom (Bradley 2013b) reported these four chemicals in other common foods at concentrations similar to those observed in this study.

6. Stepwise screening assessment

6.1 Introduction

The standard total diet study approach to estimating dietary exposure to the chemicals included in phase 2 of the 24th ATDS could not be applied due to the nature of the chemicals studied. Typically, in a total diet study foods analysed are 'mapped' to a wider number of similar foods/food groups reported as consumed in national nutrition surveys (NNSs) to estimate total dietary exposure to each chemical studied (Moy and Vannoort 2013). In this case, it was not possible to map analysed foods to similar foods that also had the same type of packaging, because details of the packaging of foods reported as consumed in the NNSs was not reported, with the exception of some canned food.

The details of the packaging for the food samples included in phase 1 were also not recorded. Instead an internationally accepted step-wise approach (FSA 2003, de Fatima Pocas and Hogg 2007) was followed to provide appropriate data to characterise risk. The methodology is detailed in Appendix 9.

The primary purpose of this screening study was to identify chemicals that should be investigated further in future work. However, the results are also valid indicators for characterising risk. The screening process first assessed whether the levels of chemicals reported in the food and beverage samples were above or below the relevant SML listed in European regulations for that chemical (see section 2.3 above). A TMDE to the chemical was then calculated using a modified budget method (see Chapter 6.3, FAO/WHO 2009) and compared to the appropriate HBGV. Calculations reported were based on the maximum occurrence of the chemical of interest, and assuming that 50% of foods and beverages contained the chemical at that level.

For chemicals with no established HBGV, the published literature and publically accessible databases were searched for appropriate toxicity data to enable a MOE analysis. In this report, the MOE is the ratio of the NOAEL to the TMDE. The higher the MOE, the less likely there is a health or safety concern.

Those chemicals with no HBGV and no appropriate toxicity data were screened using a threshold of TTC approach (Kroes et al 2004). This approach assigns safe levels of human exposure to chemicals based on a consideration of chemical structure (Kroes et al 2004, FAO/WHO 2011).

The modified budget method used makes highly conservative assumptions about food consumption, in that the maximum physiological levels of consumption for food and beverages (Hansen 1979) are used instead of actual food consumption amounts from national nutrition surveys (expressed in kg food or beverage per kg body weight). In this process it was assumed that the chemical of interest is in half the food and half the beverage supply at the highest chemical concentration detected in any food or beverage to calculate the TMDE (see Appendix 9 for further details).

The ATDS approach assumes that a consumer randomly selects foodstuffs available in the marketplace. However, in the case of packaging material, it should be noted that brand loyalty is quite likely and therefore the proposed scenarios may not necessarily be worst cases for a small proportion of the population.

6.2 The screening process

Overview

Screening was carried out in five sequential steps that give regard to the presence or absence of the chemical in the food, the availability of SMLs and HBGVs, and the maximum concentration of the chemical detected. The individual steps are outlined below and illustrated in Figure 1.

Step 1: Chemicals not detected in any samples

Chemicals that were not detected in any of the composites sampled for each food were excluded from further analysis. Chemicals that were detected were then progressed to Step 2.

Step 2: Chemical detected has an SML

The concentration of the chemical detected in foods was compared to the SML. A modified budget method was used to derive a TMDE and the output was compared with the HBGV (see hazard summaries in Chapter 3) and expressed as a % HBGV.

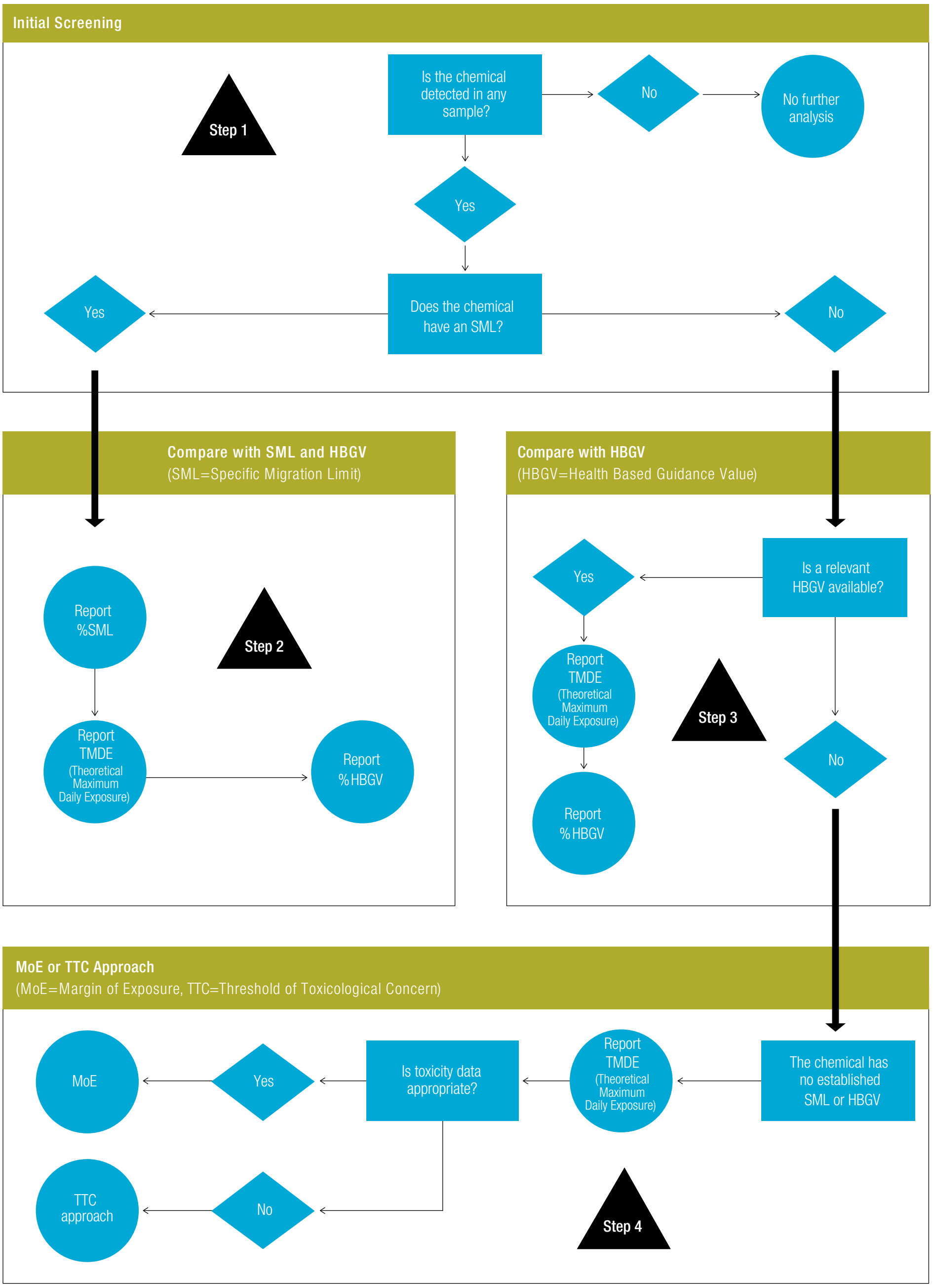
Step 3: Chemical detected has no SML but there is a relevant HBGV

For chemicals with no SML but with an appropriate HBGV (see hazard summaries in Chapter 3), the modified budget method was used to derive a TMDE. The output was compared with the HBGV and expressed as a % HBGV.

Step 4: Chemical detected has no established SML or HBGV

In cases where there was no established HBGV, the published literature and publically accessible databases were searched for appropriate toxicity data to enable an MOE analysis. Finally, those chemicals with no HBGV and no appropriate toxicity data were screened using a TTC approach (Kroes et al 2004).

Figure 1: Stepwise approach to screening chemicals



6.3 Outcomes of stepwise screening process

The results from applying the stepwise screening process are set out below and summarised in Appendix 12. The occurrence data used as inputs for calculating TDMEs are given in Appendix 10 (Table A10.1). A more detailed tabulation of chemicals that were detected in some samples at levels meeting or exceeding the associated SML is given in Table A10.2, Appendix 10.

Step 1: Chemicals not detected in any samples

Fifteen chemicals were not detected in any samples (Table 11), so no further analysis was undertaken on these chemicals.

Table 11. Chemicals not detected in any food samples

Printing ink chemicals	Phthalates	Perfluorinated chemicals
4-BZP	BBP	PFOA
DEABP	DDP	
DETX	DHxP	
DMPAP	DIBP	
EHDAB	DIDP	
ITX (2- & 4-)	DIPP	
4-MBP	DNOP	

For full chemical names see Table 1

Step 2: Chemical detected has an SML

Chemicals with detections below the SML

Chemicals that were detected in foods but at levels that did not exceed the EU established SMLs are listed in Table 12 together with the TMDE for each chemical and the %TDI.

Table 12. Chemicals detected in foods at levels below the SML

Chemical	SML (mg/kg)	Food with highest level detected (mg/kg)	TMDE (mg/kg bw)	%TDI
BPA	0.6	Infant dinner (0.074)	0.159	5
ESBO	60 (30)[1]	Olives (14.0)	0.358	36
DEHA	18	Lamb chops, loin (4.1)	0.110	37

For full chemical names see Table 1; SML – specific migration limit; TMDE – theoretical maximum daily exposure; TDI – tolerable daily intake

1. Value in brackets is for infants.

For BPA, all foods except infant dinner had detections that were less than 5% of the SML. For infant dinner the detection represented 12% of the SML.

The TMDE to BPA estimated using the modified budget method was 5% of the TDI, when it was assumed that 50% of foods and beverages consumed contained BPA at the maximum detected level (Table 12).

Using a back calculation, a 10 kg child would have to consume 7 kg of infant dinner a day to reach the TDI. It is highly unlikely that this quantity would be consumed daily. For the other foods that had detections, hundreds of kilograms of each food would have to be consumed by a 60 kg person to reach the TDI. The public health and safety risk from BPA is considered to be very low.

ESBO

For ESBO, all foods had detections that were less than 25% of the SML, except for one sample of olives where the detection represented 47% of the SML.

The TMDE to ESBO estimated using the modified budget method was 36% of the TDI, when it was assumed that 50% of foods and beverages consumed contained ESBO at the maximum detected level (Table 12).

Using a back calculation, a 60 kg person would have to consume 4 kg of olives a day to reach the TDI. It is highly unlikely that this quantity would be consumed daily. The public health and safety risk from ESBO is considered to be low.

DEHA

For DEHA, all foods had detections that were less than 25% of the SML, the highest detection was in lamb chops and represented 23% of the SML.

The TMDE to DEHA estimated using the modified budget method was 37% of the TDI, when it was assumed that 50% of foods and beverages consumed contained DEHA at the maximum detected level (Table 12).

Using a back calculation, a 60 kg person would have to consume 4 kg of lamb chops a day to reach the TDI. It is unlikely that this quantity would be consumed daily. The public health and safety risk from DEHA is considered to be low.

Chemical detected at concentrations that exceed the SML

Three chemicals (BP, DBP and DEHP) were detected in some samples at concentrations that exceeded the relevant EU SML. These are shown together with the TMDE for each chemical and the %TDI in Table 13 below.

Table 13. Chemicals detected in foods that exceed the SML

Chemical	SML (mg/kg)	Food/s with highest level detected (mg/kg)	TMDE (mg/kg bw)	%TDI
BP	0.6	Fish portions, frozen, crumbed; snack food, corn based chips & taco shells (1.0)	0.03	92
DBP	0.3	Breakfast cereals, wheat based (0.48)	0.02	200
DEHP	1.5	Bread, fancy, fresh, savoury (6.7)	0.20	402

For full chemical names see Table 1; SML – specific migration limit; TMDE – theoretical maximum daily exposure; TDI – tolerable daily intake.

BP

For BP, crumbed fish products and corn-based snack foods both exceeded the SML, with the highest concentration found to be 1.0 mg/kg.

The TMDE to BP estimated using the modified budget method was 92% of the TDI, when it was assumed that 50% of foods and beverages consumed contained BP at the maximum detected level (Table 13).

Using a back calculation, a 60 kg person would have to consume 2 kg of the foods containing the maximum reported level of BP a day to reach the TDI. It is unlikely that this quantity would be consumed daily, so the public health and safety risk from BP is considered to be low.

DBP

For DBP there were only two detections (in a wheat-based breakfast cereal and a chargrilled vegetable sample) but both were above the EU SML (Appendix 10 Table A10.2).

Noting the large number of foods in which there were no detections, the TMDE showed that the TDI was exceeded two-fold assuming 50% of foods and beverages contained the DBP at the maximum detected level (Table 13).

Using a back calculation, a consumer would have to eat 1.3 kg of cereal or 1.9 kg of chargrilled vegetables every day to reach the TDI, assuming they contained the chemical at the maximum level. It is unlikely that these quantities would be consumed daily, so the public health and safety risk from DBP is considered to be low.

DEHP

DEHP had the greatest number of detections across a variety of foods. Most of the detections that exceeded the SML were in takeaway hamburgers where concentrations ranged from 0.6 to 4.2 mg/kg (SML 1.5 mg/kg). However, the highest value of 6.7 mg/kg was found in a single savoury fresh fancy bread sample.

TMDE calculations showed that the TDI was exceeded four-fold assuming 50% of foods and beverages contained DEHP at the maximum detected level (Table 13).

A back calculation showed that a 60 kg person would need to consume 0.5 kg of the fancy bread a day to reach the TDI, assuming it contained the highest DEHP concentration detected in bread. For takeaway hamburgers, the amount needed to reach the TDI for a 60 kg person would be 0.7 kg per day, assuming the maximum concentration detected in this food type.

While these examples indicate that the likelihood of regularly exceeding the TDI may be low, DEHP was also detected in a range of other foods that would contribute to daily exposure. A more refined estimate of exposure based on additional food concentration data and survey food consumption data would be required to allow a better estimate of exposure to DEHP to be made.

Step 3: Chemical detected has no SML but there is a relevant HBGV

Three chemicals did not have an SML but had a relevant TDI: DEP, DINP and PFOS. These are shown together with the TMDE to each chemical and the %TDI in Table 14 and are summarised below.

Table 14. Screening of chemicals with no SML but a relevant TDI

Chemical	TDI mg/kg bw	TMDE mg/kg bw	%TDI
DEP	5	0.05	1
DINP	0.15	1.38	917
PFOS	0.00015	0.00005	33

For full chemical names see Table 1; TDI – tolerable daily intake; TMDE – theoretical maximum daily exposure.

DEP

The TMDE was 1% of the TDI, assuming 50% of foods and beverages contained DEP at the maximum detected level (Table 14). This indicates a negligible public health and safety risk.

DINP

The TMDE to DINP exceeded the TDI (by approximately 9-fold) if it was assumed that 50% of foods and beverages contained DINP at the maximum concentration detected (Table 14).

It should be noted that this exceedance was caused by the comparatively high concentration of DINP in a single sample of peanut butter (54 mg/kg), which would result in reaching the TDI if 200 g of this product was consumed daily. In addition, one hamburger sample had a concentration of 14 mg/kg, and the concentration in one pizza sample was 16 mg/kg. Consuming 0.6 kg of either of these foods daily would be sufficient to reach the TDI.

While these examples indicate that the likelihood of regularly exceeding the TDI is low, DINP was also detected in a range of other foods that would contribute to daily exposure. A more refined estimate of exposure based on additional food concentration data and survey food consumption data would be required to allow a better estimate of exposure to DINP to be made.

PFOS

The TMDE to PFOS was low in comparison to the TDI (33% at the maximum concentration assuming PFOS was present in 50% of all foods; Table 14). This indicates a negligible public health and safety risk.

Step 4: Chemical detected has no established SML or HBGV

There were six detected chemicals that had no EU SML or relevant TDI. A NOAEL from appropriate toxicity studies was available for four of these chemicals, while the other two chemicals were assessed using a TTC approach (Table 15).

Table 15. Screening of chemicals without an assigned HBGV

Chemical	NOAEL mg/kg bw/day	TTC threshold mg/kg bw/day
DHpP	–	0.03
DMP	1000	
DPP	11	
EDAB	–	0.0015
HMPP	50	
IRG 184	300	

For full chemical names see Table 1; HBGV – health-based guidance value; NOAEL – no observed adverse effect level; TTC – threshold of toxicological concern.

DHpP

The TMDE to DHpP was 0.022 mg/kg bw assuming the maximum detected level was present in 50% of food and beverages. The exposure was below the TTC threshold indicating a negligible public health and safety risk.

DMP

The TMDE to DMP was 0.02 mg/kg bw assuming the maximum detected level was present in 50% of food and beverages. The ratio of NOAEL to TMDE was high (50,000), indicating a negligible public health and safety risk.

DPP

The TMDE to DPP was 0.1 mg/kg bw assuming the maximum detected level was present in 50% of food and beverages. The ratio of NOAEL to TMDE was low (110), but DPP was detected in only 1/264 composite samples, indicating that the TMDE is likely to be overly conservative. On that basis, it is concluded that the public health and safety risk associated with DPP is low.

EDAB

The TMDE to EDAB was 0.003 mg/kg bw, which was approximately twice the TTC threshold. It should be noted that EDAB was detected in only 4/335 composite samples, and the TMDE calculation assumes the maximum detected level was present in 50% of food and beverages. On that basis, it is concluded that the public health and safety risk associated with EDAB is likely to be low. Additional food concentration data and survey food consumption data would be required to allow a better estimate of exposure to EDAB to be made. A more refined estimate of hazard would require identification of toxicological data on a suitable analogue of EDAB.

HMPP

The TMDE to HMPP was 0.003 mg/kg bw assuming the maximum detected level was present in 50% of food and beverages. The ratio of NOAEL to TMDE was high (17,000), indicating negligible public health and safety risk from HMPP.

IRG184

The TMDE to IRG184 was 0.018 mg/kg bw assuming the maximum detected level was present in 50% of food and beverages. The ratio of NOAEL to TMDE was high (17,000), indicating a negligible public health and safety risk.

6.4 Uncertainty

The major sources of uncertainty in this screening assessment are discussed in Appendix 11. The use of the modified budget method by design is conservative and its purpose is to screen chemicals for further study; it is not intended to be a dietary exposure estimate. Overall, the approach used is more likely, and indeed designed to overestimate exposure.

A better estimate of exposure could be obtained by sampling a wider range of foods (e.g. fatty, acidic, alcoholic and aqueous foods) and estimating packaging chemical exposure from actual food consumption data reported through national nutrition surveys.

7. Conclusions and recommendations

The screening study confirms that overall Australian consumers are exposed to low levels of packaging chemicals through food consumption, and provides reassurance that concentrations of these chemicals in food represent a negligible to low risk to public health and safety. FSANZ has determined that, at this point in time, no further risk assessment or risk management is required for 28 of the 30 chemicals.

DEHP and DINP were each detected in approximately a third of the foods tested for phthalates, across a variety of food groups. The EU SML for DEHP was exceeded in samples of fancy fresh savoury bread and hamburger, and for both DEHP and DINP the TMDE exceeded the respective TDI. While these theoretical exposure estimates were highly conservative, FSANZ is currently in the process of planning a follow–up survey to allow a better estimate of dietary exposure to these two chemicals. This will enable a more robust assessment of any potential health and safety risks that may require risk management measures, either non-regulatory or regulatory, for DEHP and DINP.

Results of the current study are consistent with those observed internationally which have shown the presence of phthalates (including DEHP) in a range of foods commonly consumed in the diet, with some conservative dietary exposure estimates in the range of relevant health-based guidance values. Importantly, these studies also recognise that whilst diet is a source of phthalate exposure, other sources (eg. environmental) would also need to be considered for a complete risk assessment.

In regard to BPA, all detections were below the internationally recognised EU SML. Canada, the EU, and some states and counties in the US have phased out the use of BPA in polycarbonate baby bottles, whereas a voluntary phase-out has been introduced in Australia. FSANZ notes these phase-outs have been instigated primarily in response to consumer concerns rather than being based on demonstration of a clear public health risk.

FSANZ will continue to liaise with industry and international regulators over issues associated with chemicals migrating from packaging into food, with a view to understanding how they are managing these issues as described in the packaging proposal P1034. The overall purpose of proposal P1034 is to determine whether there is a need to make changes to the way in which food packaging materials are managed in Australia and New Zealand. It recognises that countries with comparable food regulatory frameworks currently have significantly more specific mandatory requirements for food contact materials than Australia and New Zealand.

The Proposal will consider chemicals migrating from packaging materials into food offered for retail sale. In the first phase of this work, the proposal includes virgin and recycled packaging materials from which chemicals could migrate into food through direct contact with food, and other more indirect mechanisms.

8. References

Begley T, White K, Honigfort P, Twaroski M, Neches R, Walker R 2005. Perfluorochemicals: potential sources of and migration from food packaging. *Food Additives and Contaminants* 22(10):1023–1031.

Bemrah N, Jean J, Rivière G, Sanaa M, Leconte S, Bachelot M, Deceuninck Y, Bizec BL, Dauchy X, Roudot AC, Camel V, Grob K, Feidt C, Picard-Hagen N, Badot PM, Foures F, Leblanc JC 2014. Assessment of dietary exposure to bisphenol A in the French population with a special focus on risk characterisation for pregnant French women. Fo*od and Chemical Toxicology* 72:90-7.

Bradley EL 2012. Determination of phthalates in foods and establishing methodology to distinguish their source. Report FD 10/05, FSA Project 101048. The Food and Environment Research Agency, York, UK. 305pp.

Bradley EL, Burden RA, Bentayeb K, Driffield M, Harmer N, Mortimer DN, Speck DR, Ticha J and Castle L 2013a. Exposure to phthalic acid, phthalate diesters and phthalate monoesters from foodstuffs: UK total diet study results. *Food Additives and Contaminants* Part A 30(4):735-742.

Bradley EL, Stratton JS, Leak J, Lister L and Castle L 2013b. Printing ink compounds in foods: UK study. *Food Additives and Contaminants* Part B: Surveillance 6(2):73-83.

Cao X 2010. Phthalate esters in foods: sources, occurrence, and analytical methods. *Comprehensive Reviews in Food Science and Food Safety* 9:21–43

Cao X-L, Perez-Locas C, Dufresne G, Clement G, Popovic S, Beraldin F, Dabeka RW and Feeley M 2011. Concentrations of bisphenol A in the composite food samples from the 2008 Canadian total diet study in Quebec City and dietary intake estimates. *Food Additives and Contaminants* 28(6):791–798.

Cao X-L, Zhao W, Churchill R and Hilts C 2014. Occurrence of di-(2-ethylhexyl) adipate and phthalate plasticizers in samples of meat, fish, and cheese and their packaging films. *Journal of Food Protection* 77(4):610–620.

Casajuana N and Lacorte S 2004. New methodology for the determination of phthalate esters, bisphenol A, bisphenol A diglycidyl ether, and nonylphenol in commercial whole milk samples. *Journal of Agricultural and Food Chemistry* 52:3702-3707.

COT (Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment) 2011. COT statement on dietary exposure to phthalates – data from the total diet study (TDS). http://cot.food.gov.uk/sites/default/files/cot/cotstatementphthalates201104.pdf

Cunha SC, Almeida C, Mendes E & Fernandes JO 2011. Simultaneous determination of bisphenol A and bisphenol B in beverages and powdered infant formula by dispersive liquid–liquid micro-extraction and heart-cutting multidimensional gas chromatography-mass spectrometry. *Food Additives and Contaminants* Part A 28(4):513–526.

de Fatima Pocas M and Hogg T 2007. Exposure assessment of chemicals from packaging materials in food: a review. *Trends in Food Science and Technology* 18:219–30.

Duffy E, Hearty AP, Gilsenan MB and Gibney MJ 2006. Estimation of exposure from food packaging materials. 1: Development of a food-packaging database. *Food Additives and Contaminants* 23(6):623–33.

ECHA (European Chemicals Agency) 2013a. 2-hydroxy-2-methylpropiophenone. Toxicological information. Repeated dose toxicity: oral.002. http://apps.echa.europa.eu/registered/data/dossiers/DISS-97d825c2-33ec-3385-e044-00144f67d031/AGGR-71f04738-0c26-4ccf-a28a-47a7c3ad806a_DISS-97d825c2-33ec-3385-e044-00144f67d031.html#AGGR-71f04738-0c26-4ccf-a28a-47a7c3ad806a

ECHA 2013b. Hydroxycyclohexyl phenyl ketone. Toxicological information. Repeated dose toxicity: oral.002. http://apps.echa.europa.eu/registered/data/dossiers/DISS-975e8192-4649-058b-e044-00144f67d031/AGGR-78a5b938-3309-402e-8a21-55202b17a802_DISS-975e8192-4649-058b-e044-00144f67d031.html#AGGR-78a5b938-3309-402e-8a21-55202b17a802

EFSA (European Food Safety Authority) 2004. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) on a request from the Commission related to the use of epoxidised soybean oil in food contact materials. *The EFSA Journal* 64:1–17.

EFSA 2005a. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Material in Contact with Food (AFC)on a request from the Commission related to Di-Butylphthalate (DBP) for use in food contact materials. *The EFSA Journal* 242, 1-17. www.efsa.europa.eu/en/scdocs/doc/242.pdf

EFSA 2005b. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) on a request from the Commission related to Butylbenzylphthalate (BBP) for use in food contact materials. *The EFSA Journal* 241, 1-14. www.efsa.europa.eu/en/scdocs/doc/241.pdf

EFSA 2005c. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) on a request from the Commission related to Bis(2-ethylhexyl)phthalate (DEHP) for use in food contact materials. *The EFSA Journal* (2005) 243, 1-20. http://www.efsa.europa.eu/en/efsajournal/doc/243.pdf

EFSA 2005d. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) on a request from the Commission related to Di-isononylphthalate (DINP) for use in food contact materials. *The EFSA Journal* 244, 1-18. http://www.efsa.europa.eu/en/efsajournal/doc/244.pdf

EFSA 2005e. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) on a request from the Commission related to Di-isodecylphthalate (DIDP) for use in food contact materials. *The EFSA Journal* 245, 1-14. http://www.efsa.europa.eu/en/efsajournal/doc/245.pdf

EFSA 2005f. Opinion of the Scientific Panel on Food Additives,Flavourings, Processing Aids and Materials in Contact with Food (AFC) on a request from the Commission on the application of A Total Reduction Factor of 5 for di(2-ethylhexyl)adipate used as plasticiser in flexible PVC food packaging films. *The EFSA Journal* 217:1–5. http://www.efsa.europa.eu/de/scdocs/doc/217.pdf

EFSA 2006a. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food on a request from the Commission related to 2,2-bis(4-hydroxyphenyl)propane (bisphenol A). *The EFSA Journal* 428:1–75.

EFSA 2006b. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food related to exposure of adults to epoxidised soybean oil used in food contact materials. *The EFSA Journal* 332:1-9.

EFSA 2008. Opinion of the Scientific Panel on Contaminants in the Food Chain on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts. *The EFSA Journal* 653:1–131.

EFSA 2009. Scientific Opinion of EFSA prepared by the Panel on Food Contact Materials, Enzymes, Flavourings and Processing Aids (CEF) on toxicological evaluation of benzophenone. *The EFSA Journal* 1104:1–30.

EFSA 2013. Draft Scientific Opinion on the risks to public health related to the presence of bisphenol A (BPA) in foodstuffs- Part: Exposure assessment. *The EFSA Journal* 2.

EFSA 2015. Scientific Opinion on the risks to public health related to the presence of bisphenol A (BPA) in foodstuffs. *The EFSA Journal* 13(1):3978.

Ericson I, Martí-Cid R, Nadal M, Van Bavel B, Lindström G and Domingo JL 2008. Human exposure to perfluorinated chemicals through the diet: intake of perfluorinated compounds in foods from the Catalan (Spain) market. *Journal of Agricultural and Food Chemistry* 56:1787–1794.

Errico S, Bianco M, Mita L, Migliaccio M, Rossi S, Nicolucci C, Menale C, Portaccio M, Gallo P, Mita D, Diano N 2014. Migration of bisphenol A into canned tomatoes produced in Italy: Dependence on temperature and storage conditions. *Food Chemistry* 160(1):157–164. http://www.sciencedirect.com/science/article/pii/S0308814614004762

Europa 2004. Regulation (EC) No 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with food and repealing Directives 80/590/EEC and 89/109/EEC. http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32004R1935

European Commission 2011. Commission Regulation (EU) no. 10/2011 on plastic materials and articles intended to come ito contact with food. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2011R0010:20111230:EN:PDF

European Printing Ink Association 2013. *EuPIA Suitability List of Photo-initiators for Low Migration UV Printing Inks and Varnishes.* http://www.eupia.org/uploads/tx_edm/130219_corr3_EuPIA_Suitability_List_of_Photoinitiators_for_Low_migration_UV_Printing_Inks_and_Varnishes.pdf

Fankhauser-Noti A, Fiselier K, Biedermann S, Biedermann M, Grob K, Armellini F, Rieger K, Skjevrak I 2005. Epoxidized soy bean oil (ESBO) migrating from the gaskets of lids into food packed in glass jars. *European Food Research and Technology* 221(3-4):416-422.

Fankhauser-Noti A and Grob K 2006. Migration of plasticizers from PVC gaskets of lids for glass jars into oily foods: Amount of gasket material in food contact, proportion of plasticizer migrating into food and compliance testing by simulation. *Trends in Food Science & Technology* 17:105–112.

Fantoni L and Simoneau C 2003. European survey of contamination of homogenized baby food by epoxidized soybean oil migration from plasticized PVC gaskets. *Food Additives and Contaminants* 20(11):1087–1096.

FAO/WHO (Food and Agriculture Organization of the United Nations and the World Health Organization) 2009. *Principles and Methods for the Risk Assessment of Chemicals in Food. Environmental Health Criteria* 240. FAO and WHO.

FAO/WHO 2010 *Toxicological and Health Aspects of Bisphenol A*. http://apps.who.int/iris/bitstream/10665/44624/1/97892141564274_eng.pdf?ua=1

Fierens T, Servaes K, Van Holderbeke M, Geerts L, De Henauw S, Sioen I and Vanermen G 2012a. Analysis of phthalates in food products and packaging materials sold on the Belgian market. *Food and Chemical Toxicology* 50:2575-2583.

Fierens T, Vanermen G, Van Holderbeke M, De Henauw S and Sioen I 2012b. Effect of cooking at home on the levels of eight phthalates in foods. *Food and Chemical Toxicology* 50:4428-4435.

FSA (Food Standards Agency) 2003. *Investigation of the Significant Factors in Elemental Migration from Glass in Contact with Food*. Final Report Project Code A03029. UK: Food Standards Agency.

FSANZ (Food Standards Australia New Zealand) 2005. The 21st Australian Total Diet Study. Food Standards Australia New Zealand, Canberra, Australia.
http://www.foodstandards.gov.au/scienceandeducation/publications/21staustraliantotald2963.cfm

FSANZ 2008. 22nd Australian Total Diet Study. Food Standards Australia New Zealand, Canberra, Australia.
http://www.foodstandards.gov.au/scienceandeducation/publications/22ndaustraliantotaldietstudy/.

FSANZ 2010a. FSANZ Activities in Relation to Bisphenol A. Food Standards Australia New Zealand, Canberra, Australia. http://www.foodstandards.gov.au/science/monitoring/surveillance/documents/BPA%20paper%20October%202010%20FINAL.pdf

FSANZ 2010b. Survey of Chemical Migration from Food Contact Packaging Materials in Australian Food. Food Standards Australia New Zealand, Canberra, Australia.

http://www.foodstandards.gov.au/science/monitoring/surveillance/pages/surveyofchemicalmigr5148.aspx

FSANZ 2011. The 23rd Australian Total Diet Study. Food Standards Australia New Zealand, Canberra, Australia.

FSANZ 2014a. The 24th Australian Total Diet Study (Phase 1). Food Standards Australia New Zealand, Canberra, Australia. http://www.foodstandards.gov.au/publications/Pages/24th-Australian-Total-Diet-Study.aspx

FSANZ 2014b. *Australia New Zealand Food Standards Code*. FSANZ. http://www.foodstandards.gov.au/code/Pages/default.aspx

Geens T, Apelbaum T Z, Goeyens L, Neels H and Covaci A 2010. Intake of bisphenol A from canned beverages and foods on the Belgian market. *Food Additives and Contaminants* 27(11):1627-1637.

Goodson A, Summerfield W and Cooper I 2002. Survey of bisphenol A and bisphenol F in canned foods. *Food Additives and Contaminants* 19(8):796-802. http://www.ncbi.nlm.nih.gov/pubmed/12227943

Gray LEJ, Ostby J, Furr J, Price M, Veeramachaneni D, & Parks L 2000. Perinatal exposure to the phthalates DEHP, BBP, and DINP, but not DEP, DMP, or DOTP, alters sexual differentiation of the male rat. *Toxicological Sciences* 58(2): 350-365.

Guo Y, Zhang Z, Liu L, Li Y, Ren N, Kannan K 2012. Occurrence and profiles of phthalates in foodstuffs from China and their implications for human exposure. *Journal of Agricultural and Food Chemistry* 60:6913–6919.

Hammarling L, Gustavsson H, Svensson K, Karlsson S and Oskarsson A 1998. Migration of epoxidized soya bean oil from plasticized PVC gaskets into baby food. *Food Additives and Contaminants* 15(2): 203-208.

Han W, Yu Y, Li N, Wang L 2011. Determination of photoinitiators in printing inks used in food contact material. *Chinese Journal of Chromatography* 29(5):417-421.

Hannas BR, Furr J, Lambright CS, Wilson VS, Foster PM, Gray LE 2011. Dipentyl phthalate dosing during sexual differentiation disrupts fetal testis function and postnatal development of the male Sprague-Dawley rat with greater relative potency than other phthalates. *Toxicological Sciences* 120(1):184-193.

Hansen SC 1979. Conditions for the use of food additives based a budget method for an acceptable daily intake. *Journal of Food Protection* 42: 429–34.

Health Canada 2009. *Survey of Bisphenol A in Baby Food Products Prepackaged in Glass Jars with Metal Lids*. Bureau of Chemical Safety, Health Canada. 10pp.

Jung T, Simat TJ, Altkofer W and Fügel D 2013. Survey on the occurrence of photo-initiators and amine synergists in cartonboard packaging on the German market and their migration into the packaged foodstuffs. *Food Additives and Contaminants* 30(11):1993-2016.

Kawamura Y, Etoh M, Hirakawa Y, Abe Y and Mutsuga M 2014. Bisphenol A in domestic and imported canned foods in Japan. *Food Additives & Contaminants* Part A: Chemistry, Analysis, Control, Exposure & Risk Assessment. 31(2):330-340.

Kawamura Y, Kanno S, Mutsuga, M and Tanamoto K 2006. Determination of epoxidized soybean oil in bottled foods. [English abstract] *Journal of the Food Hygienic Society of Japan* 47(6):243-248.

Kroes R, Renwick AG, Cheeseman M, Kleiner J, Mangelsdorf I, Piersma A, Schilter B, Schlatter J, van Schothorst F, Vos JG, Würtzen G 2004. Structure-based thresholds of toxicological concern (TTC): guidance for application to substances present at low levels in the diet. *Food Chem Toxicol* 42(1):65-83.

Lacoste F 2014. Undesirable substances in vegetable oils: anything to declare? *OCL (Oilseeds and fats Crops and Lipids) 2014* 21(1):1–9. http://www.ocl-journal.org/articles/ocl/abs/2014/01/ocl130041/ocl130041.html

Lambe J. 2002. The use of food consumption data in assessments of exposure to food chemicals including the application of probabilistic modelling. Proceedings of the Symposium 'Nutritional aspects of food safety'. *Nutrition Society* 61:11–8.

Liao C and Kannan K 2013. Concentrations and profiles of bisphenol A and other bisphenol analogues in foodstuffs from the United States and their implications for human exposure. *Journal of Agricultural and Food Chemistry* 61:4655-4662.

McCombie G, Harling A, Bierdermann M, Beidermann-Brem S, Eicher A, Suter G, Morandini M, Pechstein S, Schmäschke G, Lauber U and Grob K 2015. Survey of plasticizers migrating from the gaskets of lids into oily food in glass jars: The second European enforcment campaign shows poor compliance work. Food Control 50:65–71.

Moy GG and Vannoort RW. 2013. *Total Diet Studies*. Springer, New York. 550pp.

NICNAS (National Industrial Chemicals Notification and Assessment) 2008. Existing Chemical Hazard Assessment Report. Phthalates Hazard Compendium. A summary of physicochemical and human health hazard data for 24 ortho-phthalate chemicals. National Industrial Chemicals Notification and Assessment Scheme. Australia.

Norwegian Scientific Committee for Food Safety 2005. Opinion of the Panel on Food Additives, Flavourings, Processing Aids, Materials in Contact with Food and Cosmetics of the Norwegian Scientific Committee for Food Safety – Risk assessment of health hazards from epoxidised soybean oil (ESBO) migrated from lids used on glass containers of baby food. Report 04-411-5.

Oldring PK, O'Mahony C, Dixon J, Vints M, Mehegan J, Dequatre C and Castle L 2014. Development of a new modelling tool (FACET) to assess exposure to chemical migrants from food packaging. *Food Additives & Contaminants. Part A, Chemistry, Analysis, Control, Exposure & Risk Assessment* 31(3):444–65.

Oldring PKT, Castle I and Franz R 2009. *Exposure to Substances from Food Contact Materials and an Introduction to the FACET Project*. Deutsche Lebensmittel-Rundschau 105: August 2009.

Page D and LaCroix GM 1995. The occurrence of phthalate ester and di-2-ethylhexyl adipate plasticizers in Canadian packaging and food sampled in 1985-1989: A survey. *Food Additives and Contaminants* Part A 12(1):129–151.

Pederson GA, Jensen LK, Fankhauser A, Biedermann S, Petersen JH and Fabech B 2008. Migration of epoxidised soybean oil (ESBO) and phthalates from twist closures into food and enforcement of the overall migration limit. *Food Additives and Contaminants* 25(4):503–510.

Petersen JH and Breindahl T. (2000) Plasticisers in total diet samples, baby food and infant formulae. *Food Additives and Contaminants* 17: 133-141.

Rees NMA and Tennant DR 1993. Estimating consumer intakes of food chemicals contaminants. In: DH Watson (ed), *Safety of Chemicals in Food: Chemical Contaminants*. pp 175-81. Chichester: Ellis Horwood.

Sathyanarayana S, Alcedo G, Saelens BE, Zhou C, Dills RL, Yu J and Lanphear B 2013. Unexpected results in a randomized dietary trial to reduce phthalate and bisphenol A exposures. *Journal of Exposure Science and Environmental Epidemiology* 23:378–384.

SCF (Scientific Committee on Food) 2000. Opinion of the Scientific Committee on Food on a survey on dietary intake of the food contact material di-2-(ethylhexyl) adipate (DEHA). ec.europa.eu/food/fs/sc/scf/out77_en.pdf

Schecter A, Malik N, Haffner D, Smith S, Harris TR, Paepke O and Birnbaum L 2010. Bisphenol A (BPA) in US foods. *Environmental Science and Technology* 44:9425–9430.

Schecter A, Lorber M, Guo Y, Hun Yun S, Kannan K, Hommel M, Imran N, Hynan L, Cheng D, Colcino J and Birmbaum L. (2013) Phthalate concentrations and dietary exposure from food purchased in New York State. *Environ. Health Perspect*. 12(4): 473-479.

Schug TT, Heindel JJ, Camacho L, Delclos KB, Howard P, Johnson AF, Aungst J, Keefe D, Newbold R, Walker NJ, Thomas Zoeller R, Bucher JR 2013. A new approach to synergize academic and guideline-compliant research: the CLARITY-BPA research program. *Reproductive Toxicology* 40:35-40.

SIAM (SIDS Initial Assessment Meeting) 2006. SIDS Initial Assessment Meeting 22. SIDS Initial Assessment Profile. Fatty acids, tall-oil, epoxidized, 2-ethylhexylesters (ETP), Octadecanoic acid (Z)-, epoxidized, ester w/propylene glycol (EODA), Epoxidized soybean oil (ESBO), Epoxidized linseed oil (ELSO or ELO). http://webnet.oecd.org/Hpv/ui/handler.axd?id=97482cc3-8e70-48f4-b55a-4ca56286243f

Sorensen LK 2006. Determination of phthalates in milk and milk products by liquid chromatography/tandem mass spectrometry. *Rapid Communications Mass Spectrometry* 20:1135–1143.

Thomson BM and Grounds PR 2005. Bisphenol A in canned foods in New Zealand: an exposure assessment. *Food Additives and Contaminants* 22(1):65–72.

Tittlemier SA, Pepper K, Seymour C, Moisey J, Bronson R, Cao X-L and Dabeka RW 2007. Dietary exposure of Canadians to perfluorinated carboxylates and perfluorooctane sulfonate via consumption of meat, fish, fast foods, and food items prepared in their packaging. *Journal of Agricultural and Food Chemistry* 55:3203–3210.

UK COT (2011) Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment : COT statement (2011/04) on dietary exposure to phthalates – data from the total diet study (TDS) http://cot.food.gov.uk/pdfs/cotstatementphthalates201104.pdf.

USEPA (United States Environmental Protection Agency) 2015. EPA Method 537: Determination of selected perfluorinated alkyl acids in drinking water by solid phase extraction and liquid chromatography/Tandem mass spectrometry (LC/MS/MS). In: *Drinking water methods developed by EPA's Exposure Research Program*. http://www.epa.gov/nerlcwww/ordmeth.htm

USFDA (United States Food and Drug Administration) 2014. Code of Federal Regulations, Title 21, Volume 3, Chapter I, Subchapter B – Food for human consumption http://www.ecfr.gov/cgi-bin/text-idx?SID=74e2c1543c1500ee2789d02f92bf8122&tpl=/ecfrbrowse/Title21/21chapterI.tpl

Weller P, Herrnreiter M and Donaubauer A 2007. A miniaturised method to determine epoxidised soybean soybean oil in baby food. *Chromatography Online* 10(3). http://www.chromatographyonline.com/lcgc/Miniaturized+Method/A-Miniaturized-Method-to-Determine-Epoxidized-Soyb/ArticleStandard/Article/detail/458032

http://www.who.int/entity/foodsafety/publications/fs_management/No_05_Bisphenol_A_Nov09_en.pdf

WHO (World Health Organization) 2003. Concise International Chemical Assessment Document 52. Diethyl phthalate. World Health Organization, Geneva.
WHO 2009. *Principles and Methods for the Risk Assessment of Chemicals in Food*. Environment Health Criteria 240. WHO Press.

Wormuth M, Scheringer M, Vollenweider M and Hungerbuhler K 2006. What are the sources of exposure to eight frequently used phthalic acid esters in Europeans? *Risk Analysis* 26(3):803–824.

Appendix 1: Foods sampled in Phase II of the 24th ATDS

ATDS food	Food packaging chemical assessed				
	Phthalates and adipate	Perfluorinated compounds (PFOA, PFOS)	BPA	ESBO	Printing inks
Bacon (N)	√				√
Baked beans in tomato sauce (N)	√	√	√	√	√
Beef, minced, lean (R)		√			√
Beer, full strength (N)			√	√	
Biscuits, savoury, corn based (N)					√
Biscuits, savoury, rice based (N)					√
Biscuits, savoury, wheat based (N)					√
Biscuits, sweet, plain (N)	√				√
Bread, fancy, fresh (savoury) (R)	√	√			√
Bread, fancy, fresh (sweet) (R)	√	√			√
Bread, flat (pita, burrito, etc.) (R)	√	√			√
Bread, multigrain, fresh (R)	√	√			√
Bread, white, fresh (R)	√	√			√
Bread, wholemeal, fresh (R)	√	√			√
Breakfast bars, baked style (N)	√	√			√
Breakfast cereals, mixed grains (N)	√	√			√
Breakfast cereals, muesli toasted (N)	√	√			√
Breakfast cereals, single grain, corn based (N)	√	√			√

ATDS food	Food packaging chemical assessed				
	Phthalates and adipate	Perfluorinated compounds (PFOA, PFOS)	BPA	ESBO	Printing inks
Breakfast cereals, single grain, rice based (N)	√	√			√
Breakfast cereals, single grain, wheat based (N)	√	√			√
Cake, chocolate, iced (N)	√				√
Cake, dried fruit (N)					√
Cake, sponge, plain (N)					√
Chicken breast (R)					√
Chicken products, battered or crumbed (N)	√	√			√
Chicken products, battered or crumbed, deep fried from takeaway (N)	√	√			√
Chocolate energy drink, powdered (N)			√	√	
Chocolate, plain, milk (N)	√				√
Coffee, espresso short black, from takeaway (N)			√	√	
Coffee, instant (N)				√	
Confectionery, soft candy (N)	√				√
Crumpets, English style muffins (R)	√				√
Fish fillets, battered from takeaway (R)		√			√
Fish fillets - white fish, fresh (R)		√			√
Fish portions, frozen from supermarket (crumbed only) (N)	√	√			√

ATDS food	Food packaging chemical assessed				
	Phthalates and adipate	Perfluorinated compounds (PFOA, PFOS)	BPA	ESBO	Printing inks
Fruit, dried or processed (sultanas) (N)		√			√
Hamburger, from takeaway (R)	√				√
Infant cereal, mixed (N)	√	√			√
Infant dessert, fruit based (N)	√	√	√	√	√
Infant dessert, milk based (N)	√	√		√	√
Infant dinner (N)	√	√	√	√	√
Infant formula (non-soy) (N)	√	√		√	
Infant formula, soy- based (N)	√	√		√	
Infant rusks/biscuits (N)					√
Jams (e.g. marmalade) - not fruit spreads, not diet varieties (N)	√	√	√	√	
Juice, prune (N)	√	√	√	√	
Lamb chops, loin (R)	√	√			√
Milk, fresh (full fat) (R)	√	√			√
Milk, UHT (full fat) (R)	√	√			√
Muesli bars, with dried fruit (N)		√			√
Noodles, egg fresh (N)	√				√
Noodles, instant (N)					√
Nuts, mixed, roasted & salted (N)		√			√
Olives (N)	√			√	
Onions – frozen packaged (N)	√	√			√
Pasta (cooked) (N)					√

ATDS food	Food packaging chemical assessed				
	Phthalates and adipate	Perfluorinated compounds (PFOA, PFOS)	BPA	ESBO	Printing inks
Peanut butter (N)	√	√		√	
Pie, containing fruit (N)					√
Pie, meat, individual size (N)	√				√
Pikelets/pancakes from shaker (N)					√
Pikelets/pancakes ready-to-eat (N)	√				√
Pizza, meat and vegetable topped, (takeaway and frozen) (N)	√	√			√
Popcorn, microwave (N)		√			√
Potato crisps (mixed varieties excluding salt & vinegar) (N)	√	√			√
Potato chips, deep fried, take away style (N)		√			
Potato chips, frozen (N)		√			√
Potatoes (baked) (R)		√	√		
Potatoes (boiled) (R)		√	√		
Sauce, tomato (N)		√		√	
Sausages, beef (R)	√	√			√
Snack foods, corn based chips & taco shells (N)					√
Snack foods, extruded (excluding potato crisps) (N)	√				√
Soup, base (liquid and dry packet mix) (N)			√	√	
Sugar, white (N)	√	√			√

ATDS food	Food packaging chemical assessed				
	Phthalates and adipate	Perfluorinated compounds (PFOA, PFOS)	BPA	ESBO	Printing inks
Tea, regular, (non-herbal) (N)			√	√	
Tea, herbal (N)			√	√	
Tomatoes, canned (N)	√	√	√	√	
Vegetables, chargrilled in oil (N)	√	√	√	√	
Vegetables, mixed, frozen (N)	√	√	√	√	√
Water, tap (R)		√			
Yeast extract (N)		√	√		

N = National Food. Three retail samples make up each composite sample, 4 composite samples of each food.
R = Regional Food. Three retail samples make up each composite sample, 8-12 composite samples of each food.

Appendix 2: Food preparation instructions

These instructions were included in a procedures manual provided to the laboratory to specify sample preparation instructions.

General instructions

Avoiding cross contamination

Care must be taken to ensure no mixing of any kind between the three primary samples ('purchases') when preparing composite samples. This means careful cleaning and drying of utensils in between removing portions of each primary sample for compositing.

Gloves

Gloves are to be worn whenever the food being prepared could come into contact with hands. Food preparation gloves such as Ansell latex gloves (subject to allergy concerns) or nitrile not containing lubricant should be used.

Equipment

- Stainless steel knives
- Wooden cutting board (good quality, smooth, crack free)
- Stainless steel utensils (i.e. fry pans, spatulas, etc.).
- Glass/Pyrex equipment can also be used.
- For the purposes of mixing liquids, a large stainless steel or Pyrex receptacle such as a jug or bowl is to be used.
- Laboratory mixer with stainless steel or glass vessel.
- Laboratory grade storage containers suitable for long-term freezing without leaching.
- Plastic bags for enclosing sample containers.

Washing of Equipment

The analytical laboratory or preparation facility is to determine the detergent to be used in the washing of food preparation equipment. The detergent chosen should not interfere with the methods for the analytes of interest.

Handling purchases for food preparation

Each purchase as provided by the purchasing officer should arrive in separate packaging. Purchases from each jurisdiction will be in lots of three. Each purchase will represent a primary sample. Unprocessed, raw foods such as chicken breast and fish fillets will be in separate packages clearly labelled with the name of the food and primary sample identification (A, B or C) which will correspond with the detailed information on the sample spreadsheet completed by the purchasing officer. The sample spreadsheet should be checked by the laboratory for completeness and to ensure that recorded information corresponds to sample labels.

Preparing and storing samples

1. Primary samples (purchases) are to be prepared in their 'ready to eat state' as indicated e.g. if cooking is required cook first (Refer to table under Food Preparation Instructions below). In preparing foods for ATDS analysis it is important that preparation instructions are followed and that all of the food that would be consumed forms the analytical sample in the proportions that would typically be eaten. For example, any juices from canned tomatoes must be regarded as an integral part of the food being prepared for analysis. A proportional amount of juice and seeds must therefore be included in the sample containers.
2. Once prepared as indicated, mix the amount of primary sample specified until homogenous. If the sample is a liquid do not allow to sit and separate out.
3. Fill and label a suitably sized and type of storage container to retain sufficient amounts of the prepared primary sample for two further analyses (this step will need to be repeated for each of the three primary samples). The label should be given a unique identifier that will enable it to be definitively linked to the primary sample information recorded by the purchasing officer.
4. Accurately measure (solids and semi solids can be weighed, liquids measured by volume) the minimum amount required for the composite sample (e.g. one third of the total amount required for the composite sample allowing for some wastage) and place this into a vessel for further mixing or blending of the composite sample. For example, for prune juice, if 300 ml is required for triplicate analysis for each screen/analyte then at least 100 ml of each primary sample ('purchase') of prune juice needs to be used to prepare the composite sample. Unused composite samples are to be stored for 12 months after completion of the study.
5. Once the primary samples are all added to the vessel mix until homogenous. If the sample is a liquid do not allow to sit and separate out.
6. Fill and label a suitably sized and type of storage container to retain a sufficient amount of the composite sample for at least all of the analytical test specified as well two repeat analysis of each specified test (for repeat analyses of the original tests and possibly one inter-lab check test if required). The label for the composite sample needs to enable it to be definitively linked to its three constituent primary samples and the analytical results.
7. Note all samples are to be stored for 12 months after final report has been received.

Glossary

Boiling water

Except where other instructions are provided, 'boiling water' means that the food is to be boiled in 'unsalted' tap water.

Washing

Foods are to be washed in accordance with local practice and the food concerned.

Mix

When the preparation instruction states 'mix' or 'mix thoroughly', then the sample should be pureed in a laboratory grade mixer or ground finely by hand until the sample is homogenous and comprises only very fine particles. Liquids such as beer or tea can simply be stirred in a glass or stainless steel vessel. Do not allow mixed samples to sit and potentially separate out before decanting into the sample container.

Frying and grilling

In the case of samples of meat, it is imperative that typical cooking behaviour be followed. For example, meat that is fried will exude fat. As the fried food is removed from the fry pan some fat will remain in the fry pan and some will remain on the cooked meat product. The fat remaining in the fry pan is to be discarded and only the fat on the cooked food is to be included for analysis. No oil is to be used in the fry pan or grill prior to cooking.

Baking

This cooking method is applicable for potatoes, sweet potatoes and pumpkin. The following procedure is proposed:

1. Wash, peel and evenly cut the required amount of potatoes.
2. Place in boiling water and then cook until they start to soften. Remove before fully cooked.
3. Place on non-stick tray and bake for 1 hour in preheated oven at 200 ºC.
4. Remove from oven and ALLOW TO COOL before handling.
5. The fat remaining in the tray is to be discarded and only the fat on the cooked food is to be included for analysis.

Microwaving

The time required for microwaving will depend upon the power of the microwave. For packaged food products e.g. popcorn, follow the instructions on the label. For fresh foods e.g. asparagus, the following procedure is proposed:

1. Place the required amount of asparagus into a glass/ pyrex cooking dish that has a fitted lid and add one third of a cup of water.

2. Place in 650-Watt microwave on high power setting for 7 minutes. Higher power microwaves should have the setting adjusted to medium or the time of cooking reduced as necessary. It may also be necessary to stir during cooking to ensure even heat distribution.
3. Remove from microwave and ALLOW TO COOL before handling.

Food preparation instructions

The preparations required for foods which are not purchased in a ready-to-eat state are given in Table A2.1.

Table A2.1 Food preparation instructions

Food	Preparation Instructions
Bacon	Remove rind and dry fry.
Baked beans in tomato sauce	Include sauce.
Beef, minced, lean	Dry fry until thoroughly browned, do not scrape pan.
Bread, fancy	Toast until golden brown.
Cake, chocolate, iced	Include a proportional quantity of icing.
Cake, dried fruit	Include a proportional quantity of fruit.
Chicken breast	Grill and discard fat in grill tray.
Chicken products, battered or crumbed	Bake according to the instructions on the packaging or as advised by shop assistant at poultry store (purchasing officer to record).
Chocolate energy drink, powdered	Prepare in accordance with the instructions on the label. Use full fat milk.
Coffee, instant	Make up as directed on label using tap water. Do not add sugar or milk.
Confectionery, soft candy	Lightly toast the marshmallows only.
Crumpets, English style muffins	Toast until golden brown.
Fish portions, frozen from supermarket (crumbed only)	Bake according to the instructions on the packaging.
Fish fillets, white fish, fresh	Grill and discard fat in grill tray.
Infant cereal, mixed	Prepare in accordance with the instructions on the packaging.

Food	Preparation Instructions
Infant formula	Make up using tap water according to manufacturer's directions.
Lamb chops, loin	Grill. When cooked, cut all the meat away from the bone and trim off excess fat. Discard the fat in the grill tray.
Noodles, egg, fresh	Prepare in accordance with the instructions on the label.
Noodles, instant	Prepare in accordance with the instructions on the label. Use flavour sachet.
Nuts, mixed, roasted and salted	Shake bag up to ensure salt is spread evenly prior to sample preparation.
Onion, plain	Dry fry until translucent/light browned.
Pasta	Boil in tap water according to the instructions on the packaging. Do not add salt.
Pie, containing fruit	If uncooked, cook according to instructions on the label and cool.
Pie, meat, individual size	If uncooked, cook according to instructions on the label and cool.
Pikelets/pancakes	If from shaker, prepare in accordance with the instructions on the label.
Pizza, meat and vegetable topped	If uncooked, cook according to instructions on the label and cool.
Popcorn, microwave	Prepare in accordance with the instructions on the label.
Potato chips, frozen	Bake according to the instructions on the packaging.
Potatoes, baked	Wash, peel, evenly cut, and then oven cook for 1hr at 200°C.
Potatoes, boiled	Wash, peel, evenly cut and cook in boiling unsalted water. When cooked, drain potatoes, chop finely and mix.
Sausages, beef	Dry fry, discard fat in pan.
Soup, base (liquid and dry packet mix)	Prepare in accordance with the instructions on the label.
Tea	Brew using one teabag per 250mls of tap water. Wait 5 minutes for the tea to infuse. Do not add milk or sugar.
Tomatoes, canned	Include a representative proportion of juice.

Appendix 3: Analytical results for BPA

Table A3.1 Concentrations of BPA detected in foods (µg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Baked beans in tomato sauce	4	0	14.0	14.0	4.0	25.0
Beer, full strength	4	4	0	3.0	<LOR	<LOR
Chocolate energy drink, powdered	4	4	0	3.0	<LOR	<LOR
Coffee, espresso short black, from takeaway	4	3	1.1	3.4	<LOR	4.5
Infant dessert, fruit based	4	4	0	3.0	<LOR	<LOR
Infant dinner	4	3	19.0	21.0	<LOR	74.0
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	2	4.0	5.5	<LOR	11.0
Juice, prune	4	3	4.0	6.3	<LOR	16.0
Potatoes (baked)	10	10	0	3.0	<LOR	<LOR
Potatoes (boiled)	10	10	0	3.0	<LOR	<LOR
Soup, base (include liquid and dry packet mix)	4	0	8.0	7.9	4.8	14.0
Tea, herbal	4	4	0	3.0	<LOR	<LOR
Tea, regular (non-herbal)	4	4	0	3.0	<LOR	<LOR
Tomatoes, canned	4	0	13.0	13.0	9.0	17.0
Vegetables, chargrilled in oil	4	2	2.2	3.7	<LOR	5.3

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Vegetables, mixed, frozen	4	4	0	3.0	<LOR	<LOR
Water, laboratory	1	1	0	3.0	<LOR	<LOR
Yeast extract	4	4	0	3.5	<LOR	<LOR

BPA – bisphenol A. 'ND' = not detected. Results were derived from composite samples, except for the laboratory water. The limit of reporting (LOR) was 3.7 x 10-3 mg/kg.

Table A3.2 Comparison of BPA concentrations in 24th ATDS to other Australian and international studies

		BPA concentration (µg/kg)					
ATDS food/ beverage	24th ATDS	Australia[1]	Europe	Canada and US	United Kingdom[10]	New Zealand[11]	Other
Baked beans in tomato sauce	4.0–25.0	12	36.6 'canned legumes/nuts/oil seeds', Europe[2]; 15.7 'canned pulses', France[3]; 1.3 'haricot beans in tomato sauce', Belgium[4]	23.5 'canned baked beans', Canada[6]; 8.99 'vegetables including canned vegetables' and 15.1 'canned foods', US[8]	9–14	<10	21.86 –1858.71 'canned foodstuffs', Turkey[12]; 3.4 'canned foods from Japan' and 57 'imported canned foods' [13]
Coffee, espresso black from takeaway	<LOR–4.5	-	0.11 'coffee', France[3]	0.22 'coffee', Canada [6]	-	-	-
Infant dinner	<LOR–74.0	7.7	0.3 'canned food for infants and small children', 1.7 in 'non-canned', Europe[2]	0.84–2.46 'jarred baby foods', Canada[6]; 0.95 'baby food products', Canada[7]	-	<10 'Australian infant dinner'	ND 'jarred foods', Turkey[12]
Jams	<LOR–11.0	<3	13.7 'canned fruit and fruit products', 0.4 'non-canned', Europe[2]; 0.32 'compote and cooked fruit', France[3]	ND 'jams', Canada[6]	-	-	-

ATDS food/ beverage	BPA concentration (µg/kg)						
	24th ATDS	Australia[1]	Europe	Canada and US	United Kingdom[10]	New Zealand[11]	Other
Prune juice	<LOR–16.0	-	2.7 'canned fruit juices', 0.9 'non-canned', Europe [2]; 3.96 'canned orange juice' , Belgium[4]	0.36 'canned apple juice', Canada [6]; 0.24 'beverages including fruit juice', US[8]	-	-	0.03-4.70 'canned beverages', Portugal[14]
Soup base (incl. liquid and dry packet mix)	4.8–14.0	54 'canned soup'	1.84 'soups and broths', France[3]; 11.9–29.3 'canned soups', Belgium[4]	22.2-–44.4 'canned soups' , Canada[6]; 9.97 in 'others including soup', US [8]; 4.46-19.7 'various canned soups', Texas[9]	0–21 'range of canned soups'	16-<20	21.86 –1858.71 'range canned foodstuffs', Turkey[12]; 3.4 'canned foods from Japan', and 57 'imported canned foods'[13]
Tomatoes, canned	9.0–17.0	15	24.0 'canned vegetables', Europe[2]; 19.3 'peeled tomatoes', Belgium[4]; <0.4 'peeled,cherry, concentrated paste', Italy[5]	2.59 'canned tomatoes', Canada[6]; 8.99 'vegetables including canned vegetables', and 15.1 'canned foods', US [8]; 1.50-2.29 'canned mixed vegetables', Texas[9]	26	15-21	21.86 –1858.71 'canned foodstuffs', Turkey[12] ; 3.4 'canned foods from Japan', and 57 'imported canned foods'[13]

60

ATDS food/ beverage	BPA concentration (µg/kg)						
	24th ATDS	Australia[1]	Europe	Canada and US	United Kingdom[10]	New Zealand[11]	Other
Vegetables chargrilled in oil	<LOR–5.3	-	24 'canned vegetables and vegetable products', 1.3 'non-canned', Europe[2]; 6.88 'vegetables', France[3]	8.99 'vegetables including canned vegetables' ,US[8]	10–41 'canned vegetables in salt water'	-	ND 'jarred foods', Turkey[12]

BPA – bisphenol A. 'ND' = not detected; '–' = not tested. Means in the 24th ATDS were calculated using the limit of reporting value (LOR = 3.7 x 10-3 mg/kg) for non-detections.
1. FSANZ 2010; 2. EFSA 2013; 3. Bemrah et al 2014; 4.Geens et al 2010; 5. Errico et al 2014; 6. Cao et al 2011; 7. Health Canada 2009; 8. Liao and Kannan 2013; 9. Schecter et al 2010; 10. Goodson et al 2002; 11. Thomson and Grounds 2005; 12. Sangur et al 2014; 13. Kawamura et al 2014; 14. Cunha et al 2011.

Appendix 4: Analytical results for ESBO

Table A4.1 Concentrations of ESBO detected in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Baked beans in tomato sauce	4	4	0	0.3	<LOR	<LOR
Beer, full strength	4	4	0	0.3	<LOR	<LOR
Chocolate energy drink, powdered	4	4	0	0.3	<LOR	<LOR
Coffee, espresso short black, from takeaway	4	4	0	0.3	<LOR	<LOR
Coffee, instant	4	4	0	0.3	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.3	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.3	<LOR	<LOR
Infant dinner	4	2	0.3	0.5	<LOR	0.9
Infant formula (non-soy)	4	4	0	0.3	<LOR	<LOR
Infant formula, soy-based	4	0	1.0	1.0	0.7	1.5
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.3	<LOR	<LOR
Juice, prune	4	4	0	0.3	<LOR	<LOR
Olives	4	2	4.4	4.6	<LOR	14.0
Peanut butter	4	4	0	3.5	<LOR	<LOR
Sauce, tomato	4	4	0	0.3	<LOR	<LOR
Soup, base (include liquid and dry packet mix)	4	4	0	0.3	<LOR	<LOR
Tea, herbal	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Tea, regular, (non-herbal)	4	4	0	0.3	<LOR	<LOR
Tomatoes, canned	4	4	0	0.3	<LOR	<LOR
Vegetables, chargrilled in oil	4	1	2.5	2.5	<LOR	6.1
Vegetables, mixed, frozen	4	4	0	0.3	<LOR	<LOR
Water, laboratory	1	1	0	0.3	<LOR	<LOR

ESBO – epoxidised soybean oil. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A4.2 Comparison of ESBO concentrations in ATDS to other Australian and international studies

ATDS food/beverage	Concentration of ESBO (mg/kg)			
	24th ATDS	Australia[1]	Europe	Japan[11]
Infant dinner	<LOR–0.9	4.2	means of 12.8-15.3 'baby foods', Europe[2]; 1.5-135.2 'baby food', Europe[3]; 3-58 'baby foods' Norway[4]; 11.9 'baby foods', Sweden[5]	ND 'bottled baby foods'
Infant formula soy-based	0.7–1.5	-	-	-
Olives	<LOR–14.0	10	0-400 'vegetables in oil', Europe[6]; 100 'olives', Denmark[7]; 166 'oily foods in glass jars', Norway[8]; 100 and 150 'olives in oil' , Switzerland[9]; >200.7 'olives in olive oil', Italy[10]	-
Vegetables chargrilled in oil	<LOR–6.1	-	0-400 'vegetables in oil', Europe[6]; 390 'eggplants in oil', 160 'artichokes in oil' , Switzerland[9]	-

ESBO – epoxidised soybean oil. 'ND' = not detected; '-' = not reported. Means in the 24th ATDS were calculated using the limit of reporting (LOR) for non-detections, which was 0.3–4 mg/kg depending on the food matrix.
1. FSANZ 2010b; 2. EFSA 2004; 3. Fantoni and Simoneau 2003; 4. Norwegian Scientific Committee for Food Safety 2005; 5. Hammarling et al 1998; 6. EFSA 2006; 7. Pederson et al 2008; 8. Fankhauser-Noti et al 2005; 9. Fankhauser-Noti and Grob 2006; 10. Ezerskis et al 2007; 11. Kawamura et al 2006.

Appendix 5: Analytical results for PFOS

Table A5.1 Concentrations of perfluorinated compound PFOS detected in foods (µg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Baked beans in tomato sauce	4	4	0	0.1	<LOR	<LOR
Beef, minced, lean	10	10	0	0.2	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.2	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.2	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.1	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.4	<LOR	<LOR
Bread, white, fresh	12	12	0	0.2	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.1	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.2	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.1	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.1	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.1	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.1	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Chicken products, battered or crumbed	4	4	0	0.1	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.2	<LOR	<LOR
Fish fillets - white fish, fresh	12	11	0.1	0.4	<LOR	1.0
Fish fillets, battered from takeaway	10	10	0	0.2	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.3	<LOR	<LOR
Fruit, dried or processed (sultanas)	4	4	0	0.3	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.2	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.1	<LOR	<LOR
Infant dessert, milk based	4	4	0	2.0	<LOR	<LOR
Infant dinner	4	4	0	0.2	<LOR	<LOR
Infant formula (non-soy)	4	4	0	0.6	<LOR	<LOR
Infant formula, soy-based	4	4	0	0.3	<LOR	<LOR
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.1	<LOR	<LOR
Juice, prune	4	4	0	0.1	<LOR	<LOR
Lamb chops, loin	10	10	0	0.2	<LOR	<LOR
Milk, fresh (full fat)	12	12	0	0.2	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Milk, UHT (full fat)	12	12	0	0.08	<LOR	<LOR
Muesli bars, with dried fruit	4	4	0	0.3	<LOR	<LOR
Nuts, mixed, roasted & salted	4	4	0	0.1	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.1	<LOR	<LOR
Peanut butter	4	4	0	0.3	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	0.1	<LOR	<LOR
Popcorn, microwave	4	4	0	0.6	<LOR	<LOR
Potato chips, frozen	4	4	0	0.1	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.1	<LOR	<LOR
Potato, chips, deep fried, from takeaway	8	8	0	0.1	<LOR	<LOR
Potatoes (baked)	10	10	0	0.1	<LOR	<LOR
Potatoes (boiled)	10	10	0	0.1	<LOR	<LOR
Sauce, tomato	4	4	0	0.1	<LOR	<LOR
Sausages, beef	10	9	0.02	0.4	<LOR	0.2
Sugar, white	4	4	0	0.01	<LOR	<LOR
Tomatoes, canned	4	4	0	0.1	<LOR	<LOR
Vegetables, chargrilled in oil	4	4	0	0.2	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.1	<LOR	<LOR
Water, laboratory	2	2	0	0.003	<LOR	<LOR
Water, tap	8	8	0	0.003	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Yeast extract	4	4	0	0.3	<LOR	<LOR

PFOS - perfluorooctane sulphonic acid. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 2 x 10-7– 0.006 mg/kg depending on the food matrix.

Table A5.2 Comparison of concentrations of PFOS in the 24th ATDS to other Australian and international studies

ATDS food	Concentration of PFOS (µg/kg)						
	24th ATDS	Australia[1]	Asia[2]	Canada [3]	Europe	United Kingdom[6]	US[7]
Fish fillets, white fish, fresh	<LOR–1.0	ND 'fish portions frozen'	7.01 'fish, muscle or whole body'	1.3-2.6 'freshwater' and 'marine fish'	15.3 'fish, muscle or whole body', Europe[4]; 0.41 'white fish', Spain[5]	ND 'whitefish'	129 'fish, muscle or whole body'
Sausages, beef	<LOR–0.2	ND 'minced beef pre-packaged'	-	2.1 'ground beef'	-	ND 'meat (not offal)'	max 0.852 'ground beef'

PFOS - perfluorooctane sulphonic acid. 'ND' = not detected; '-' = not reported. The limit of reporting (LOR) was 2 x 10-7–0.006 mg/kg depending on the food matrix.
1. FSANZ 2010b; 2. EFSA 2008; 3. Tittlemier 2007; 4. EFSA 2008; 5. Ericson et al 2008; 6. FSA 2009; 7. EFSA 2008.

Appendix 6: Analytical results for phthalates

Table A6.1 Concentrations of DBP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.3	<LOR	<LOR
Baked beans in tomato sauce	4	4	0	0.3	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.3	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.3	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.3	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.3	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.3	<LOR	<LOR
Bread, white, fresh	12	12	0	0.3	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.3	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, single grain, wheat based	4	3	0.1	0.4	<LOR	0.5
Cake, chocolate, iced	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.3	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.3	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.3	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.3	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.3	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.3	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.3	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.3	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.3	<LOR	<LOR
Infant dinner	4	4	0	0.3	<LOR	<LOR
Infant formula (non-soy)	4	4	0	0.3	<LOR	<LOR

68

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Infant formula, soy-based	4	4	0	0.3	<LOR	<LOR
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.3	<LOR	<LOR
Juice, prune	4	4	0	0.3	<LOR	<LOR
Lamb chops, loin	10	10	0	0.3	<LOR	<LOR
Milk, fresh (full fat)	12	12	0	0.3	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.3	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.3	<LOR	<LOR
Olives	4	4	0	0.3	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.3	<LOR	<LOR
Peanut butter	4	4	0	0.3	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.3	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.3	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	1.0	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.3	<LOR	<LOR
Sausages, beef	10	10	0	0.3	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.3	<LOR	<LOR
Sugar, white	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Tomatoes, canned	4	4	0	0.3	<LOR	<LOR
Vegetables, chargrilled in oil	4	3	0.1	0.3	<LOR	0.3
Vegetables, mixed, frozen	4	4	0	0.3	<LOR	<LOR
Water, laboratory	1	1	0	0.3	<LOR	<LOR

DBP - dibutyl phthalate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A6.2 Concentrations of DEHP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.5	<LOR	<LOR
Baked beans in tomato sauce	4	4	0	0.5	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.5	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	7	0.8	1.3	<LOR	6.7
Bread, fancy, fresh (sweet)	8	7	0.1	0.5	<LOR	0.7
Bread, flat (pita, burrito etc)	8	8	0	0.5	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.5	<LOR	<LOR
Bread, white, fresh	12	12	0	0.5	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.5	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.5	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, mixed grains	4	4	0	0.5	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.5	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.5	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.5	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.5	<LOR	<LOR
Cake, chocolate, iced	4	4	0	0.5	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.5	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	2	0.3	0.6	<LOR	0.7
Chocolate, plain, milk	4	2	0.3	0.6	<LOR	0.6
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.5	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.5	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	3	0.2	0.6	<LOR	0.9
Hamburger, from takeaway	8	2	1.8	1.9	<LOR	4.2

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Infant cereal, mixed	4	4	0	0.5	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.5	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.5	<LOR	<LOR
Infant dinner	4	4	0	0.5	<LOR	<LOR
Infant formula (non-soy)	4	3	0.2	0.6	<LOR	0.8
Infant formula, soy-based	4	3	0.1	0.5	<LOR	0.6
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.5	<LOR	<LOR
Juice, prune	4	4	0	0.5	<LOR	<LOR
Lamb chops, loin	10	10	0	0.5	<LOR	<LOR
Milk, fresh (full fat)	12	10	0.1	0.5	<LOR	0.7
Milk, UHT (full fat)	12	9	0.2	0.5	<LOR	0.6
Noodles, egg fresh	4	4	0	0.5	<LOR	<LOR
Olives	4	3	0.2	0.6	<LOR	0.9
Onions, frozen packaged	4	4	0	0.5	<LOR	<LOR
Peanut butter	4	2	0.4	0.7	<LOR	0.9
Pie, meat, individual size	4	4	0	0.5	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.5	<LOR	<LOR
Pizza, meat and vegetable topped	4	3	0.4	1.1	<LOR	1.4

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Potato crisps (mixed varieties excluding salt & vinegar)	4	2	0.3	0.5	<LOR	0.5
Sausages, beef	10	10	0	0.5	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.5	<LOR	<LOR
Sugar, white	4	4	0	0.5	<LOR	<LOR
Tomatoes, canned	4	2	0.3	0.6	<LOR	0.7
Vegetables, chargrilled in oil	4	4	0	0.5	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.5	<LOR	<LOR
Water, laboratory	1	1	0	0.5	<LOR	<LOR

DEHP - di(2-ethylhexyl) phthalate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A6.3 Concentrations of DEP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.3	<LOR	<LOR
Baked beans in tomato sauce	4	4	0	0.3	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.3	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	7	0.1	0.4	<LOR	0.9
Bread, fancy, fresh (sweet)	8	7	0.2	0.5	<LOR	1.6
Bread, flat (pita, burrito etc)	8	8	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bread, multigrain, fresh	12	11	0.1	0.4	<LOR	1.0
Bread, white, fresh	12	11	0.1	0.4	<LOR	1.1
Bread, wholemeal, fresh	12	11	0.1	0.3	<LOR	0.6
Breakfast bars, baked style	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.3	<LOR	<LOR
Cake, chocolate, iced	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.3	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.3	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.3	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.3	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.3	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.3	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.3	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.3	<LOR	<LOR
Infant dinner	4	4	0	0.3	<LOR	<LOR
Infant formula (non-soy)	4	4	0	0.3	<LOR	<LOR
Infant formula, soy-based	4	4	0	0.3	<LOR	<LOR
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.3	<LOR	<LOR
Juice, prune	4	4	0	0.3	<LOR	<LOR
Lamb chops, loin	10	10	0	0.3	<LOR	<LOR
Milk, fresh (full fat)	12	12	0	0.3	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.3	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Olives	4	4	0	0.3	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.3	<LOR	<LOR
Peanut butter	4	4	0	0.3	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.3	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.3	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	1.0	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.3	<LOR	<LOR
Sausages, beef	10	10	0	0.3	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.3	<LOR	<LOR
Sugar, white	4	4	0	0.3	<LOR	<LOR
Tomatoes, canned	4	4	0	0.3	<LOR	<LOR
Vegetables, chargrilled in oil	4	4	0	0.3	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.3	<LOR	<LOR
Water, laboratory	1	1	0	0.3	<LOR	<LOR

DEP - diethyl phthalate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A6.4 Concentrations of DHpP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.3	<LOR	<LOR
Baked beans in tomato sauce	4	4	0	0.3	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.3	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.3	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.3	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.3	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.3	<LOR	<LOR
Bread, white, fresh	12	12	0	0.3	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.3	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Cake, chocolate, iced	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.3	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.3	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.3	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.3	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.3	<LOR	<LOR
Hamburger, from takeaway	8	7	0.1	0.3	<LOR	0.6
Infant cereal, mixed	4	4	0	0.3	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.3	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.3	<LOR	<LOR
Infant dinner	4	4	0	0.3	<LOR	<LOR
Infant formula (non-soy)	4	4	0	0.3	<LOR	<LOR
Infant formula, soy-based	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.3	<LOR	<LOR
Juice, prune	10	10	0	0.3	<LOR	<LOR
Lamb chops, loin	10	10	0	0.3	<LOR	<LOR
Milk, fresh (full fat)	12	12	0	0.3	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.3	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.3	<LOR	<LOR
Olives	4	4	0	0.3	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.3	<LOR	<LOR
Peanut butter	4	4	0	0.3	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.3	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.3	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	1.0	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.3	<LOR	<LOR
Sausages, beef	10	10	0	0.3	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.3	<LOR	<LOR
Sugar, white	4	4	0	0.3	<LOR	<LOR
Tomatoes, canned	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Vegetables, chargrilled in oil	4	4	0	0.3	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.3	<LOR	<LOR
Water, laboratory	1	1	0	0.3	<LOR	<LOR

DHpP - diheptyl phthalate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A6.5 Concentrations of DINP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	2	1.0	2.0	<LOR	2.4
Baked beans in tomato sauce	4	4	0	1.0	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	1.0	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	6	0.7	1.9	<LOR	4.2
Bread, fancy, fresh (sweet)	8	7	0.2	1.1	<LOR	1.8
Bread, flat (pita, burrito etc)	8	7	0.2	1.2	<LOR	1.4
Bread, multigrain, fresh	12	12	0	1.0	<LOR	<LOR
Bread, white, fresh	12	12	0	1.0	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	1.0	<LOR	<LOR
Breakfast bars, baked style	4	3	1.0	1.8	<LOR	4.0
Breakfast cereals, mixed grains	4	4	0	1.0	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, muesli toasted	4	4	0	1.0	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	1.0	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	1.0	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	1.0	<LOR	<LOR
Cake, chocolate, iced	4	3	0.3	1.1	<LOR	1.3
Chicken products, battered or crumbed	4	3	0.4	1.9	<LOR	1.5
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	1.0	<LOR	<LOR
Chocolate, plain, milk	4	4	0	1.0	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	1.0	<LOR	<LOR
Crumpet, English style muffins	8	8	0	1.0	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	3	0.4	1.2	<LOR	1.7
Hamburger, from takeaway	8	5	2.3	3.7	<LOR	14.0
Infant cereal, mixed	4	4	0	1.0	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Infant dessert, fruit based	4	4	0	1.0	<LOR	<LOR
Infant dessert, milk based	4	4	0	1.0	<LOR	<LOR
Infant dinner	4	4	0	1.0	<LOR	<LOR
Infant formula (non-soy)	4	4	0	1.0	<LOR	<LOR
Infant formula, soy-based	4	4	0	1.0	<LOR	<LOR
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	1.0	<LOR	<LOR
Juice, prune	4	4	0	1.0	<LOR	<LOR
Lamb chops, loin	10	7	0.4	1.1	<LOR	1.5
Milk, fresh (full fat)	12	12	0	1.0	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	1.0	<LOR	<LOR
Noodles, egg fresh	4	4	0	1.0	<LOR	<LOR
Olives	4	2	0.8	1.3	<LOR	2.0
Onions, frozen packaged	4	4	0	1.0	<LOR	<LOR
Peanut butter	4	3	14.0	14.0	<LOR	54.0
Pie, meat, individual size	4	4	0	1.0	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	1.0	<LOR	<LOR
Pizza, meat and vegetable topped	4	1	7.7	8.0	<LOR	16.0

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	1.0	<LOR	<LOR
Sausages, beef	10	9	0.2	1.1	<LOR	1.8
Snack foods, extruded (excluding potato crisps)	4	4	0	1.0	<LOR	<LOR
Sugar, white	4	4	0	1.0	<LOR	<LOR
Tomatoes, canned	4	4	0	1.0	<LOR	<LOR
Vegetables, chargrilled in oil	4	3	0.4	1.1	<LOR	1.4
Vegetables, mixed, frozen	4	4	0	1.0	<LOR	<LOR
Water, laboratory	1	1	0	1.0	<LOR	<LOR

DINP - diisononyl phthalate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A6.6 Concentrations of DMP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.3	<LOR	<LOR
Baked beans in tomato sauce	4	4	0	0.3	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.3	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.3	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	7	0.1	0.3	<LOR	0.4
Bread, flat (pita, burrito etc)	8	8	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bread, multigrain, fresh	12	12	0	0.3	<LOR	<LOR
Bread, white, fresh	12	12	0	0.3	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.3	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.3	<LOR	<LOR
Cake, chocolate, iced	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.3	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.3	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Crumpet, English style muffins	8	8	0	0.3	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.3	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.3	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.3	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.3	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.3	<LOR	<LOR
Infant dinner	4	4	0	0.3	<LOR	<LOR
Infant formula (non-soy)	4	4	0	0.3	<LOR	<LOR
Infant formula, soy-based	4	4	0	0.3	<LOR	<LOR
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.3	<LOR	<LOR
Juice, prune	4	4	0	0.3	<LOR	<LOR
Lamb chops, loin	10	10	0	0.3	<LOR	<LOR
Milk, fresh (full fat)	12	12	0	0.3	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.3	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.3	<LOR	<LOR
Olives	4	4	0	0.3	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Peanut butter	4	4	0	0.3	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.3	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.3	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	1.0	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.3	<LOR	<LOR
Sausages, beef	10	9	0.1	0.3	<LOR	0.5
Snack foods, extruded (excluding potato crisps)	4	4	0	0.3	<LOR	<LOR
Sugar, white	4	4	0	0.3	<LOR	<LOR
Tomatoes, canned	4	4	0	0.3	<LOR	<LOR
Vegetables, chargrilled in oil	4	4	0	0.3	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.3	<LOR	<LOR
Water, laboratory	1	1	0	0.3	<LOR	<LOR

DMP - dimethyl phthalate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A6.7 Concentrations of DPP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.3	<LOR	<LOR
Baked beans in tomato sauce	4	4	0	0.3	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.3	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.3	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.3	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.3	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.3	<LOR	<LOR
Bread, white, fresh	12	12	0	0.3	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.3	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Cake, chocolate, iced	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.3	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.3	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.3	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.3	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.3	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.3	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.3	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.3	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.3	<LOR	<LOR
Infant dinner	4	4	0	0.3	<LOR	<LOR
Infant formula (non-soy)	4	4	0	0.3	<LOR	<LOR
Infant formula, soy-based	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.3	<LOR	<LOR
Juice, prune	4	4	0	0.3	<LOR	<LOR
Lamb chops, loin	10	9	0.4	0.6	<LOR	3.7
Milk, fresh (full fat)	12	12	0	0.3	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.3	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.3	<LOR	<LOR
Olives	4	4	0	0.3	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.3	<LOR	<LOR
Peanut butter	4	4	0	0.3	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.3	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.3	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	1.0	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.3	<LOR	<LOR
Sausages, beef	10	10	0	0.3	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.3	<LOR	<LOR
Sugar, white	4	4	0	0.3	<LOR	<LOR
Tomatoes, canned	4	4	0	0.3	<LOR	<LOR
Vegetables, chargrilled in oil	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Vegetables, mixed, frozen	4	4	0	0.3	<LOR	<LOR
Water, laboratory	1	1	0	0.3	<LOR	<LOR

DPP - dipentyl phthalate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A6.8 Comparison of phthalate concentrations in the 24th ATDS to other Australian and international studies

ATDS food/beverage	Concentration of phthalates (mg/kg)						
	24th ATDS	Australia[1]	Canada[2] and US[3]	China	Europe	New Zealand[12]	United Kingdom
DBP							
Breakfast cereals, single grain, wheat based	<LOR–0.5	-	0.3 'cooked wheat cereal'	0.054 'flour/ noodle'[4]	0.002–0.011 'breakfast cereals', Belgium[6]; 0.565 'breakfast cereals', Europe[7]	ND 'various cereals'	0.014 'misc cereals'[13]
Vegetables, chargrilled in oil	<LOR–0.3	-	ND 'peppers'	-	0.033 'vegetables', Europe[7]	-	0.004 'other vegetables'[13]
DEHP							
Bread (2 types)	<LOR–6.7	-	0.68-1.5 'breads', Canada	0.135 'flour/ noodle'[4]; 0.130 'cereals'[5]	ND–1.073 'bread', Belgium[6]; 0.068 Europe[7]	ND 'various breads'	0.125[13]
Chicken products, battered or crumbed (deep fried from takeaway)	<LOR–0.7	ND 'chicken breast'	ND 'whole chicken', Canada	0.230 'meat'[5]	0.019–0.433 'meat and meat products', Belgium[6]; 0.518 'poultry' Europe[7]	ND	0.076 'breaded chicken pieces'[14]
Chocolate, milk	<LOR–0.6	-	4.1 'milk', Canada	0.0285 'milk or beverage'[4]	0.003–0.017 'milk beverages', Belgium[6]; 0.040 'milk and milk beverages', Europe[7]	ND 'milk'	ND 'milk'[13]
Fish portions, frozen from supermarket (crumbed only)	<LOR–0.9	-	0.1 'fish', Canada	-	ND–5.932 'fish and fish products', Belgium[6]; 0.013 'fish, seafood', Europe[7]	ND	0.789 'fish'[13]

ATDS food/beverage	Concentration of phthalates (mg/kg)						
	24th ATDS	Australia[1]	Canada[2] and US[3]	China	Europe	New Zealand[12]	United Kingdom
Hamburger, from takeaway	<LOR–4.2	ND in minced beef	ND 'ground beef pattie', Canada	-	0.037–0.049 'minced meat fried', Belgium[8]	ND 'hamburgers', ND-0.39 'beef patties'	-
Infant formula (non-soy)	<LOR–0.8	-	-	-	0.037–0.062 'baby food milk powder', Belgium[6]; 0.110 Europe[7]; 0.021 Spain[9]	ND	0.125 'organic infant milk formula'[14]
Infant formula, soy-based	<LOR–0.6	-	-	-	-	ND	ND[14]
Milk (UHT and fresh full fat)	<LOR–0.7	-	4.1 'milk', Canada; 0.673 'milk', US	0.0285 'milk or beverage'[4]	0.008–0.020 Belgium[6]; 0.040 'milk and milk beverages', Europe[7]; 0.015–0.027 Spain[9]; 0.013–0.027 Denmark[10]	ND	ND[13]
Olives	<LOR–0.9	-	-	-	-	ND	-
Peanut butter	<LOR–0.9	-	ND Canada	-	0.810 'nuts and nut spreads', Europe[7]	ND	-
Pizza, meat and vegetable topped	<LOR–1.4	-	1.2 Canada	-	-	ND	-
Potato crisps (mixed varieties excluding salt & vinegar)	<LOR–0.5	-	ND 'potato chips', Canada	-	<0.015–0.050 'fried potato', 0.109 'chips'[8]	ND	-
Tomatoes, canned	<LOR–0.7	-	-	-	-	-	ND 'canned vegetables'[13]

ATDS food/beverage	Concentration of phthalates (mg/kg)						
	24th ATDS	Australia[1]	Canada[2] and US[3]	China	Europe	New Zealand[12]	United Kingdom
DEP							
Bread (5 types)	<LOR–1.6	-	-	0.002 'flour/ noodle'[4]	0.006 'bread' Europe[7]	ND various breads	ND bread[13]
DHpP							
Hamburger, from takeaway	<LOR–0.6	-	-	-		ND	-
DINP							
Bacon	<LOR–2.4	-	-	-	0-0.01 'meat and meat products', Europe[7]	ND	ND 'streaky bacon'[14]
Bread (3 types)	<LOR–4.2	-	-	-	ND 'bread', Europe[7]	ND various breads	ND 'bread'[14]
Breakfast bars, baked style	<LOR–4	-	-	-	ND 'breakfast cereals', Europe[7]	-	-
Cake, chocolate, iced	<LOR–1.3	-	-	-	ND 'cakes, buns, puddings', Europe[7]	ND–2.2 'cake'	ND 'iced cake'[14]
Chicken products, battered or crumbed	<LOR–3.0	ND 'chicken breast'	-	-	ND 'poultry', Europe[7]	ND 'chicken products' (supermarket), ND–1.4 'takeaway chicken products'	1.82 'chicken thighs', ND 'breaded chicken products'[14]

94

ATDS food/beverage	Concentration of phthalates (mg/kg)						
	24th ATDS	Australia[1]	Canada[2] and US[3]	China	Europe	New Zealand[12]	United Kingdom
Fish portions, frozen from supermarket (crumbed only)	<LOR–1.7	-	-	-	0–0.035 'fish, seafood', Europe[7]	ND 'fish portions' (supermarket)	ND 'white fish' species[14]
Hamburger, from takeaway	<LOR–14.0	ND 'minced beef'	-	-	-	ND 'hamburgers', ND-0.97 'meat patties'	-
Lamb chops, loin	<LOR–1.5	-	-	-	0–0.011 'meat and meat products', Europe[7]	ND 'lamb (plastic)'	ND[14]
Olives	<LOR–2.0	-	-	-	-	ND	
Peanut butter	<LOR–54.0	-	-	-	ND 'nuts and nut spreads', Europe[7]; 99 Denmark[11] (withdrawn from market)	ND	
Pizza, meat and vegetable topped	<LOR–16.0	-	-	-	-	ND	-
Sausages, beef	<LOR–1.8	-	-	-	0–0.007 'sausages', Europe[7]	ND	ND[14]
Vegetables, chargrilled in oil	<LOR–1.4	-	-	-	ND 'vegetables', Europe[7]	-	ND 'green', 'canned' or 'other vegetables'[14]
DMP							

ATDS food/beverage	Concentration of phthalates (mg/kg)						
	24th ATDS	Australia[1]	Canada[2] and US[3]	China	Europe	New Zealand[12]	United Kingdom
Bread, fancy, fresh (sweet)	<LOR–0.4	-	-	0.001 flour/ noodle[4]	ND–0.001 'bread', Belgium[6]; ND 'bread', Europe[7]	ND various breads	ND bread[14]
Sausages, beef	<LOR–0.5	-	-	0.001[4]	ND 'minced meat fried', Belgium[8]; ND 'sausages', Europe[7]	ND 'sausages on tray'	ND[14]
DPP							
Lamb chops, loin	<LOR–3.7	-	-	-		ND 'lamb (plastic)'	ND[14]

The limit of reporting (LOR) was 0.3–4 mg/kg for the 24th ATDS depending on the food matrix. 'ND' = not detected, result less than the LOR for that study (value of LOR may vary with study). '-'data for that food group or chemical was not reported. Full chemical names are in Table 1.

1. FSANZ 2010b; 2. Page and Lacroix 1995; 3. Sathyanarayana et al 2013; 4. Guo et al 2012; 5. Sui et al 2014; 6. Fierens et al 2012a; 7. Wormuth et al 2006; 8. Fierens et al 2012b; 9. Casajuana and Lacorte 2004; 10. Sorensen 2006; 11. Pederson et al 2008; 12. NZMPI 2014; 13. Bradley et al 2013a; 14. Bradley 2012.

Appendix 7: Analytical results for DEHA

Table A7.1 Concentrations of adipate DEHA in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.3	<LOR	<LOR
Baked beans in tomato sauce	4	4	0	0.3	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.3	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.3	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.3	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.3	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.3	<LOR	<LOR
Bread, white, fresh	12	12	0	0.3	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.3	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, corn based	4	4	0	0.3	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, single grain, wheat based	4	4	0	0.3	<LOR	<LOR
Cake, chocolate, iced	4	3	0.9	1.2	<LOR	3.7
Chicken products, battered or crumbed	4	4	0	0.3	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.3	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.3	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.3	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.3	<LOR	<LOR
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.3	<LOR	<LOR
Hamburger, from takeaway	8	6	0.2	0.4	<LOR	1.1
Infant cereal, mixed	4	4	0	0.3	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.3	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.3	<LOR	<LOR
Infant dinner	4	4	0	0.3	<LOR	<LOR
Infant formula (non-soy)	4	4	0	0.3	<LOR	<LOR
Infant formula, soy-based	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Jams (e.g. marmalade) - excluding fruit spreads and diet varieties	4	4	0	0.3	<LOR	<LOR
Juice, prune	4	4	0	0.3	<LOR	<LOR
Lamb chops, loin	10	1	1.7	1.8	<LOR	4.1
Milk, fresh (full fat)	12	12	0	0.3	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.3	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.3	<LOR	<LOR
Olives	4	4	0	0.3	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.3	<LOR	<LOR
Peanut butter	4	4	0	0.4	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.3	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.3	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	1	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.3	<LOR	<LOR
Sausages, beef	10	7	0.2	0.4	<LOR	1.0
Snack foods, extruded (excluding potato crisps)	4	4	0	0.3	<LOR	<LOR
Sugar, white	4	4	0	0.3	<LOR	<LOR
Tomatoes, canned	4	4	0	0.3	<LOR	<LOR
Vegetables, chargrilled in oil	4	4	0	0.3	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Vegetables, mixed, frozen	4	4	0	0.3	<LOR	<LOR
Water, laboratory	1	1	0	0.3	<LOR	<LOR

DEHA – di(2-ethylhexyl) adipate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.3–4 mg/kg depending on the food matrix.

Table A7.2 Comparison of concentrations of adipate DEHA in the 24th ATDS to international studies

ATDS food	Concentration of DEHA (mg/kg)			
	24th ATDS	Canada[1]	New Zealand[2]	United Kingdom[3]
Cake, chocolate, iced	<LOR–3.7	-	ND 'cake, plastic wrapped'	-
Hamburger, from takeaway	<LOR–1.1	ND 'ground beef pattie'	ND 'hamburgers'	-
Lamb chops, loin	<LOR–4.1	ND	4.8 'lamb, plastic wrapped'	3.9 'lamb breast', 10.6 'lamb, leg steak'
Sausages, beef	<LOR–1	ND-4.0 'ground beef'	0.4 'sausages on tray'	4.5-8.0 'beef, minced'

DEHA - di(2-ethylhexyl) adipate. The limit of reporting (LOR) was 0.3–4 mg/kg for the 24th ATDS depending on the food matrix.'ND' = not detected, result less than the LOR for that study (value of LOR may vary with study).
1. Page and Lacroix 1995; 2. NZMPI 2014; 3. Cao 2010.

Appendix 8: Analytical results for printing ink chemicals

Table A8.1 Concentrations of BP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.1	<LOR	<LOR
Baked beans in tomato sauce	1	1	0	0.1	<LOR	<LOR
Beef, minced, lean	10	10	0	0.1	<LOR	<LOR
Biscuits, savoury, corn based	4	4	0	0.1	<LOR	<LOR
Biscuits, savoury, rice based	4	4	0	0.1	<LOR	<LOR
Biscuits, savoury, wheat based	4	4	0	0.1	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.1	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.1	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.1	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.1	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.1	<LOR	<LOR
Bread, white, fresh	12	12	0	0.1	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.1	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.1	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.1	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.1	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, single grain, corn based	4	4	0	0.1	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.1	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.1	<LOR	<LOR
Cake, chocolate, iced	4	4	0	0.1	<LOR	<LOR
Cake, dried fruit	4	4	0	0.1	<LOR	<LOR
Cake, sponge, plain	4	4	0	0.1	<LOR	<LOR
Chicken breast	10	10	0	0.1	<LOR	<LOR
Chicken products, battered or crumbed	4	1	0.3	0.4	<LOR	0.8
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.1	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.1	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.1	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.1	<LOR	<LOR
Fish fillets - white fish, fresh	12	12	0	0.1	<LOR	<LOR
Fish fillets, battered from takeaway	10	10	0	0.1	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Fish portions, frozen from supermarket (crumbed only)	4	2	0.4	0.4	<LOR	1.0
Fruit, dried or processed (sultanas)	4	4	0	0.1	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.1	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.1	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.1	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.1	<LOR	<LOR
Infant dinner	4	4	0	0.1	<LOR	<LOR
Infant rusks/biscuits	4	4	0	0.1	<LOR	<LOR
Lamb chops, loin	10	10	0	0.1	<LOR	<LOR
Milk, fresh (full fat)	12	12	0	0.1	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.1	<LOR	<LOR
Muesli bars, with dried fruit	4	4	0	0.1	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.1	<LOR	<LOR
Noodles, instant	4	4	0	0.1	<LOR	<LOR
Nuts, mixed, roasted & salted	4	4	0	0.1	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.1	<LOR	<LOR
Pasta (cooked)	4	4	0	0.1	<LOR	<LOR
Pie, fruit	4	4	0	0.1	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.1	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Pikelets/pancakes from shaker	4	3	0	0.1	<LOR	0.1
Pikelets/pancakes ready-to-eat	4	4	0	0.1	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	0.1	<LOR	<LOR
Popcorn, microwave	4	4	0	0.1	<LOR	<LOR
Potato chips, frozen	4	4	0	0.1	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.1	<LOR	<LOR
Sausages, beef	10	10	0	0.1	<LOR	<LOR
Snack foods, corn based chips & taco shells	4	3	0.3	0.3	<LOR	1.0
Snack foods, extruded (excluding potato crisps)	4	4	0	0.1	<LOR	<LOR
Sugar, white	4	4	0	0.1	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.1	<LOR	<LOR
Water, laboratory	2	2	0	0.1	<LOR	<LOR

BP – benzophenone. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.05–1 mg/kg depending on the food matrix.

Table A8.2 Concentrations of EDAB in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.05	<LOR	<LOR
Baked beans in tomato sauce	1	1	0	0.05	<LOR	<LOR
Beef, minced, lean	10	10	0	0.05	<LOR	<LOR
Biscuits, savoury, corn based	4	4	0	0.05	<LOR	<LOR
Biscuits, savoury, rice based	4	4	0	0.05	<LOR	<LOR
Biscuits, savoury, wheat based	4	4	0	0.05	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.05	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.05	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.05	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.05	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.05	<LOR	<LOR
Bread, white, fresh	12	12	0	0.05	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.05	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, single grain, corn based	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.05	<LOR	<LOR
Cake, chocolate, iced	4	4	0	0.05	<LOR	<LOR
Cake, dried fruit	4	4	0	0.05	<LOR	<LOR
Cake, sponge, plain	4	4	0	0.05	<LOR	<LOR
Chicken breast	10	10	0	0.05	<LOR	<LOR
Chicken products, battered or crumbed	4	3	0	0.06	<LOR	0.08
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.05	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.05	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.05	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.05	<LOR	<LOR
Fish fillets - white fish, fresh	12	12	0	0.05	<LOR	<LOR
Fish fillets, battered from takeaway	10	10	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.05	<LOR	<LOR
Fruit, dried or processed (sultanas)	4	4	0	0.05	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.05	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.05	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.05	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.05	<LOR	<LOR
Infant dinner	4	4	0	0.05	<LOR	<LOR
Infant rusks/biscuits	4	4	0	0.05	<LOR	<LOR
Lamb chops, loin	10	9	0	0.05	<LOR	0.05
Milk, fresh (full fat)	12	12	0	0.05	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.05	<LOR	<LOR
Muesli bars, with dried fruit	4	4	0	0.05	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.05	<LOR	<LOR
Noodles, instant	4	4	0	0.05	<LOR	<LOR
Nuts, mixed, roasted & salted	4	4	0	0.05	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.05	<LOR	<LOR
Pasta (cooked)	4	4	0	0.05	<LOR	<LOR
Pie, fruit	4	4	0	0.05	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Pikelets/pancakes from shaker	4	4	0	0.05	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.05	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	0.05	<LOR	<LOR
Popcorn, microwave	4	4	0	0.05	<LOR	<LOR
Potato chips, frozen	4	4	0	0.05	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.05	<LOR	<LOR
Sausages, beef	10	8	0	0.05	<LOR	0.06
Snack foods, corn based chips & taco shells	4	4	0	0.05	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.05	<LOR	<LOR
Sugar, white	4	4	0	0.05	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.05	<LOR	<LOR
Water, laboratory	2	2	0	0.05	<LOR	<LOR

EDAB - ethyl 4-(dimethylamino)benzoate. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.05–1 mg/kg depending on the food matrix.

Table A8.3 Concentrations of HMPP in foods (mg/kg)

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Bacon	4	4	0	0.05	<LOR	<LOR
Baked beans in tomato sauce	1	1	0	0.05	<LOR	<LOR
Beef, minced, lean	10	10	0	0.05	<LOR	<LOR
Biscuits, savoury, corn based	4	4	0	0.05	<LOR	<LOR
Biscuits, savoury, rice based	4	4	0	0.05	<LOR	<LOR
Biscuits, savoury, wheat based	4	4	0	0.05	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.05	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.05	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.05	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	8	0	0.05	<LOR	<LOR
Bread, multigrain, fresh	12	12	0	0.05	<LOR	<LOR
Bread, white, fresh	12	12	0	0.05	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.05	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, single grain, corn based	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.05	<LOR	<LOR
Cake, chocolate, iced	4	4	0	0.05	<LOR	<LOR
Cake, dried fruit	4	4	0	0.05	<LOR	<LOR
Cake, sponge, plain	4	4	0	0.05	<LOR	<LOR
Chicken breast	10	10	0	0.05	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.05	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	4	0	0.05	<LOR	<LOR
Chocolate, plain, milk	4	4	0	0.05	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.05	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.05	<LOR	<LOR
Fish fillets - white fish, fresh	12	12	0	0.05	<LOR	<LOR
Fish fillets, battered from takeaway	10	10	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Fish portions, frozen from supermarket (crumbed only)	4	4	0	0.05	<LOR	<LOR
Fruit, dried or processed (sultanas)	4	4	0	0.05	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.05	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.05	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.05	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.05	<LOR	<LOR
Infant dinner	4	4	0	0.05	<LOR	<LOR
Infant rusks/biscuits	4	4	0	0.05	<LOR	<LOR
Lamb chops, loin	10	10	0	0.05	<LOR	<LOR
Milk, fresh (full fat)	12	12	0	0.05	<LOR	<LOR
Milk, UHT (full fat)	12	12	0	0.05	<LOR	<LOR
Muesli bars, with dried fruit	4	4	0	0.05	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.05	<LOR	<LOR
Noodles, instant	4	4	0	0.05	<LOR	<LOR
Nuts, mixed, roasted & salted	4	4	0	0.05	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.05	<LOR	<LOR
Pasta (cooked)	4	4	0	0.05	<LOR	<LOR
Pie, fruit	4	4	0	0.05	<LOR	<LOR
Pie, meat, individual size	4	4	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Pikelets/pancakes from shaker	4	4	0	0.05	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.05	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	0.05	<LOR	<LOR
Popcorn, microwave	4	4	0	0.05	<LOR	<LOR
Potato chips, frozen	4	4	0	0.05	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.05	<LOR	<LOR
Sausages, beef	10	9	0	0.05	<LOR	0.1
Snack foods, corn based chips & taco shells	4	4	0	0.05	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.05	<LOR	<LOR
Sugar, white	4	4	0	0.05	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.05	<LOR	<LOR
Water, laboratory	2	2	0	0.05	<LOR	<LOR

HMPP - 2-hydroxy-2-methylpropiophenone. 'ND' = not detected. Results were derived from composite samples, except for laboratory water. The limit of reporting (LOR) was 0.05–1 mg/kg depending on the food matrix.

Table A8.4 Concentrations of IRG184 detected in the 24th ATDS

Food	No. of analyses	No. of ND samples	Mean ND=0	Mean ND=LOR	Minimum	Maximum
Bacon	4	4	0	0.05	<LOR	<LOR
Baked beans in tomato sauce	1	1	0	0.05	<LOR	<LOR
Beef, minced, lean	10	10	0	0.05	<LOR	<LOR
Biscuits, savoury, corn based	4	4	0	0.05	<LOR	<LOR
Biscuits, savoury, rice based	4	4	0	0.05	<LOR	<LOR
Biscuits, savoury, wheat based	4	4	0	0.05	<LOR	<LOR
Biscuits, sweet, plain	4	4	0	0.05	<LOR	<LOR
Bread, fancy, fresh (savoury)	8	8	0	0.05	<LOR	<LOR
Bread, fancy, fresh (sweet)	8	8	0	0.05	<LOR	<LOR
Bread, flat (pita, burrito etc)	8	7	0	0.09	<LOR	0.4
Bread, multigrain, fresh	12	12	0	0.05	<LOR	<LOR
Bread, white, fresh	12	12	0	0.05	<LOR	<LOR
Bread, wholemeal, fresh	12	12	0	0.05	<LOR	<LOR
Breakfast bars, baked style	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, mixed grains	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, muesli toasted	4	4	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Breakfast cereals, single grain, corn based	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, single grain, rice based	4	4	0	0.05	<LOR	<LOR
Breakfast cereals, single grain, wheat based	4	4	0	0.05	<LOR	<LOR
Cake, chocolate, iced	4	4	0	0.05	<LOR	<LOR
Cake, dried fruit	4	4	0	0.05	<LOR	<LOR
Cake, sponge, plain	4	4	0	0.05	<LOR	<LOR
Chicken breast	10	10	0	0.05	<LOR	<LOR
Chicken products, battered or crumbed	4	4	0	0.05	<LOR	<LOR
Chicken products, battered or crumbed (deep fried from takeaway)	4	3	0.2	0.22	<LOR	0.7
Chocolate, plain, milk	4	4	0	0.05	<LOR	<LOR
Confectionery, soft candy e.g. jelly beans, jelly babies & snakes	4	4	0	0.05	<LOR	<LOR
Crumpet, English style muffins	8	8	0	0.05	<LOR	<LOR
Fish fillets - white fish, fresh	12	12	0	0.05	<LOR	<LOR
Fish fillets, battered from takeaway	10	10	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Fish portions, frozen from supermarket (crumbed only)	4	3	0.1	0.12	<LOR	0.3
Fruit, dried or processed (sultanas)	4	4	0	0.05	<LOR	<LOR
Hamburger, from takeaway	8	8	0	0.05	<LOR	<LOR
Infant cereal, mixed	4	4	0	0.05	<LOR	<LOR
Infant dessert, fruit based	4	4	0	0.05	<LOR	<LOR
Infant dessert, milk based	4	4	0	0.05	<LOR	<LOR
Infant dinner	4	4	0	0.05	<LOR	<LOR
Infant rusks/biscuits	4	4	0	0.05	<LOR	<LOR
Lamb chops, loin	10	10	0	0.05	<LOR	<LOR
Milk, fresh (full fat)	12	11	0.1	0.10	<LOR	0.6
Milk, UHT (full fat)	12	10	0	0.07	<LOR	0.2
Muesli bars, with dried fruit	4	4	0	0.05	<LOR	<LOR
Noodles, egg fresh	4	4	0	0.05	<LOR	<LOR
Noodles, instant	4	4	0	0.05	<LOR	<LOR
Nuts, mixed, roasted & salted	4	4	0	0.05	<LOR	<LOR
Onions, frozen packaged	4	4	0	0.05	<LOR	<LOR
Pasta (cooked)	4	4	0	0.05	<LOR	<LOR
Pie, fruit	4	4	0	0.05	<LOR	<LOR

Food	No. of analyses	No. of ND samples	Mean		Minimum	Maximum
			ND=0	ND=LOR		
Pie, meat, individual size	4	4	0	0.05	<LOR	<LOR
Pikelets/pancakes from shaker	4	4	0	0.05	<LOR	<LOR
Pikelets/pancakes ready-to-eat	4	4	0	0.05	<LOR	<LOR
Pizza, meat and vegetable topped	4	4	0	0.05	<LOR	<LOR
Popcorn, microwave	4	4	0	0.05	<LOR	<LOR
Potato chips, frozen	4	4	0	0.05	<LOR	<LOR
Potato crisps (mixed varieties excluding salt & vinegar)	4	4	0	0.05	<LOR	<LOR
Sausages, beef	10	10	0	0.05	<LOR	<LOR
Snack foods, corn based chips & taco shells	4	4	0	0.05	<LOR	<LOR
Snack foods, extruded (excluding potato crisps)	4	4	0	0.05	<LOR	<LOR
Sugar, white	4	4	0	0.05	<LOR	<LOR
Vegetables, mixed, frozen	4	4	0	0.05	<LOR	<LOR
Water, laboratory	2	2	0	0.05	<LOR	<LOR

IRG184 - 1-hydroxycyclohexyl phenyl ketone; Irgacure184 . 'ND' = not detected. Results were derived from composite samples, except for laboratory water.
The limit of reporting (LOR) was 0.05–1 mg/kg depending on the food matrix.

Table A8.5 Comparison of concentrations of printing ink chemicals in the 24th ATDS to international studies

ATDS food/beverage	Concentration of printing ink chemicals (mg/kg)		
	24th ATDS	New Zealand[1]	United Kingdom[2]
BP			
Chicken products, battered or crumbed	<LOR–0.8	ND supermarket 'chicken nuggets', 'crumbed chicken'	0.0189 'BBQ chicken grills'
Fish portions, frozen from supermarket ,crumbed	<LOR–1.0	ND 'fish portions'	0.897 'fish fingers', 0.439 'fish cakes'
Pikelets/pancakes from shaker	<LOR–0.1	-	2.02 'Scotch pancakes'
Snack foods, corn based chips & taco shells	<LOR–1.0	ND 'corn based chips'	ND 'savoury snacks'
EDAB			
Chicken products, battered or crumbed (supermarket)	<LOR–0.08	ND supermarket 'chicken wings', 'chicken nuggets' , 'chicken crumbed'	ND 'BBQ chicken grills', 'chicken burgers'
Lamb chops, loin	≤LOR–0.05	ND 'lamb,plastic'	-
Sausages, beef	<LOR–0.06	ND	-
HMPP			
Sausages, beef	<LOR–0.08	ND 'sausages'	-
IRG184			
Bread, flat (pita, burrito etc)	<LOR–0.35	ND 'flat bread'	ND 'bakery products'
Chicken products, battered or crumbed, deep fried from takeaway	<LOR–0.73	ND takeaway 'chicken wings','chicken nuggets'	-
Fish portions, frozen from supermarket (crumbed)	<LOR–0.32	ND supermarket 'fish portions'	ND 'frozen fish products'
Milk, fresh (full fat)	<LOR–0.59	ND	-

The limit of reporting (LOR) was 0.05–1 mg/kg in the 24th ATDS, depending on the food matrix. 'ND' = not detected, result less than the LOR for that study (value of LOR may vary with study); - = not reported. Full chemical names are in Table 1.
1. NZMPI 2014; 2. Bradley et al 2013b.

Appendix 9: Screening chemicals migrating from packaging

It has been well established that the method used for an exposure assessment is dependent on its purpose, the chemical of interest, data availability and quality and available resources. The basic guiding principles for estimating exposure have been well described (WHO 2009, de Fatima Pocas and Hogg 2007, Lambe 2002, Rees and Tennant 1993).

In the case of chemicals migrating from packaging, it has been accepted that additional data is required to estimate exposure compared to estimating exposure for food additives, contaminates and agricultural residues (de Fatima Pocas and Hogg 2007, Oldring et al 2009). These include:

- nature and chemical composition of the packaging material
- packaging usage/market share and brand loyalty
- migration levels of the chemical
- which food items are packaged and which are not
- relevant physio-chemical characteristics of the food
- contact time and temperature, surface-to-volume ratio.

In addition to the occurrence data, food consumption data from national nutrition surveys as it is currently collected does not contain data on the packaging of the food consumed, so more recently some small surveys have recorded the packaging of food consumed (Duffy et al 2006). Currently, it is highly unlikely that sufficient data is available to estimate dietary exposure to these chemicals with a high amount of certainty.

There is currently no single agreed approach to estimating dietary exposure to chemicals migrating from packaging. Instead, risk assessors elsewhere have followed a stepwise approach that takes account of the data gaps and follows the recommendation of the World Health Organization (FAO/WHO 2009). This means progressing from highly conservative screening methods (usually a single point estimate) to more intensive estimates using detailed consumption and concentration data. Commonly, if the screening methods indicate a low likelihood of exceeding safety limits, a decision can be made that no further risk assessment work is necessary. Recently, such a stepwise approach for estimating exposure to a chemical migrating from packaging was proposed by the UK Food Safety Authority (FSA 2003). Other approaches taken have been summarised by de Fatima Pocas and Hogg (2007).

Most recently, over a four-year period and with a multimillion dollar budget, the European Flavours, Additives, and Food Contact Materials Exposure Task (FACET) project developed a tool to probabilistically estimate dietary exposure to chemicals from food contact materials in Europe (Oldring et al 2014).

FACET collected detailed statistics on the sizes of packages and market shares for the materials used to package different foods. Statistical distributions of the concentration data were then linked using probabilistic methods to data from national consumption surveys to estimate exposure. Estimates of dietary exposure are at the level of the individual consumer and various percentiles can be derived for populations for which data exists from national dietary surveys. This tool probably provides the best estimate of dietary exposure to chemicals from food contact materials.

Occurrence data

The occurrence data for this phase of the 24th ATDS had a series of limitations, some due to gaps in the data and some due to survey methodology.

Sampling of the food supply in this survey was based on the standard TDS approach used by FSANZ (e.g. FSANZ 2014), which is highly suitable for nutrients, pesticide residues and some contaminants, but less suitable for chemicals migrating from packaging. A future targeted packaging survey should be more representative of packaging types (e.g. glass, cans, or different types of plastics) in contact with a variety of food matrices (e.g. fatty, acidic, or alcoholic).

Another limitation in the occurrence data was the high levels of detection for some of the chemicals. This considerably increased the uncertainty of the data and derived mean concentration level, in particular when combined with a high number of samples that had no detections.

There were a number of gaps in the data that made an estimate of dietary exposure not possible at this stage:

- some fat based foods were not analysed for the chemicals of interest, e.g. cooking oils, oil based spreads, cheeses
- data on the packaging in which the sample was sold was often not collected and there was no complete sampling matrix, i.e. not all foods were analysed for all chemicals of interest.

Typically, in a total diet study foods analysed are ‘mapped’ to a wider number of similar foods reported as consumed in national nutrition surveys to estimate dietary exposure. In this case, it was not possible to map analysed foods to similar foods that also had the same type of packaging, because details of the packaging of foods reported as consumed in the national nutrition surveys was not collected, with the exception of some canned food. The details of the packaging for the food samples included in this study were also not recorded.

Modified budget method

The budget method is a well-established screening method that calculates a Theoretical Maximum Daily Exposure (TMDE) (Formula 1). The aim of a screening method is not to assess true dietary exposure but to identify chemicals for which a more comprehensive dietary exposure assessment is necessary (FAO/WHO 2009).

Formula 1 Theoretical Maximum Daily Exposure

Theoretical Maximum Daily Exposure

$$= \{\text{maximum level of chemical in beverage } {}^{mg}\!/\!{}_{kg}$$
$$\times\ 0.1\ ({}^{litre}\!/\!{}_{kg\ bodyweight}) \times \%\ \text{beverage that may contain chemical}\}$$
$$+ \{\text{maximum level of chemical in solid food } {}^{mg}\!/\!{}_{kg}$$
$$\times\ 0.05\ ({}^{kg}\!/\!{}_{kg\ bodyweight}) \times \%\ \text{solid food that may contain chemical}\}$$

The method makes assumptions on:

1. the level of consumption of food and beverages
2. the concentration of the chemical of interest present
3. the proportion of food and beverage supply that contains the chemical.

The levels of consumption used are theoretical maximum physiological levels of food and beverage required; the method therefore does not rely on consumption data *per se*. The physiological limit of consuming a solid food assumed by the budget method is 0.05 kg/kg of body weight. For a beverage it is 0.1 litres/kg of body weight.

The concentration of the chemical is commonly the maximum reported in any category of food. The proportion of solid foods and beverages containing the chemical of interest are set arbitrarily; for example, 50% is commonly used for additives used in a wide range of foods.

For this report, the concentration of the chemical used is the maximum reported in any category of food/beverage sampled and it has been assumed that 50% of foods and beverages contain the chemical of interest at the maximum concentration detected. Where appropriate, the TMDE calculated was compared to relevant HBGVs.

It should be noted that an ATDS approach assumes that a consumer is randomly selecting from foodstuffs available in the marketplace. However, in the case of packaging material, it is likely that brand loyalty is a factor in food selection and the proposed scenarios may not necessarily be worst cases for a small proportion of the population.

Treatment of non-detects

Wherever a chemical was detected the TMDE was calculated based on the highest concentration that occurred in any given food and/or beverage. However, there was no reason to assume that any sample (for example, where there was a detection in a food sample but not in any beverage sample) did not contain a chemical of interest. Therefore, it was assumed that all samples with non-detectable levels of a chemical may contain that chemical at some level below the level of reporting (LOR) (WHO 2009). In these cases 'maximum levels' for use in the modified budget method were obtained by setting all non-detects to half of the LOR (Helsel 1990, WHO 1995, WHO 2009). This approach was used because it errs on the side of caution but is not too conservative so that it still suits the purpose of this study.

Back calculation method

In some cases, a simple back-calculation was used to estimate how much food might be consumed at the highest concentration reported before dietary exposure from that food reached the relevant HBGV. The purpose of this calculation is to provide some indication of the likelihood of consuming the food of interest at the amount calculated.

Appendix 10: Additional data for Theoretical Maximum Daily Exposure

Table A10.1 Occurrence data used as inputs for calculating Theoretical Maximum Daily Exposure

Chemical[1]	Maximum concentration mg/kg	
	Beverage	Food
BPA	0.016	0.074
ESBO	0.150	14.000
PFOS	0.0005	0.0010
DEHA	0.150	4.100
Phthalates		
DBP	0.150	0.500
DEHP	0.670	6.700
DEP	0.150	1.600
DHpP	0.150	0.560
DINP	0.500	54.000
DMP	0.150	0.500
DPP	0.150	3.700
Printing ink chemicals		
BP	0.050	1.000
EDAB	0.025	0.080
HMPP	0.025	0.080
IRG 184	0.590	0.730

1. Full chemical names are in Table 1.

Table A10.2 Chemicals that were detected in some samples at levels meeting or exceeding the SML

Chemical	Sample	Concentration mg/kg	% SML	Exceed
BP	Chicken products, battered or crumbed	0.26	43	No
		0.29	48	No
		0.80	**133**	**Yes**
	Fish portions, frozen from supermarket (crumbed only)	0.53	88	No
		1.00	**167**	**Yes**
	Snack foods, corn based chips and taco shells	**1.00**	**167**	**Yes**
	Pikelets/pancakes from shaker	0.12	20	No
DBP	Breakfast cereals, single grain, wheat based	**0.48**	**160**	**Yes**
	Vegetables, chargrilled in oil	**0.32**	**107**	**Yes**

Chemical	Sample	Concentration mg/kg	% SML	Exceed
DEHP	Bread, fancy, fresh (savoury)	**6.7**	**447**	**Yes**
	Bread, fancy, fresh (sweet)	0.73	49	No
	Chicken products, battered or crumbed (deep fried from takeaway)	0.53	35	No
		0.65	43	No
	Chocolate, plain, milk	0.63	42	No
		0.55	37	No
	Fish portions, frozen from supermarket (crumbed only)	0.93	62	No
	Hamburger, from takeaway	1.30	87	No
		4.20	**280**	**Yes**
		3.40	**227**	**Yes**
		2.10	**140**	**Yes**
		2.50	**167**	**Yes**
		0.62	41	No
	Infant formula (non-soy)	0.76	51	No
	Infant formula (soy- based)	0.57	38	No
	Milk, fresh (full fat)	0.67	45	No
		0.61	41	No
	Milk, UHT (full fat)	0.55	37	No
		0.62	41	No
		0.58	39	No
	Olives	0.90	60	No
	Peanut butter	0.75	50	No
		0.85	57	No
	Potato crisps (mixed varieties excluding salt & vinegar)	0.54	36	No
		0.51	34	No
	Tomatoes, canned	0.60	40	No
		0.74	49	No

SML – specific migration limit

Appendix 11: Uncertainty analysis for dietary exposure estimates

The major sources of uncertainties for estimating dietary exposure have been summarised in Table A11.1. The use of the budget method by design is conservative and leads to overestimation of exposure to deal with high levels of uncertainty. The uncertainty surrounding the market share of foods in specific packaging types could lead to over- or underestimates of exposure, depending on packaging type and what foods have been sampled and subsequently analysed. The data gaps surrounding some food types, such as fats and oils, may potentially lead to underestimates of exposure.

Overall, the exposure estimates are more likely to overestimate exposure.

Table A11.1 Evaluation of uncertainties

Source	Direction and magnitude*
Consumption data: theoretical maximum physiological levels are used	+++
Exposure scenario: % of foods that contain packaging that is source of exposure unknown (assumed 50% in screening)	++/--
Exposure model: foods may not be representative of the Australian market	++/--
Model inputs: use of maximum concentrations as inputs where there are detections	+++
Model inputs: use of half LOR concentrations as inputs where there are no detections	++
Model inputs: uncertainty over analytical methodology leads to high level of uncertainty about non-detects and high upper bound means	+++
Model inputs: no analytical data on some key food groups	--
Model inputs: approach assumes that a consumer is randomly selecting foodstuffs. However, brand loyalty challenges this assumption	--

*plus signs indicate a certainty that could cause a small (+) medium (++) or large (+++) overestimation of exposure, minus signs small (-) medium (--) or large (---) underestimation of exposure. Some uncertainties may cause either over or underestimates.

The following factors would reduce uncertainty and allow a better estimate of exposure:

- use of more refined analytical methods
- sampling of food groups excluded from this study (particularly high-fat foods, in which phthalates are highly soluble)
- sampling from a variety of food packaging types
- considering information on each food's packaging, to assist with conclusions on the source of chemicals detected in foods
- mapping of sampled foods to foods reported as consumed in the national nutrition surveys should be considered in the sampling plan.
- Obtaining data related to brands and how brand loyalty effects consumption patterns

Appendix 12: Summary of screen of food packaging chemicals

The table below summarises both non-detections and detections of the packaging chemicals in foods and the stepwise screening assessment of potential health and safety risks. When a chemical had no detections, or if it was detected at a level below the SML[a], it was concluded there was negligible risk to public health and safety and no further assessment was undertaken. If a chemical was detected (and either exceeded the SML or had no SML value), a TMDE was estimated to compare to either a TDI, a NOAEL from an appropriate toxicity study (MOE approach[b]), or, if no appropriate toxicity data were located, a TTC[c] based on chemical structure. Details on the screening assessment process are in Chapter 6.

Chemical name	Detections/foods	Screening assessment	Outcome
Bisphenol A; 2,2-bis(4-hydroxyphenyl) propane (BPA)	8/17	<SML, <TDI	Negligible risk to public health and safety.
Epoxidised soybean oil (ESBO)	4/21	<SML, <TDI	Negligible risk to public health and safety.
Perfluorinated compounds:			
Perfluorooctanoic acid (PFOA)	0/50	NA	Negligible risk to public health and safety.
Perfluorooctane sulphonic acid (PFOS)	2/50	No SML, <TDI	Negligible risk to public health and safety.
Adipate:			
Di(2-ethylhexyl) adipate (DEHA)	4/48	<SML, <TDI	Negligible risk to public health and safety.
Phthalates:			
Butyl benzyl phthalate (BBP)	0/48	NA	Negligible risk to public health and safety.
Dibutyl phthalate (DBP)	2/48	>SML, >TDI	Low risk to public health and safety.
Didecyl phthalate (DDP)	0/48	NA	Negligible risk to public health and safety.

Chemical name	Detections/foods	Screening assessment	Outcome
Di(2-ethylhexyl) phthalate (DEHP)	14/48	>SML, >TDI	FSANZ recommends a follow-up survey to better characterise exposure and risk.
Diethyl phthalate (DEP)	5/48	No SML, <TDI	Negligible risk to public health and safety.
Diheptyl phthalate (DHpP)	1/48	No SML, no TDI, < TTC	Negligible risk to public health and safety.
Dihexyl phthalate (DHxP)	0/48	NA	Negligible risk to public health and safety.
Diisobutyl phthalate (DIBP)	0/48	NA	Negligible risk to public health and safety.
Diisodecyl phthalate (DIDP)	0/48	NA	Negligible risk to public health and safety.
Diisononyl phthalate (DINP)	15/48	No SML, >TDI	FSANZ recommends a follow-up survey to better characterise exposure and risk.
Diisopropyl phthalate (DIPP)	0/48	NA	Negligible risk to public health and safety.
Di-n-octyl phthalate (DNOP)	0/48	NA	Negligible risk to public health and safety.
Dimethyl phthalate (DMP)	2/48	No SML, no TDI, MOE 50,000	Negligible risk to public health and safety.
Dipentyl phthalate, di-n-pentyl phthalate (DPP)	1/48	No SML, no TDI, MOE 110	Low risk to public health and safety.
Printing ink chemicals:			
Benzophenone (BP)	4/60	>SML, <TDI	Low risk to public health and safety.
4-Benzoylbiphenyl (4-BZP)	0/60	NA	Negligible risk to public health and safety.
4,4’-Bis(diethylamino) benzophenone (DEABP)	0/60	NA	Negligible risk to public health and safety.

Chemical name	Detections/foods	Screening assessment	Outcome
2,4-Diethyl-9H-thioxanthen-9-one (DETX)	0/60	NA	Negligible risk to public health and safety.
2,2-Dimethoxy-2-phenylacetophenone (DMPAP)	0/60	NA	Negligible risk to public health and safety.
Ethyl 4-(dimethylamino) benzoate (EDAB)	3/60	No SML, no TDI, approx. 2xTTC	Low risk to public health and safety.
2-Ethylhexyl-4-(dimethylamino)benzoate (EHDAB)	0/60	NA	Negligible risk to public health and safety.
1-Hydroxycyclohexyl phenyl ketone; ***Irgacure184*** (IRG184)	5/60	No SML, no TDI, MOE >17,000	Negligible risk to public health and safety.
2-Hydroxy-2-methylpropiophenone (HMPP)	1/60	No SML, no TDI, MOE >17,000	Negligible risk to public health and safety.
Isopropyl-9H-thioxanthen-9-one, mix of 2-and 4-isomers (ITX (2- & 4-))	0/60	NA	Negligible risk to public health and safety.
4-Methylbenzophenone (4-MBP)	0/60	NA	Negligible risk to public health and safety.

a. An SML is the maximum permitted amount of a given substance released from a material or article into food or food simulants (European Commission 2011).
b. In this report, the MOE is the ratio of the NOAEL to the TMDE calculated using a modified budget method. The higher the MOE, the less likely there is a health or safety concern.
c. The TTC approach assigns safe levels of human exposure to chemicals based on consideration of chemical structure (Kroes et al 2004, FAO/WHO 2011).

Appendix 13: Glossary

Benchmark dose (BMD)

The BMD is the dose of a substance which corresponds with a particular level or rate of physiological response. It is derived by modelling the dose-response curve in a range of relevant observable data, and then using that model to estimate a dose that corresponds to a particular level of response. The Benchmark Dose Lower Confidence Level ($BMDL_{10}$) refers to the dose that corresponds with a 10% response rate for a particular physiological response.

Dietary exposure

The amount of a specified chemical that is ingested by a person as part of the diet (via food, beverages and drinking water).

Good manufacturing practice (GMP)
(with respect to the addition of additives and processing aids to food, means)

- the quantity of additive or processing aid added to food shall be limited to the lowest possible level necessary to accomplish its desired effect; and
- the quantity of the additive or processing aid that becomes a component of food as a result of its use in the manufacture, processing or packaging of a food, and which is not intended to accomplish any physical or other technical effect in the finished food itself, is reduced to the extent reasonably possible; and
- the additive or processing aid is prepared and handled in the same way as a food ingredient.

Limit of reporting (LOR)

The LOR is the lowest concentration level that the laboratory reports analytical results.

Lowest observed adverse effect level (LOAEL)

Lowest concentration that causes any alteration of morphology, functional capacity, growth, development or lifespan of the target organism distinguishable from normal (control) organisms of the same species and strain under the same defined conditions of exposure.

Margin of exposure (MOE)

Ratio of the no observed adverse effect level (NOAEL) or BMDL for the critical effect to the theoretical, predicted or estimated exposure. The calculation usually involves a reference point value (also called a point of departure) derived from the hazard assessment that is then divided by an estimate of human dietary exposure to give a dimensionless ratio that is the MOE.

Mean

Arithmetic mean.

National foods

Those foods that are distributed nationwide and therefore not expected to show regional variation, such as breakfast cereals, tea, coffee, soft drink and canned fruit.

NNS (National Nutrition Survey)

National Nutrition Surveys collect information on food and nutrition from national populations.

No observed adverse effect level (NOAEL)

The highest exposure level at which there are no biologically significant increases in the frequency or severity of adverse effect between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse or precursors of adverse effects.

Regional foods

Those foods that may be expected to show regional variation including red meat, chicken, breads and milk.

Specific migration limit

The maximum permitted amount of a given substance released from a material or article into food or food simulants.

Theoretical maximum daily exposure (TMDE)

Output of the budget method calculated by summing the theoretical potential exposure from beverages and foods based on maximum physiological levels of consumption.

Threshold of toxicological concern (TTC) approach

TTC values have been established for substances of similar chemical structure and likelihood of toxicity, based on extensive published toxicological data. If human exposure to a substance is below the TTC value, the likelihood of adverse effects is considered to be very low.

Tolerable daily intake

Estimated maximum amount of a substance, expressed on a body mass basis, to which each individual in a sub-population may be exposed (i.e. ingest) to daily over a lifetime without appreciable health risk.

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