



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Pesticides and Metals in Grain Products and Ready-to-Eat Meals - April 1, 2016 to March 31, 2017

Food chemistry - Targeted surveys - Final Report



Summary

Targeted surveys provide information on potential food hazards and enhance the Canadian Food Inspection Agency's (CFIA's) routine monitoring programs. These surveys provide evidence regarding the safety of the food supply, identify potential emerging hazards, and contribute new information and data to food categories where it may be limited or non-existent. They are often used by the Agency to focus surveillance on potential areas of higher risk. Surveys can also help to identify trends and provide information about how industry complies with Canadian regulations.

Grain-based and vegetable-based products are staple foods consumed in Canada^{1,2}. These are products of agricultural commodities and may contain pesticide residues introduced from the environment or if the crops were treated with pesticides in the field, during transport and/or during storage to prevent damage from insects, moulds or other pests. These products may also contain levels of metals from environmental sources. Though metals such as arsenic, cadmium, lead and mercury are not permitted to be added to foods, and manufacturers are responsible for measures aimed at reducing accidental introduction of these elements in foods (for example, from lead solder in steel equipment), their presence is expected in foods, at very low levels, primarily as a result of their natural presence in the environment.

The main objectives of this targeted survey were to generate additional baseline surveillance data on the level of pesticide residues and metal levels in selected grain-based foods and ready-to-eat (RTE) meals available on the Canadian market.

A total of 3998 samples of grain-based products, and RTE meals such as pizza, soup and complete toddler meals, were collected and tested for pesticides and metals. Residues of 127 different pesticides were detected in 1189 (30%) of the samples. The overall compliance rate for pesticides in grain and RTE meals tested was 99.6%. All of the non-compliant results were associated with pesticide residues exceeding the general MRL of 0.1 ppm (mg/kg). Health Canada (HC) determined the levels of pesticides observed in the current survey are not expected to pose a concern to human health, therefore there were no recalls resulting from this survey. The CFIA conducted appropriate follow up activities to improve compliance which included further testing of similar products in subsequent years.

All samples collected were subjected to a multi-metal laboratory method that analyzes for 20 metals. Only the data for metals of highest concern to human health at low levels of exposure, most notably: arsenic, cadmium, lead, and mercury, are presented in this report. Corn products were associated with lowest prevalence and the lowest observed levels of the metals. As expected based on the types of ingredients and the results of previous studies, detection rates were highest for products with multiple ingredients such as RTE meals.

There are no regulations in Canada for metal levels in the products tested. All data generated were forwarded to HC for human risk assessment and determined to pose no concern to human health.

The detection rates for pesticides in all commodity types collected were similar to those reported by other jurisdictions such as the United States, the European Union (EU), the United Kingdom, and Australia. In general, the detection rate and highest observed levels for arsenic, cadmium, lead and mercury were comparable those reported by the United States, the EU and Australia. This means that Canadian consumers' exposure to pesticides and metals from these foods is lower than or similar to the exposure of consumers in other jurisdictions.

What are targeted surveys

Targeted surveys are used by the CFIA to focus its surveillance activities on areas of highest health risk. The information gained from these surveys provides support for the allocation and prioritization of the Agency's activities to areas of greater concern. Originally started as a project under the Food Safety Action Plan (FSAP), targeted surveys have been embedded in our regular surveillance activities since 2013. Targeted surveys are a valuable tool for generating information on certain hazards in foods, identifying and characterizing new and emerging hazards, informing trend analysis, prompting and refining health risk assessments, highlighting potential contamination issues, as well as assessing and promoting compliance with Canadian regulations.

Food safety is a shared responsibility. We work with federal, provincial, territorial and municipal governments and provide regulatory oversight of the food industry to promote safe handling of foods throughout the food production chain. The food industry and retail sectors in Canada are responsible for the food they produce and sell, while individual consumers are responsible for the safe handling of the food they have in their possession.

Why did we conduct this survey

Chemical hazards in foods can come from a variety of sources. Pesticides may be present as contaminants in the environment or they may be deliberately used by farmers to protect food and crops from pests. Different pest pressures and climatic conditions in food export countries may result in the potential use of pesticides that are not approved for use in Canada, or result in pesticide residues in products that do not meet established Canadian maximum residue limits (MRLs) to be legally sold in Canada³.

Inappropriate use of pesticides may pose a health risk to consumers, with the risk dependant on the type of pesticide, its concentration, the interaction with the human body, and the length of exposure to the pesticide by the consumer.

Metals are naturally-occurring elements that may be present in very low amounts in rock, water, soil, or air. Therefore, finding these substances in food products is not unexpected as trace levels generally reflect normal accumulation from the environment. They may be present in finished foods due to their presence in the ingredients used to manufacture those foods, and/or may be unintentionally incorporated along the food production chain.

There are a number of metals that may be of concern to human health at certain levels of exposure. Most notably, arsenic, cadmium, lead, and mercury have been shown to have effects on human health, even at low levels of exposure. The results of only these metals of highest concern are presented in this report.

Grain and vegetable-based foods are products of agricultural commodities and may contain pesticide residues introduced from the environment or if the crops were treated with pesticides in the field. The objective of this targeted survey was to obtain additional baseline data on the levels of pesticides, arsenic, cadmium, lead and mercury in these types of products available on the Canadian market, and to compare the prevalence of pesticides in foods with previous targeted surveys.

What did we sample

A variety of domestic and imported grain products and RTE meals were sampled between August 1, 2016 and March 21, 2017. Samples of products were collected from local/regional retail locations located in 6 major cities across Canada. These cities encompassed 4 Canadian geographical areas: Atlantic (Halifax), Quebec (Montreal), Ontario (Toronto, Ottawa) and the West (Vancouver, and Calgary). The number of samples collected from these cities was in proportion to the relative population of the respective areas. The shelf life, storage conditions, and the cost of the food on the open market were not considered in this survey.

Table 1. Distribution of samples based on product type and origin

Product type	Number of domestic samples	Number of imported samples	Number of samples of unspecified^a origin	Total number of samples
Corn products	44	363	168	575
Oat products	109	64	175	348
Other/mixed grain products	141	236	273	650
RTE meals	660	935	405	2000
Wheat products	148	81	196	425
Grand total	1102	1679	1217	3998

^a Unspecified refers to those samples for which the country of origin could not be assigned from the product label or available sample information

How were samples analyzed and assessed

Samples were analyzed by an ISO/IEC 17025 accredited food testing laboratory under contract with the Government of Canada. See Appendix A for a list of the pesticides included in the PESTICIDE-GCLC multi-residue pesticide method. Glyphosate and its metabolite AMPA were also tested for in this survey. The results are based on the food products as sold and not necessarily as they would be consumed.

Pesticide MRLs are established by the Pest Management Regulatory Agency (PMRA) of HC and appear in their MRL database³. Pesticide MRLs apply to the specified raw agricultural commodity as well as to any processed food product that contains the commodity unless otherwise specified. According to [section B.15.002 \(1\) of the Food and Drug Regulations](#) (FDR), in the absence of a specific MRL, residues of a pesticide or other agricultural chemical must not exceed the general MRL of 0.1 ppm.

Contaminants and other adulterating substances in foods have regulatory maximum levels that are established by HC. In the absence of a specific maximum level, they assess the levels of arsenic, cadmium, mercury and lead on a case-by-case basis using the most current scientific data available.

What were the survey results

Pesticides

A total of 3998 samples of domestic and imported grain products and RTE meals were tested for over 480 pesticides in this targeted survey. Pesticide residues were not detected in 2809 (70%) samples. In the remaining 1189 samples, residues of 127 different pesticides were detected. A summary of the pesticide results by each product type can be seen in Table 2.

The percentage of samples with pesticide residues detected ranged from 0.3% in oat products to 53% in RTE meals. Difenconazole and chlorpropham were the most frequently detected pesticides. The overall compliance rate for pesticides in grain products and RTE meals tested was 99.6%. There were 14 non-compliant results associated with 9 popcorn samples and 8 with other product types. All of the non-compliant results were associated with pesticide residues exceeding the general MRL of 0.1 ppm. The average amount of residue detected in these non-compliant samples was 0.44 ppm.

HC determined the levels of pesticides in grain and RTE meals observed in the current survey were not expected to pose a concern to human health, therefore there were no recalls resulting from this survey.

Table 2. Results of pesticide testing in grain products and RTE meals

Product type	Number of samples	Number (percentage) of samples with detected pesticide residue(s)	Number of non-compliant residue result(s)/number (percentage) of non-compliant samples ^a
Corn products	575	31 (5%)	15/10 (1.7%)
Oat products	348	1 (0.3%)	0
Grain products (other)	650	33 (5%)	1/1 (0.1%)
RTE meals	2000	1062 (53%)	2/2 (0.1%)
Wheat products	425	62 (15%)	4/4 (0.9%)
Grand total	3998	1189 (30%)	22/17 (0.4%)

^a Sample may contain 1 or more non-compliant residues. 5 samples contained 1 non-compliant pesticide each and 5 samples contained 2 non-compliant residues each.

Metals

All 3998 samples collected were subjected to a multi-metal laboratory method that analyzes for 20 metals. Only the results of the metals of highest human health concern (arsenic, cadmium, lead and mercury) are presented in this report. Most of the survey samples (89%) contained one or more of these four metals, while only 13% of the samples contained traces of all 4 metals.

Table 3. Detected levels of metals in grain products and RTE meals

Product type	Number of samples	% pos for arsenic	Average level (range) of arsenic (ppm)	%pos for cadmium	Average level (range) of cadmium (ppm)	%pos for lead	Average level (range) of lead (ppm)	%pos for mercury	Average level (range) of mercury (ppm)
Corn products	575	7	0.0025 (<LOD-0.077)	7	0.0010 (<LOD-0.036)	2	0.0005 (<LOD-0.039)	33	0.00006 (<LOD-0.0021)
Oat products	348	24	0.0081 (<LOD-0.101)	77	0.015 (<LOD-0.077)	2	0.0016 (<LOD-0.251)	46	0.00008 (<LOD-0.0006)
Grain products (other)	650	12	0.0059 (<LOD-0.313)	88	0.033 (<LOD-0.188)	8	0.0020 (<LOD-0.047)	55	0.00012 (<LOD-0.0016)
RTE meals	2000	54	0.0067 (<LOD-0.808)	96	0.0095 (<LOD-0.337)	92	0.0042 (<LOD-0.082)	38	0.00014 (<LOD-0.024)
Wheat products	425	24	0.0084 (<LOD-0.182)	98	0.054 (<LOD-0.319)	7	0.0038 (<LOD-0.54)	37	0.0006 (<LOD-0.0006)

<LOD = Below the limit of detection (0.0001 - 0.01 ppm, depending on the laboratory and the analyte)

Note: Average values were calculated using only results for samples with quantifiable metal levels

Table 3 illustrates the level of these metals found in the products tested. The average levels and detection rates were similar for most products tested. Lead and cadmium had the lowest and the highest overall prevalence, respectively. Corn products were associated with the lowest prevalence and the lowest observed levels of the metals, while wheat products and RTE meals containing fish and seafood (due to bioaccumulation of metals) were often found to contain the highest detected levels of these metals. As expected, detection rates were highest for products with multiple ingredients such as RTE meals. There are no regulations in Canada for the levels of these metals in the products tested. HC determined that none of the products posed a health risk to consumers.

What do the survey results mean

In comparison to previous survey years, the detection rates for pesticides in all commodity types collected were consistent (Table 4). A slight increase in the detection and non-compliance rates for products in the 2015 to 2016 survey can be attributed to increase in the method sensitivity and a larger number of analytes. Some differences observed may also be due to the sample size and the specific type of product tested.

Table 4. Pesticide testing results in grain products and RTE meals from various survey years

Product type	Survey year	Number of samples	Number (percentage) of samples with detected pesticide residue(s)	Number (percentage) of non-compliant samples
Corn products	2016 to 2017	575	31 (5%)	10 (1.7%)
Corn products	2013 to 2014	29	1 (3.4%)	0
Corn products	2012 to 2013	94	1 (1.1%)	0
Corn products	2011 to 2012	83	1 (1.2%)	0
Oat products	2016 to 2017	348	1 (0.3%)	0
Oat products	2013 to 2014	75	1 (1.3%)	0
Oat products	2012 to 2013	100	2 (2%)	1 (1%)
Oat products	2011 to 2012	86	1 (1.2%)	0
Grain products (other)	2016 to 2017	650	33 (5%)	1 (0.1%)
Grain products (other)	2015 to 2016	365	53 (15%)	1 (0.3%)
Grain products (other)	2014 to 2015	57	7 (12.3%)	0
Assorted foods	2014 to 2015	226	32 (14.2%)	3 (1.3%)
Grain products (other)	2013 to 2014	99	7 (7.1%)	0
Assorted foods	2013 to 2014	582	55 (9.4%)	1 (0.2%)
Grain products (other)	2012 to 2013	79	7 (8.9%)	0
Grain products (other)	2011 to 2012	30	2 (6.7%)	1 (3.3%)
RTE meals	2016 to 2017	2000	1062 (53%)	2 (0.1%)
RTE meals	2014 to 2015	46	18 (39%)	0
Wheat products	2016 to 2017	425	62 (15%)	4 (0.9%)
Wheat products	2013 to 2014	34	4 (11.8%)	0
Wheat products	2012 to 2013	109	17 (15.6%)	0
Wheat products	2011 to 2012	135	21 (15.6%)	0

The detection rates and the levels of metals reported in this targeted survey were very close to those previously found in similar product types, namely corn, wheat, oat and other grain products^{4,5,6,7}.

Comparisons to other jurisdictions

Pesticides. The detection rates for pesticides in all commodity types collected were similar to those reported by other jurisdictions such as the United States^{8,9}, the European Union^{10,11}, the United Kingdom¹², and Australia¹³, (see Appendix B for more details). This means that Canadian consumers' exposure to pesticides from these foods is lower than or similar to the exposure of consumers in other jurisdictions.

Metals. Average levels reported in this study and in other countries are not easily comparable as it might not be clear how averages were calculated. For this survey, all non-detects are excluded from the calculation of averages. Some jurisdictions may set the non-detects at the Limit of detection (LOD), at one-half the LOD or may include them as zeroes. For this reason, only detection rates and highest observed levels will be compared.

In general, the detection rate and highest observed levels for arsenic, cadmium, lead and mercury were comparable those reported by the United States¹⁴, the European Union (EU)^{15,16,17,18,19}, and Australia¹³. This suggests that, in general, the Canadian consumers' exposure to these metals is comparable to or lower than those of other jurisdictions. For further details, consult Appendix C, D, E and F for arsenic, cadmium, lead, and mercury, respectively.

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Appendix A

List of analytes (485) included in the PESTICIDE-GCLC multi-residue pesticide program used by the accredited laboratory in this survey

3-hydroxyCarbofuran	Demeton-S-methyl	Fosthiazate	Piperonyl butoxide
Acephate	Demeton-s-methyl sulfone	Fuberidazole	Piperophos
Acetamiprid	Demeton-s-methyl sulfoxide	Furalaxyl	Pirimicarb
Acetochlor	Des-ethyl Atrazine	Furathiocarb	Pirimiphos-ethyl
Acibenzolar-s-methyl	Desmedipham	Griseofulvin	Pirimiphos-methyl
Aclonifen	Desmetryn	Halofenozide	Pretilachlor
Alachlor	Di-allate	Haloxypop	Primisulfuron-methyl
Alanycarb	Dialofos	Heptachlor	Prochloraz
Aldicarb	Diazinon	Heptachlor epoxide endo	Procymidone
Aldicarb Sulfone	Diazinon o analogue	Heptenophos	Prodiamine
Aldicarb sulfoxide	Dichlobenil	Hexachlorobenzene	Profenofos
Aldrin	Dichlofenthion	Hexaconazole	Profluralin
Allidochlor	Dichlofluanid	Hexaflumuron	Promecarb
Ametryn	Dichloran	Hexazinone	Prometon
Aminocarb	Dichlormid	Hexythiazox	Prometryne
Anilofos	Dichlorvos	Hydramethylnon	Pronamide
Aramite	Diclobutrazole	Imazalil	Propachlor
Aspon	Diclocymet	Imazamethabenz-methyl	Propamocarb
Atrazine	Diclofop-methyl	Imidacloprid	Propanil
Azaconazole	Dicofol	Indoxacarb	Propargite
Azinphos-ethyl	Dicrotophos	Iodofenphos	Propazine
Azinphos-methyl	Dieldrin	Ipconazole	Propetamphos
Azoxystrobin	Diethyl-ethyl	Iprobenfos	Propham
Benalaxyl	Diethofencarb	Iprodione	Propiconazole
Bendiocarb	Difenoconazole	Iprovalicarb	Propoxur
Benfluralin	Diflubenzuron	Isazophos	Prothioconazole
Benfuracarb	Dimethachlor	Isocarbamide	Prothiophos
Benodanil	Dimethametryn	Isofenphos	Pymetrozine
Benomyl	Dimethenamid	Isoprocab	Pyracarbolid
Benoxacor	Dimethoate	Isopropalin	Pyraclostrobin
Benzoximate	Dimethomorph	Isoprothiolane	Pyraflufen-ethyl
Benzoylprop-ethyl	Dimoxystrobin	Isoproturon	Pyrazophos
BHC Alpha	Diniconazole	Isoxathion	Pyridaben
BHC beta	Dinitramine	Kresoxim-methyl	Pyridalyl
Bifenazate	Dinotefuran	Leptophos	Pyridaphenthion
Bifenox	Dioxacarb	Lindane (gamma-BHC)	Pyridate
Bifenthrin	Dioxathion	Linuron	Pyrifenoxy
Biphenyl	Diphenamid	Lufenuron	Pyrimethanil
Bitertanol	Diphenylamine	Malaoxon	Pyriproxyfen
Boscalid	Dipropetryn	Malathion	Pyroxsulam
Bromacil	Diquat	Mandipropamid	Quinalphos
Bromophos	Disulfoton	Mecarbam	Quinomethionate

Bromophos-ethyl	Disulfoton sulfone	Mefenacet	Quinoxyfen
Bromopropylate	Diuron	Mepanipyrim	Quintozene
Bromuconazole	Dodemorph	Mephosfolan	Quizalofop
Bupirimate	Edifenphos	Mepronil	Quizalofop-ethyl
Buprofezin	Emamectin B1a	Metaflumizone	Schradan
Butachlor	Emamectin B1b	Metalaxyl	Secbumeton
Butafenacil	Endosulfan alpha	Metazachlor	Siduron
Butocarboxim	Endosulfan beta	Metconazole	Simazine
Butocarboxim sulfoxide	Endosulfan sulfate	Methabenzthiazuron	Simetryn
Butoxycarboxim	Endrin	Methamidophos	Spinetoram
Butralin	EPN	Methidathion	Spinosyn A
Butylate	Epoxiconazole	Methiocarb	Spinosyn D
Cadusafos	EPTC	Methiocarb sulfone	Spirodiclofen
Captafol	Esfenvalerate	Methiocarb Sulfoxide	Spiromesifen
Captan	Etaconazole	Methomyl	Spirotetramat
Carbaryl	Ethalfuralin	Methoprotryne	Spiroxamine
Carbendazim	Ethiofencarb	Methoxychlor	Sulfallate
Carbetamide	Ethiofencarb sulfone	Methoxyfenozide	Sulfentrazone
Carbofenthion	Ethiofencarb sulfoxide	Methyl - trithion	Sulfotep
Carbofuran	Ethion	Metobromuron	Sulprophos
Carbosulfan	Ethiprole	Metolachlor	TCMTB
Carboxin	Ethirimol	Metolcarb	Tebuconazole
Carfentrazone-ethyl	Ethofumesate	Metoxuron	Tebufenozide
Chlorantranilprole	Ethoprop	Metribuzin	Tebufenpyrad
Chlorbenside	Ethylan	Mevinphos-cis	Tebupirimfos
Chlorbromuron	Etofenprox	Mexacarbate	Tebuthiuron
Chlorbufam	Etoxazole	Mirex	Tecnazene
Chlordane cis	Etridiazole	Molinate	Teflubenzuron
Chlordane trans	Etrimfos	Monocrotophos	Temephos
Chlordimeform	Famoxadone	Monolinuron	Tepraloxydim
Chlorfenson	Fenamidone	Myclobutanil	Terbacil
Chlorfenvinphos (e+z)	Fenamiphos	Naled	Terbufos
Chlorfluazuron	Fenamiphos sulfone	Napropamide	Terbumeton
Chlorflurenol-methyl	Fenamiphos sulfoxide	Naptalam	Terbutryne
Chloridazon	Fenarimol	Neburon	Terbutylazine
Chlorimuron-ethyl	Fenazaquin	Nitenpyram	Tetrachlorvinphos
Chlormephos	Fenbuconazole	Nitralin	Tetraconazole
Chlorobenzilate	Fenchlorphos (Ronnell)	Nitrapyrin	Tetradifon
Chloroneb	Fenfuram	Nitrofen	Tetraiodoethylene
Chloropropylate	Fenhexamid	Nitrothal-isopropyl	Tetramethrin
Chlorothalonil	Fenitrothion	Norflurazon	Tetrasul
Chloroxuron	Fenobucarb	Novaluron	Thiabendazole
Chlorpropham	Fenoxanil	Nuarimol	Thiacloprid
Chlorpyrifos	Fenoxycarb	o,p'-DDD (o,p'-TDE)	Thiamethoxam
Chlorpyrifos-methyl	Fenpropathrin	o,p'-DDE	Thiazopyr
Chlorthiamid	Fenpropidin	o,p'-DDT	Thidiazuron

Chlorthion	Fenpropimorph	Octhilinone	Thiobencarb
Chlorthiophos	Fenpyroximate	Ofurace	Thiodicarb
Chlortoluron	Fenson	Omethoate	Thiofanox
Chlozolinate	Fensulfothion	Ortho-phenylphenol	Thiofanox sulfone
Clethodim	Fenthion	Oxadiazon	Thiofanox sulfoxide
Clodinafop-propargyl	Fentrazamide	Oxadixyl	Thiophanate-methyl
Clofentezine	Fenuron	Oxamyl	Tolclofos-methyl
Clomazone	Fenvalerate	Oxamyl-oxime	Tolfenpyrad
Cloquintocet-mexyl	Fipronil	Oxycarboxin	Tolyfluanid
Clothianidin	Flamprop-isopropyl	Oxychlorane	Tralkoxydim
Coumaphos	Flamprop-methyl	Oxyfluorfen	Triadimefon
Crotoxyphos	Flonicamid	p,p'-DDD (p,p'-TDE)	Triadimenol
Crufomate	Fluazifop-butyl	p,p'-DDE	Tri-allate
Cyanazine	Flubendiamide	p,p'-DDT	Triazophos
Cyanofenphos	Flucarbazone-sodium	Paclobutrazol	Tribufos
Cyanophos	Fluchloralin	Paraoxon	Trichlorfon
Cyazofamid	Flucythrinate	Paraquat	Tricyclazole
Cycloate	Fludioxonil	Parathion	Trietazine
Cycloxydim	Flufenacet	Parathion-methyl	Trifloxystrobin
Cycluron	Flufenoxuron	Pebulate	Trifloxysulfuron
Cyfluthrin (I,II,III,IV)	Flumetralin	Penconazole	Triflumizole
Cyhalothrin-lambda	Fluometuron	Pencycuron	Triflumuron
Cymoxanil	Fluorochloridone	Pendimethalin	Trifluralin
Cypermethrin	Fluorodifen	Penoxsulam	Triforine
Cyprazine	Fluoxastrobin	Permethrin (Total)	Trimethacarb
Cyproconazole	Fluquinconazole	Phenmedipham	Triticonazole
Cyprodinil	Flusilazole	Phenthoate	Vamidothion
Cyromazine	Flutolanil	Phorate	Vernolate
Dacthal (chlorthal-dimethyl)	Flutriafol	Phorate sulfone	Vinclozolin
delta-HCH (delta-lindane)	Fluvalinate	Phosalone	Zinophos
Deltamethrin	Folpet	Phosmet	Zoxamide
delta-trans-allethrin	Fonofos	Phosphamidon	
Demeton-O	Forchlorfenuron	Picolinafen	
Demeton-S	Formetanate	Picoxystrobin	

Appendix B

Pesticide testing results in grain products and RTE meals from various jurisdictions

Product type	Jurisdiction	Survey year	Number of samples	Number (percentage) of samples with detected pesticide residue(s)	Number (percentage) of non-compliant samples
Corn products	Canada	2016 to 2017	575	31 (5%)	10 (1.7%)
Corn products	USA	2016	919	298 (32%)	3 (0.3%)
Corn products	USA	2015	31	7 (22%)	0 (0%)
Corn products	EU	2015	33	0 (0%)	0 (0%)
Oat products	Canada	2016 to 2017	348	1 (0.3%)	0 (0%)
Oat products	USA	2016	40	18 (45%)	0 (0%)
Oat products	USA	2015	3	3 (100%)	0 (0%)
Oat products	EU	2015	22	2 (9%)	0 (0%)
Oat products	Australia	2013 to 2014	4	1 (25%)	0 (0%)
Grain products (Other)	Canada	2016 to 2017	650	33 (5%)	1 (0.1%)
Grain products (Other)	USA	2016	103	44 (43%)	5 (5%)
Grain products (Other)	USA	2015	68	42 (62%)	5 (7%)
Grain products (Other)	EU	2016	769	250(33%)	11 (1%)
Grain products (Other)	EU	2015	1	0 (0%)	1 (100%)
RTE meals	Canada	2016 to 2017	2000	1062 (53%)	2 (0.1%)
RTE meals	EU	2015	260	0 (0%)	0 (0%)
RTE meals	Australia	2013 to 2014	12	7 (58%)	0 (0%)
Wheat products	Canada	2016 to 2017	425	62 (15%)	4 (0.9%)
Wheat products	USA	2016	137	65 (47%)	5 (3.6%)
Wheat products	USA	2015	46	20 (44%)	4 (8.7%)
Wheat products	EU	2016	813	105 (13%)	0 (0%)
Wheat products	EU	2015	1197	631(53%)	2 (0.2%)
Wheat products	UK	2015	66	63 (95%)	15 (16%)

Appendix C

Arsenic testing results in grain products and RTE meals from various jurisdictions

Product type	Jurisdiction	Survey year	No. of samples	No. (%) of samples with detected arsenic	Min. (ppm or mg/kg)	Max. (ppm or mg/kg)	Ave. (ppm or mg/kg)
Corn products	Canada	2016 to 2017	575	42 (7%)	0.020	0.077	0.0025
Corn products	USA	2006 to 2013	64	1 (1.6%)	0	0.014	0.0004
Corn products	EU	2009	2215	509 (23%)	<LOD	5.662	0.0147
Oat products	Canada	2016 to 2017	348	84 (24%)	0.020	0.101	0.0081
Oat products	EU	2009	2215	509 (23%)	<LOD	5.662	0.0147
Oat products	USA	2006 to 2013	32	2 (6.2%)	0	0.01	0.001
Oat products	Australia	2013 to 2014	4	0 (0%)	N/A	N/A	N/A
Grain products (Other)	Canada	2016 to 2017	650	77 (12%)	0.021	0.313	0.0059
Grain products (Other)	EU	2009	2215	509 (23%)	<LOD	5.662	0.0147
RTE meals	Canada	2016 to 2017	2000	1087 (54%)	0.0050	0.808	0.0067
RTE meals	USA	2006 to 2013	192	45 (23%)	0	0.031	0.10
RTE meals	EU	2009	400	213 (46%)	<LOD	0.039	0.012
RTE meals	Australia	2013 to 2014	16	6 (38%)	<LOR	0.014	0.008
Wheat products	Canada	2016 to 2017	425	103 (24%)	0.020	0.66	0.176
Wheat products	USA	2006 to 2013	32	1 (3.1%)	0	0.01	0.0003
Wheat products	EU	2009	2215	509 (23%)	<LOD	5.662	0.0147

Appendix D

Cadmium testing results in grain products and RTE meals from various jurisdictions

Product type	Jurisdiction	Survey year	No. of samples	No. (%) of samples with detected cadmium	Min. (ppm or mg/kg)	Max. (ppm or mg/kg)	Ave. (ppm or mg/kg)
Corn products	Canada	2016 to 2017	575	38 (7%)	0.010	0.036	0.0010
Corn products	USA	2006 to 2013	64	18 (28%)	0	0.010	0.002
Corn products	EU	2009	4216	3541 (84%)	<LOD	0.1300	0.0100
Oat products	Canada	2016 to 2017	348	268 (77%)	0.010	0.077	0.015
Oat products	EU	2009	4216	3541 (84%)	<LOD	0.1300	0.0100
Oat products	USA	2006 to 2013	32	27 (84%)	0	0.004	0.002
Oat products	Australia	2013 to 2014	4	0 (0%)	N/A	N/A	N/A
Grain products (other)	Canada	2016 to 2017	650	570 (88%)	0.010	0.188	0.033
Grain products (other)	EU	2009	2215	509 (23%)	<LOD	5.662	0.0147
RTE meals	Canada	2016 to 2017	2000	1916 (96%)	0.0060	0.337	0.0095
RTE meals	USA	2006 to 2013	192	182 (95%)	0	0.036	0.011
RTE meals	EU	2009	1826	1182 (65%)	<LOD	0.19	0.007
RTE meals	Australia	2013 to 2014	16	9 (56%)	<LOR	0.010	0.007
Wheat products	Canada	2016 to 2017	425	415 (98%)	0.010	0.319	0.054
Wheat products	USA	2006 to 2013	32	1 (3.1%)	0	0.01	0.0003
Wheat products	EU	2009	4591	4069 (87%)	<LOD	0.2200	0.0292

Appendix E

Lead testing results in grain products and RTE meals from various jurisdictions

Product type	Jurisdiction	Survey year	No. of samples	No. (%) of samples with detected lead	Min. (ppm or mg/kg)	Max. (ppm or mg/kg)	Ave. (ppm or mg/kg)
Corn products	Canada	2016 to 2017	575	11 (2%)	0.016	0.039	0.0005
Corn products	USA	2006 to 2013	64	0 (0%)	N/A	N/A	N/A
Corn products	EU	2010	2326	1072 (46%)	<LOD	7.12	0.0360
Oat products	Canada	2016 to 2017	348	8 (2.3%)	0.015	0.251	0.0016
Oat products	EU	2010	2326	1072 (46%)	<LOD	7.12	0.0360
Oat products	USA	2006 to 2013	32	0 (0%)	N/A	N/A	N/A
Oat products	Australia	2013 to 2014	4	0 (0%)	N/A	N/A	N/A
Grain products (other)	Canada	2016 to 2017	650	50 (8%)	0.015	0.047	0.0020
Grain products (other)	EU	2010	2326	1072 (46%)	<LOD	7.12	0.0360
RTE meals	Canada	2016 to 2017	2000	1846 (92%)	0.0010	0.082	0.0042
RTE meals	USA	2006 to 2013	192	11 (6%)	0	0.020	0.00087
RTE meals	EU	2010	175	52 (30%)	<LOD	0.064	0.010
RTE meals	Australia	2013 to 2014	16	1 (6%)	<LOR	0.005	0.005
Wheat products	Canada	2016 to 2017	425	30 (7%)	0.015	0.54	0.0038
Wheat products	USA	2006 to 2013	32	0 (0%)	N/A	N/A	N/A
Wheat products	EU	2010	292	105 (36%)	<LOD	0.8004	0.0263

Appendix F

Mercury testing results in grain products and RTE meals from various jurisdictions

Product type	Jurisdiction	Survey year	No. of samples	No. (%) of samples with detected mercury	Min. (ppm or mg/kg)	Max. (ppm or mg/kg)	Ave. (ppm or mg/kg)
Corn products	Canada	2016 to 2017	575	189 (33%)	0.00010	0.0021	0.00006
Corn products	USA	2006 to 2013	32	0 (0%)	N/A	N/A	N/A
Corn products	EU	2012	671	235 (35%)	<LOD	0.02	0.0016
Oat products	Canada	2016 to 2017	348	160 (46%)	0.00010	0.0006	0.00008
Oat products	EU	2012	671	235 (35%)	<LOD	0.02	0.0016
Oat products	USA	2006 to 2013	16	1 (6%)	0	0.002	0.0001
Oat products	Australia	2013 to 2014	4	0 (0%)	N/A	N/A	N/A
Grain products (other)	Canada	2016 to 2017	650	358 (55%)	0.00010	0.0016	0.00012
Grain products (other)	EU	2012	671	235 (35%)	<LOD	0.02	0.0016
RTE meals	Canada	2016 to 2017	2000	764 (38%)	0.00010	0.024	0.00014
RTE meals	USA	2006 to 2013	96	13 (14%)	0	0.067	0.016
RTE meals	EU	2012	95	49 (52%)	<LOD	0.068	0.011
RTE meals	Australia	2013 to 2014	16	0 (0%)	N/A	N/A	N/A
Wheat products	Canada	2016 to 2017	425	157 (37%)	0.00010	0.0006	0.0006
Wheat products	USA	2006 to 2013	16	0 (0%)	N/A	N/A	N/A
Wheat products	EU	2012	671	235 (35%)	<LOD	0.02	0.0016