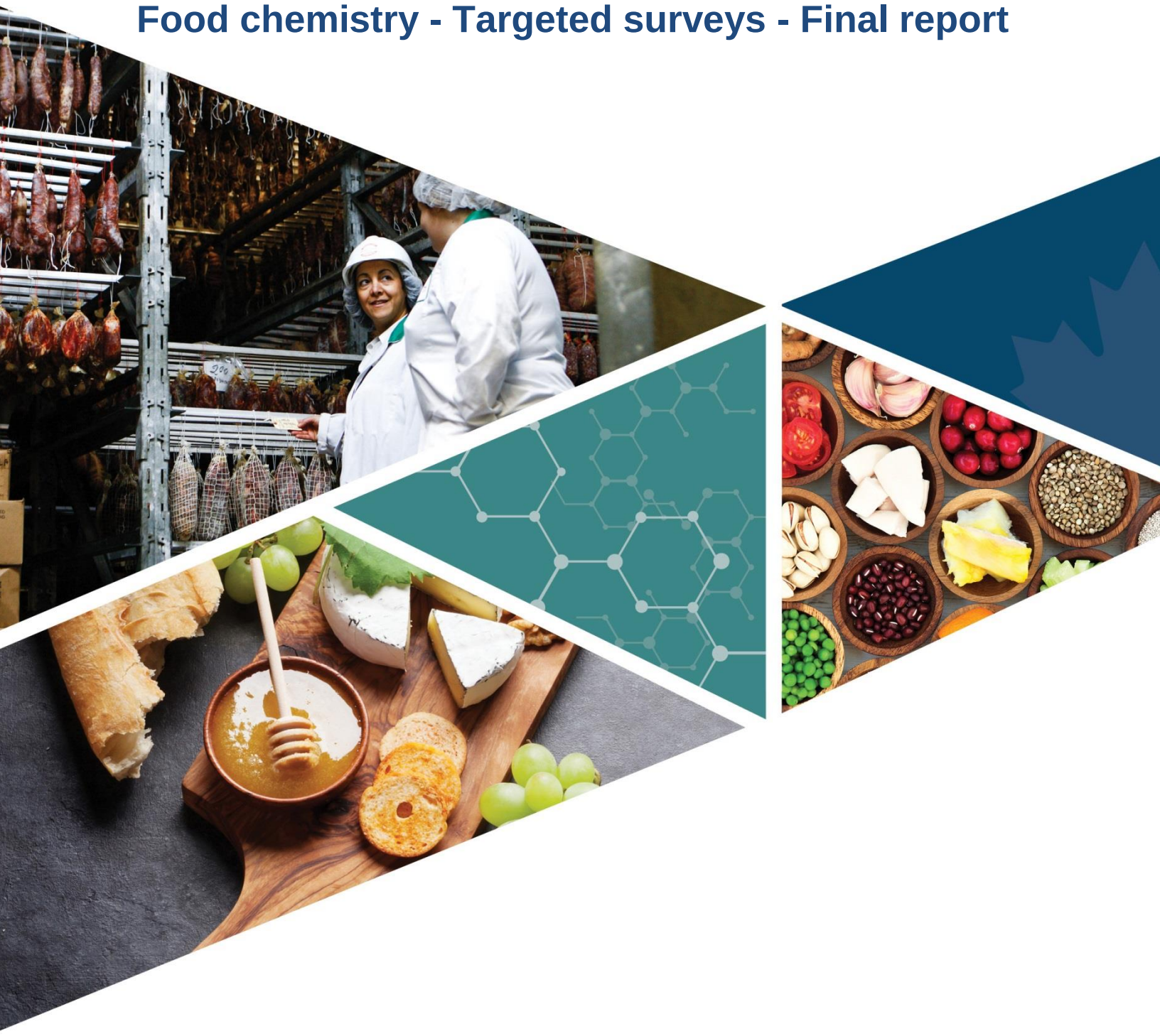
Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Pesticides and Metals in Legume Products and Vegetable Oils - April 1, 2019 to March 31, 2020

Food chemistry - Targeted surveys - Final report



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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.

Legumes and vegetable-based products are staple foods consumed by all age groups 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 legume 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 2849 samples of legume products and vegetable oils were collected and tested for pesticides and metals. Pesticide residues were detected in 1446 (51%) of the samples.The overall compliance rate for pesticides in products tested in this survey assessed against maximum residue limits (MRLs) established by Pest Management Regulatory Agency (PMRA) of Health Canada was 97.1%[3]. There were 83 non-compliant results associated with 73 samples. In 31 samples the non-compliance was associated with pesticide residues exceeding the general MRL of 0.1 parts per million (ppm), 52 samples had pesticide levels above the specific established MRLs (0.1 to 5 ppm).

All of the survey samples collected 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. Oils and shortening were associated with the lowest detection rate, while legume chips and crackers were most often found to contain detected levels of these metals.

There are no maximum limits (MLs) set in Canada for metal levels in the products tested. All data generated were forwarded to Health Canada for human risk assessment and determined to pose no concern to human health. All non-compliant results obtained during the course of these

surveys were forwarded to the CFIA's Office of Food Safety and Recall (OFSR). The extent of the follow up actions taken by the agency was based on the level of the contamination and the resulting health concern as determined by a health risk assessment.

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 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.

Legume 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 legume (bean, chickpea, lentil and pea) products, legume chips and vegetable oils/shortening available on the Canadian market were sampled between April 1, 2019 and March 21, 2020. 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)
- 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
Legumes - Bean products	272	144	131	547
Legumes - Chickpea products	237	88	125	450
Legumes - Lentil products	196	38	105	339
Legumes - Pea products	179	68	87	334
Legume chips and crackers	4	134	48	186
Oils and shortening	68	565	360	993
Total	**956**	**1037**	**856**	**2849**

[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 Aminomethylphosphonic Acid (AMPA) were also tested for in this survey using separate methodology, oil and shortening samples were excluded from this analysis. Samples were also subjected to a multi-metal method that analyzes for 20 metals. 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.

Results were assessed according to Canadian pesticide MRLs, established by the PMRA of Health Canada and appear in their MRL database[3]. Pesticide MRLs were applied 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 Health Canada. 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 2849 samples of domestic and imported legume products and vegetable oils were tested for over 480 pesticides in this targeted survey. Pesticide residues were not detected in 1403 (49%) samples. Of the samples with detectable pesticide residues, 99% contained from 1 to 3 pesticide residues per sample. The maximum of 12 pesticide residues per sample occurred in one sample of chickpea flour. A summary of the results by product type can be seen in Table 2.

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
Legumes - Bean products	547	270 (49%)	6 (1.1%)
Legumes - Chickpea products	450	337 (75%)	24 (5%)
Legumes - Lentil products	339	263 (78%)	15 (4%)
Legumes - Pea products	334	206 (62%)	13 (4%)
Legume chips and crackers	186	151 (81%)	4 (2%)

Oils and shortening[b]	993	219 (22%)	11 (1.1%)
Total	**2849**	**1446 (51%)**	**73 (2.9%)**

[b] The reported values exclude glyphosate results

When evaluated by commodity, the percentage of samples with pesticide residues detected ranged from 81% in legume chips and crackers to 22% in oils and shortening. Glyphosate was the most frequently detected pesticide in most product types. In oils and shortening (not tested for glyphosate), piperonyl butoxide and chlorpyrifos had the highest detection rates. The overall compliance rate for pesticides in the products tested was 97.1%. Compliance was assessed against the MRLs which were in place when the survey was carried out. There were 83 non-compliant results associated with 73 samples. In 31 samples the non-compliance was associated with pesticide residues exceeding the general MRL of 0.1 ppm, 52 samples had pesticide levels above the specific established MRLs (0.1 to 5 ppm). The average amount of residue detected in the non-compliant samples exceeding the general MRL was 0.69 ppm.

Of the 2849 products tested, 2450 samples were conventionally grown and 399 products were labelled as “organic”. The detection rates were 54% and 29% respectively, for conventionally grown and organic products. Detailed comparison of pesticide residues detection rates in organic and in conventional products can be seen in Table 3. The average amount of pesticide residues detected in the conventional and organic samples were 0.93 ppm and 0.23 ppm, respectively. Of the 73 non-compliant samples, 13 were organic samples.

Table 3. Results of pesticide testing in organic and conventional samples

Product type	Number of organic samples	Number (percentage) of organic samples with detected pesticide residue(s)	Number of conventional samples	Number (percentage) of conventional samples with detected pesticide residue(s)
Legumes - Bean products	106	14 (13%)	441	256 (58%)
Legumes - Chickpea products	75	38 (51%)	375	299 (80%)
Legumes - Lentil products	37	15 (41%)	302	248 (82%)
Legumes - Pea products	25	11 (44%)	309	195 (63%)
Legume chips and crackers	10	5 (50%)	176	146 (83%)
Oils and shortening[c]	146	32 (22%)	847	187 (22%)
Total	**399**	**115 (29%)**	**2450**	**1331 (54%)**

[c] The reported values exclude glyphosate results

Note: Identification of samples as organic is based solely on the info on the product label

All non-compliant results obtained during the course of these surveys were forwarded to the CFIA's Office of Food Safety and Recall (OFSR). The CFIA conducted appropriate follow up

activities to improve compliance which included further testing of similar products in subsequent years.

Metals

All of the 2849 samples collected 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 (Table 4). Only 26% of the survey samples contained one or more of these four metals, while 6% of the samples contained traces of 2 or 3 metals, and none contained all 4 metals.

Table 4. Detected levels of metals in selected foods

Product type	Number of samples	% positive for arsenic	Average level (range) of arsenic (ppm)	% positive for cadmium	Average level (range) of cadmium (ppm)	% positive for lead	Average level (range) of lead (ppm)	% positive for mercury	Average level (range) of mercury (ppm)
Legumes - Bean products	547	3	0.041 (<LOD-0.110)	5	0.026 (<LOD-0.102)	3	0.033 (<LOD-0.075)	6	0.0006 (<LOD-0.0011)
Legumes - Chickpea products	450	15	0.041 (<LOD-0.128)	15	0.016 (<LOD-0.027)	5	0.033 (<LOD-0.137)	6	0.0006 (<LOD-0.0009)
Legumes - Lentil products	339	2	0.029 (<LOD-0.046)	0.3	0.014 (<LOD-0.014)	7	0.027 (<LOD-0.096)	4	0.0006 (<LOD-0.0008)
Legumes - Pea products	334	7	0.033 (<LOD-0.056)	46	0.020 (<LOD-0.070)	2	0.030 (<LOD-0.065)	4	0.0007 (<LOD-0.0019)
Legume chips and crackers	186	37	0.060 (<LOD-0.172)	23	0.022 (<LOD-0.048)	3	0.021 (<LOD-0.030)	14	0.0007 (<LOD-0.0011)
Oils and shortening	993	5	0.038 (<LOD-0.109)	0	N/A	1	0.138 (<LOD-1.38)	1	0.0006 (<LOD-0.0007)
Total	**2849**	**8**	**0.045 (<LOD-0.172)**	**10**	**0.020 (<LOD-0.102)**	**3**	**0.046 (<LOD-1.38)**	**5**	**0.0006 (<LOD-0.0019)**

<LOD = Below the limit of detection (0.0001 - 0.02 ppm, depending on the laboratory and the analyte)
Note: Average values were calculated using only results for samples with quantifiable metal levels
N/A: not detected

Table 4 illustrates the level of these metals found in the products tested. Lead and cadmium had the lowest and the highest overall detection rate, respectively. Oils and shortening were associated with the lowest detection rate, while legume chips and crackers were most often found to contain detected levels of these metals. As expected, the highest levels of arsenic were found in rice containing products, since rice is known to accumulate arsenic[4]. Although, slightly higher maximum levels of metals were found in certain product types, the average levels of metals were similar for all product categories. These average levels were within concentrations of these metals typically found in soil[5]. There are no regulations in Canada for the levels of these metals in the products tested. Health Canada determined that none of the products posed a health risk to consumers.

What do the survey results mean

Table 5 presents a comparison of the pesticide results for the current and previous targeted surveys for pesticide residues in legume products and oils/products with high fat content[6,7,8,9]. Although the reported detection rates and non-compliance rates are higher for this survey year, the differences can be attributed to an increase in the method sensitivity and to a larger number

of analytes being tested for. The list on analytes was expanded from 144 or 298 (in previous years) to 485 in 2015 and in current fiscal year. In addition, glyphosate, the most frequently detected pesticide in this survey, was not tested for in previous survey years. Consistent with its extensive usage worldwide and in Canada, glyphosate accounted for 43% to 90% of positive results in various product types included in this survey[10]. When all these differences are considered, the results of this survey are in close agreement with those of previous survey years. Some of the differences observed may also be due to differences in the sample size and the specific type of product tested.

In this survey, highest individual pesticide residue levels were observed for glyphosate in various legume products followed by piperonyl butoxide. Elevated levels of individual pesticide residue levels were also observed in various brands of flaxseed and grapeseed oils. Although these pesticides are permitted on the raw commodity (flaxseeds and grapes) in some cases the detected levels exceeded the MRL due to possible concentration during the processing steps or excessive pesticide application in the field or in storage. The overall pesticide detection rate was still low for this commodity, and lower than the detection rate in oil-based products such as oil-based salad dressings and condiments (mayonnaise) tested in previous survey years.

Table 5. Pesticide testing results in legume products and vegetable oils from various survey years

Product type	CFIA survey year	Number of samples	Number (percentage) of samples with detected pesticide residue(s)[d]	Number (percentage) of non-compliant samples
Legumes[e]	2015	729	89 (12%)	3 (0.4%)
Legumes - Bean products	2019	547	270 (49%)	6 (1.1%)
Legumes - Bean products[e]	2014	38	6 (15.8 %)	0 (0)
Legumes - Bean products[e]	2013	46	5 (10.9%)	0 (0)
Legumes - Bean products[e]	2012	71	8 (11.3%)	1 (1.4%)
Legumes - Chickpea products	2019	450	337 (75%)	24 (5%)
Legumes - Chickpea products[e]	2014	51	17 (33.3%)	0 (0)
Legumes - Chickpea products[e]	2013	53	5 (10.9%)	0 (0)
Legumes - Chickpea products[e]	2012	79	3 (3.8%)	0 (0)
Legumes - Lentil products	2019	339	263 (78%)	15 (4%)
Legumes - Lentil products[e]	2014	36	7 (19.4%)	0 (0)
Legumes - Lentil products[e]	2013	45	2 (4.4%)	0 (0)

Legumes - Lentil products[e]	2012	71	5 (7.0%)	2 (2.8%)
Legumes - Pea products	2019	334	206 (62%)	13 (4%)
Legumes - Pea products[e]	2014	34	4 (11.8%)	0 (0)
Legumes - Pea products[e]	2013	27	2 (7.4%)	0 (0)
Legumes - Pea products[e]	2012	67	13 (19.4%)	0 (0)
Legume chips and crackers	2019	186	151 (81%)	4 (2%)
Legume chips and crackers[e]	2014	12	1 (8%)	0 (0)
Oils and shortening[e]	2019	993	219 (22%)	11 (1.1%)
Condiments/salad dressings[f,e]	2014	14	4 (29%)	0 (0)
Condiments/salad dressings[f,e]	2013	18	5 (28%)	1 (5.5%)

[d] In 2015 list on analytes was greatly expanded (to 485 from 144 or 298 in previous years)
[e] The reported values exclude glyphosate results
[f] Products with large fat content such as mayonnaise

References

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2. Household final consumption expenditure, quarterly, Canada. (2018). Canada. Statistics Canada.
3. Consumer Product Safety. Maximum Residue Limits for Pesticides. (2012). Canada. Health Canada.
4. Dabeka, R.W., McKenzie, A.D., Lacroix, G.M.A., Cleroux, C., Bowe, S., Graham, R.A., Conacher, B.S., Verdier P. Survey of arsenic in total diet food composites and estimation of the dietary intake of arsenic by Canadian adults and children. (1993). J. AOAC International, 76, pp. 14-25.
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6. 2015-2016 Pesticides and Metals in Grains and Pulses. Canada. Canadian Food Inspection Agency. [unpublished results]
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9. 2012-2013 Pesticides and Metals in Grain-based and Pulse-based Products. Canada. Canadian Food Inspection Agency. [unpublished results]
10. Glyphosate in Canada. 2020. Canada. Health Canada.

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	