Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Pesticides and Metals in Selected Foods - April 1, 2018 to March 31, 2019

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, nut/seed 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 (e.g., 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, nut/seed and vegetable-based foods available on the Canadian market and to compare the detection rates of pesticides in this targeted survey to those recorded in previous surveys.

A total of 3348 samples of grain, nut/seed and vegetable-based products were collected and tested for pesticides and metals. Residues of 5 different pesticides were detected in 1327 (40%) of the samples. The overall compliance rate for pesticides in products tested was 99.3%. Most of the non-compliant results (20 of 22) were associated with pesticide residues exceeding the general MRL of 0.1 ppm (mg/kg), while 2 non-compliant results contained pesticide residues in violation of a specific established MRL for flaxseed. Health Canada (HC) determined that 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.

Of the 3348 samples collected, 3153 were analysed for a suite of 20 metals. Only the data for metals of highest concern to human health at low levels of exposure are presented in this report, most notably: arsenic, cadmium, lead, and mercury. Lead and cadmium had the lowest and the highest overall detection rate, respectively. Potato products and ready-to-eat (RTE) meals were associated with the lowest detection rate and the lowest observed levels of the metals, while botanical powders were often found to contain the highest detected levels of these metals. 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.

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 Canada[3]. Inappropriate use of pesticides may pose a health risk to consumers, with the risk dependant on the type of pesticide, its concentration, the effects on 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, nut/seed 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, during transport and/or during storage to prevent damage from insects, moulds or other pests. 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 detection rate of pesticides in foods with previous targeted surveys.

What did we sample

A variety of domestic and imported grain, nut/seed and vegetable-based foods available on the Canadian market were sampled between April 1, 2018 and March 21, 2019. 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
Botanical powders	29	135	32	196
Grain products	250	494	241	985
Nut/seed products	215	178	102	495
Potato products	189	387	303	879
RTE meals	282	385	126	793
Grand total	**965**	**1579**	**804**	**3348**

[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 multi-residue pesticide method. Glyphosate and its metabolite AMPA were also tested for in this survey using separate methodology. Samples were also subjected to a multi-metal 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. 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 database[3]. 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 3348 samples of domestic and imported grain, nut/seed and vegetable-based foods were tested for over 480 pesticides in this targeted survey. Pesticide residues were not detected in 2021 (60%) samples. In the remaining 1327 samples, residues of up to 5 different pesticides were detected in a single sample. A summary of the pesticide results by each product type can be seen in Table 2.

When evaluated by commodity, the percentage of samples with pesticide residues detected ranged from 26% in potato products to 55% in grain products. Glyphosate was the most frequently detected pesticide in most product types. In potato products, diquat had the highest detection rate. The overall compliance rate for pesticides in the products tested was 99.3%. Compliance was assessed against the MRLs which were in place when the survey was carried out. There were 22 non-compliant results associated with 2 grain products, 12 botanical powders and 8 seed products. All of the non-compliant samples contained a single non-compliant pesticide residue and in most cases the non-compliance was associated with pesticide residues exceeding the general MRL of 0.1 ppm. Only 2 non-compliant results contained pesticide residues in violation of a specific established MRL for flaxseed. The average amount of residue detected in the non-compliant samples exceeding the general MRL was 0.22 ppm.

HC determined the levels of pesticides in observed in the current survey were 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.

Table 2. Results of pesticide testing in selected foods

Product type	Number of samples	Number (percentage) of samples with detected pesticide residue(s)	Number (percentage) of non-compliant samples
Botanical powders	196	68 (34%)	12 (6%)
Grain products	985	546 (55%)	2 (0.2%)
Nut/seed products	495	193 (39%)	8 (1.6%)
Potato products	879	225 (26%)	0 (0)
RTE meals	793	295 (37%)	0 (0)
Grand total	**3348**	**1327 (40%)**	**22 (0.7%)**

Metals

Of the 3348 samples collected, 3153 were tested to see the levels of trace elements present. 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 (77%) contained one or more of these four metals, while only 11% of the samples contained traces of more than 2 metals.

Table 3. Detected levels of metals in selected foods

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)
Botanical Powders	187	68	0.180 (<LOD-5.03)	85	0.204 (<LOD-1.19)	73	0.330 (<LOD-3.42)	53	0.0020 (<LOD-0.031)
Potato products	817	2	0.046 (<LOD-0.090)	87	0.076 (<LOD-0.353)	0	0.023 (<LOD-0.035)	7	0.0008 (<LOD-0.006)
RTE meals	740	6	0.094(<LOD-0.507)	33	0.015 (<LOD-0.075)	2	0.034 (<LOD-0.134)	8	0.0012 (<LOD-0.016)
Grain products	939	29	0.172 (<LOD-1.09)	73	0.034 (<LOD-0.174)	9	0.046 (<LOD-0.308)	28	0.0016 (<LOD-0.010)
Nut/seed products	470	19	0.069 (<LOD-0.387)	72	0.089 (<LOD-1.06)	9	0.030 (<LOD-0.15)	17	0.0009 (<LOD-0.005)
Grand total	**3153**	**17**	**0.148 (<LOD-5.03)**	**68**	**0.070 (<LOD-1.19)**	**9**	**0.180 (<LOD-3.42)**	**18**	**0.0015 (<LOD-0.031)**

<LOD = Below the limit of detection (0.0005 - 0.02 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. Lead and cadmium had the lowest and the highest overall detection rate, respectively. Potato products and RTE meals were associated with the lowest detection rate and the lowest observed levels of the metals, while botanical powders were often found to contain the highest detected levels of these metals. Not unexpectedly, the highest levels of arsenic were found in rice products[4]. High cadmium levels were frequently associated with products containing commodities that are known to accumulate relatively high concentrations of cadmium from soil[5], specifically potatoes, flaxseed and sunflower seeds. 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)[6,7,8,9,10,11]. A slight increase in the detection and non-compliance rates for products since the 2015 to 2016 survey can be attributed to an increase in the method sensitivity and a larger number of analytes being tested for. Some differences observed may also be due to the sample size and the specific type of product tested.

Table 4 includes pesticide results in raw potatoes observed in 2010 to 2011, as limited data was available on pesticide levels in potato products. The rate of detection in raw potatoes was much higher than that in potato products observed in this survey. This was expected; it has been documented that the residue levels of chlopropham are significantly lower in potato products compared to the raw commodity[12]. This pesticide was found in 38% of raw potatoes tested in 2010 to 2011 survey but it was not detected in processed potato products tested in this survey. Other pesticide residues were also less frequently detected in the processed products.

Table 4. Pesticide testing results in grain, nut/seed and vegetable-based products from various survey years

Product type	CFIA survey year	Number of samples	Number (percentage) of samples with detected pesticide residue(s)[b]	Number (percentage) of non-compliant samples
Grain products (Barley)	2018 to 2019	195	105 (54%)	0
Grain products (Barley)	2015 to 2016	68	54 (79%)[c]	0
Grain products (Barley)	2013 to 2014	15	1 (0.7%)	0
Grain products (Bran)	2018 to 2019	62	36 (58%)	0
Grain products (Bran)	2017 to 2018	170	111 (65%)	5 (3%)
Grain products (Crackers)	2018 to 2019	199	168 (84%)	0
Grain products (Crackers)	2017 to 2018	75	63 (84%)	0
Grain products (Pasta)	2018 to 2019	300	205 (68%)	0
Grain products (Pasta)	2017 to 2018	245	196 (80%)	0
Grain products (Rice products)	2018 to 2019	229	32 (14%)	2 (0.9%)
Grain products (Rice products)	2017 to 2018	449	77 (17%)	9 (2%)
Grain products (Rice products)	2015 to 2016	108	19 (18%)[c]	0
Grain products (Rice products)	2014 to 2015	23	3 (13%)	0

Grain products (Rice products)	2013 to 2014	50	12 (24%)	0
Grain products (Rice products)	2012 to 2013	93	8 (9%)	0
Grain products (Rice products)	2011 to 2012	84	10 (12%)	0
Nut/seed products	2018 to 2019	495	193 (39%)	8 (1.6%)
Seed products	2014 to 2015	33	5 (15%)	0
Seed products	2013 to 2014	26	3 (12%)	0
Potato products	2018 to 2019	879	225 (26%)	0
Potatoes	2010 to 2011	259	237 (92%)	2 (0.8%)
RTE meals	2018 to 2019	793	295 (37%)	0
RTE meals	2016 to 2017	2000	1062 (53%)	2 (0.1%)
RTE meals	2014 to 2015	46	18 (39%)	0

[b] In 2015 new improved detection method was implemented

[c] The reported value includes glyphosate results, not included in the published report

In this survey, the reported average levels of metals for RTE meals and grain products are higher and the detection rates are lower compared to those previously found in similar product types[6,7,8]. This is mostly due to differences in the limits of detection (LODs). If the LODs are considered when the values are compared, the results are in close agreement.

References

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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	Haloxyfop	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	Diethatyl-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	Isoprocarb	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	Pyrifenox
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	Ethalfluralin	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
Chlorantraniliprole	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 (Ronnel)	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	Oxychlordane	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	