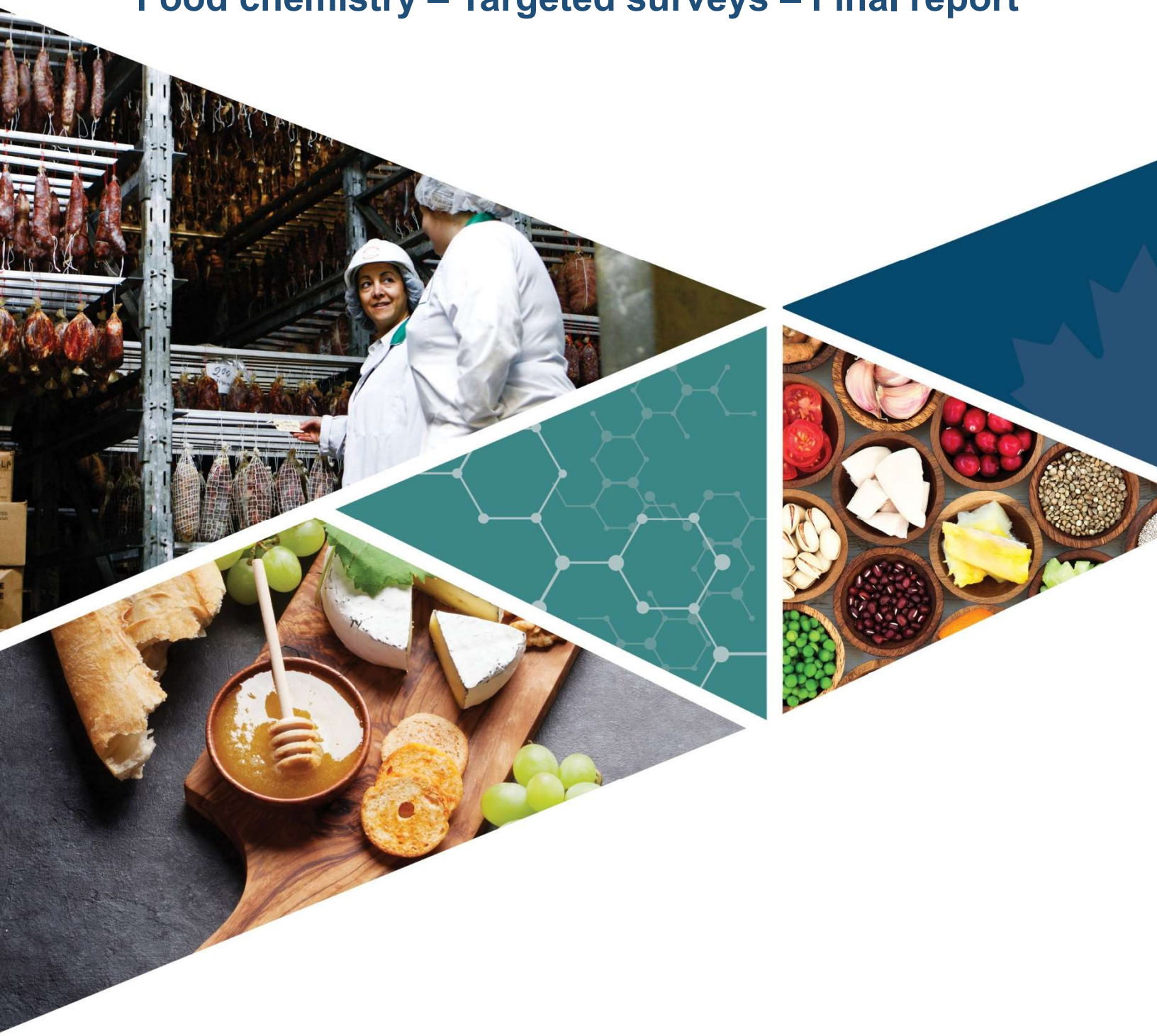
Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Toxic metals in selected foods – April 1, 2022 to March 31, 2023

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.

Chemical hazards in foods can come from a variety of sources. Metals are naturally-occurring elements that may be present in very low amounts in rock, water, soil, or air. 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. Metals of highest concern to human health include arsenic, cadmium, lead, and mercury and these have been shown to have effects on human health following long term exposure[1].

The main objectives of this targeted survey were to generate additional baseline surveillance data on the level of metals in foods not routinely monitored under other CFIA programs, and to compare, the detection rate of metals in foods in this survey with that of previous targeted surveys.

A total of 470 samples of duck eggs, juices and nectars, mushrooms, spices, sugar and syrups, sweets and vinegars were taken from retail locations in 11 cities across Canada and tested for metals/elements. Only the results of the metals of highest concern (arsenic, cadmium, lead, and mercury) are presented in this report. Mercury and lead had the lowest and the highest detection rate, respectively. Most (58%) of the survey samples did not contain any of the toxic metals, while 22% of the samples contained traces of all 4 toxic metals. The highest levels of these metals were found in dried mushrooms. While all of mushroom and spice samples contained traces of at least 1 toxic metal, only 1 egg sample and 3 juice samples contained any toxic metals. At least 1 of the toxic metals was detected in 47% of the remaining product types (sugar and syrups, sweets and vinegar). The detection rates and the levels of metals reported in this targeted survey were comparable to those previously found in similar product types.

The levels of arsenic detected in all beverage samples met the existing tolerances of 0.1 parts per million (ppm). Lead was not detected in any juice and nectar samples. Hence, the overall compliance rate was 100%. There are no regulations in Canada for metal levels in the other

products tested. Health Canada determined that none of the samples analyzed for metals in this survey posed a concern to human health.

What targeted surveys are

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 the survey was conducted

Chemical hazards in foods can come from a variety of sources. Metals are naturally-occurring elements that may be present in very low amounts in rock, water, soil, or air. 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.

Metals of highest concern to human health include arsenic, cadmium, lead, and mercury and these have been shown to have effects on human health following long term exposure. The human health effects depend on the metal, its concentration in the food, and other possible exposure effects/sources[1]. Manufacturers are responsible for measures aimed at reducing accidental introduction of these elements in foods.

The main objectives of this targeted survey were to generate additional baseline surveillance data on the level of metal levels in foods not routinely monitored under other CFIA programs, and to compare the detection rate of metals in foods in this survey with that of previous targeted

surveys. Only the results of the metals of highest concern (arsenic, cadmium, lead, and mercury) are presented in this report.

What we sampled

A variety of domestic and imported fresh duck eggs, juices and nectars (mostly marketed to infants and/or young children), dried mushrooms, spices (whole and ground), sugar and syrups (molasses), sweets (hard and soft candy, fruit rolls, etc.) and vinegars (apple cider/cider, balsamic, rice, white/red wine, etc.) were sampled between April 1, 2022 and March 31, 2023. Samples of products were collected from local/regional retail locations located in 11 major cities across Canada. These cities encompassed 4 Canadian geographical areas:

- Atlantic (Halifax and Moncton)
- Quebec (Montreal and Quebec City)
- Ontario (Toronto and Ottawa)
- West (Calgary, Saskatoon, Vancouver, Victoria and Winnipeg)

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 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
Duck eggs	3	0	13	16
Juices and nectars	37	8	40	85
Mushrooms	1	54	14	69
Spices	5	88	22	115
Sugar and syrups	15	39	13	67
Sweets	18	44	16	78
Vinegar	4	22	14	40
Total	**83**	**255**	**132**	**470**

Table notes

[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 samples were analyzed and assessed

Samples were analyzed by an ISO/IEC 17025 accredited food testing laboratory under contract with the Government of Canada. The results are based on the food products as sold and not necessarily as they would be consumed, whether the product sampled is considered an ingredient or requires preparation prior to consumption (for example, mixing with liquid or other ingredients).

Contaminants and other adulterating substances in foods have regulatory maximum levels. In 2014, Health Canada updated regulatory tolerances for arsenic and lead in a variety of ready-to-serve beverages, and infant formula when ready-to-serve[2]. In the absence of a specific maximum level, the levels of arsenic, cadmium, mercury and lead may be assessed by Health Canada on a case-by-case basis using the most current scientific data available.

Results of the survey

A total of 470 samples of duck eggs, juices and nectars, mushrooms, spices, sugar and syrups, sweets and vinegars were analysed for arsenic, cadmium, lead and mercury. Most (58%) of the survey samples contained 1 or more toxic metal, while 22% of the samples contained traces of all 4 toxic metals. While all of the mushroom and spice samples contained traces of at least 1 toxic metal, only 1 of 37 egg samples and 3 of 37 juice samples contained any toxic metals. At least 1 of the toxic metals was detected in 47% of the remaining product types (sugar and syrups, sweets and vinegar).

Table 2. Detected levels of metals

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)
Duck eggs	16	0	ND	0	ND	0	ND	6	0.0005 (<LOD-0.0005)
Juices and nectars	85	4	0.007 (<LOD-0.007)	0	ND	0	ND	0	ND
Mushrooms	69	99	0.384 (<LOD-1.31)	97	0.588 (<LOD-1.71)	100	0.157 (<LOD-1.92)	96	0.216 (<LOD-3.38)
Spices	115	95	0.070 (<LOD-0.642)	92	0.066 (<LOD-0.390)	97	0.189 (<LOD-1.51)	37	0.010 (<LOD-0.049)
Sugar and syrups	67	28	0.038 (<LOD-0.127)	0	ND	24	0.029 (<LOD-0.128)	3	0.007 (<LOD-0.009)
Sweets	78	19	0.014 (<LOD-0.047)	3	0.009 (<LOD-0.010)	40	0.012 (<LOD-0.056)	5	0.007 (<LOD-0.008)
Vinegar	40	40	0.018 (<LOD-0.106)	3	0.025 (<LOD-0.025)	58	0.026 (<LOD-0.179)	0	ND

Table notes

<LOD = Below the limit of detection (0.0001 - 0.01 ppm, depending on the analyte).
Note: Average values were calculated using only results for samples with quantifiable metal levels.
ND: not detected above LOD.

Arsenic

Arsenic was detected in 49% of samples tested in this targeted survey. Mushroom and spices had the highest percentage of samples with detectable levels of arsenic, while arsenic was not detected in any of duck egg samples. Mushrooms had a much wider range of arsenic levels than other product types with the highest observed level at 1.31 ppm. Maximum levels were observed in a sample of dried chanterelle mushrooms. The levels of arsenic detected in 3 juice samples met the existing tolerances of 0.1 ppm for ready-to-serve beverages; compliance rate is 100%.

Cadmium

Cadmium was detected in 37% of samples tested in this targeted survey. Mushrooms had the highest average cadmium level and higher maximum observed level than other product types. The highest levels of cadmium were observed in samples of dried shitake mushrooms. Ginger and cinnamon samples had the highest levels compared to other spice samples.

Lead

Lead had the highest overall detection rate; it was detected in 53% of samples tested. Mushrooms had the highest average lead level and higher maximum level than other product types, followed by spices. Lead was not detected in any duck egg or juice and nectar samples; the compliance rate is 100%.

Mercury

Mercury had the lowest overall detection rate; it was detected in 24% of samples tested. While mercury was detected in 96% of mushroom samples, other product types had much lower detection rates and detected levels of mercury. The highest levels of mercury were observed in samples of dried porcini mushrooms.

What the survey results mean

The detection rates and the levels of metals reported in this targeted survey were comparable to those previously found in these product types[3,4,5,6,7,8,9,10,11,12,12]. The differences observed may be due to the sample size and the specific type of product tested. Some increases in the detection rates between the surveys years were also associated with a more sensitive method used in the current year.

Only 1 fresh duck egg sample had detectable levels of mercury, it was within the range reported for the CFIA's 2021 National Chemical Residue Monitoring Program (NCRMP) survey in shelled eggs[3]. This survey focused on juices and nectars marketed to infants and/or young children. The levels of arsenic detected in 3 samples were within the range reported in children foods tested under Children Food Project (CFP) and below the levels reported in previous survey years for all juice types[4,5,6,8].

One of the objectives of this targeted survey was to generate additional baseline surveillance data on the level of metals in mushrooms, as elevated levels were observed in these products in

a previous survey[9]. Although 5 out of 69 samples had elevated levels of mercury (0.871 to 3.38 ppm), the remaining samples had an average (0.020 ppm) comparable to other dehydrated products such as spices. Additionally, 7 samples exceeded historical levels of cadmium or lead. All other levels of toxic metals reported were within range reported for previous surveys[7,9]. Of importance is that only a small number of dried mushroom samples were tested in the 2020 survey, all the remaining samples tested were canned mushrooms (tested with the liquid). When this is considered, median levels of toxic metals in dried and canned mushrooms products tested throughout the years are comparable.

The levels observed for spices, sugar and syrups, and sweets were comparable to those observed in previous survey years. A selection of vinegar products was tested this survey year to generate additional baseline surveillance data. Although more than half of the samples were positive for toxic metals, it was confirmed that levels of toxic metals in vinegars are low.

Table 3. Metal testing results from various survey years

Product type	Year (survey)	Number of samples	% positive for arsenic	Average level (maximum) of arsenic (ppm)	% positive for cadmium	Average level (maximum) of cadmium (ppm)	% positive for lead	Average level (maximum) of lead (ppm)	% positive for mercury	Average level (maximum) of mercury (ppm)
Duck eggs	**2022**	**16**	**0**	**ND**	**0**	**ND**	**0**	**ND**	**6**	**0.0005 (0.0005)**
Eggs	2021 (NCRMP)	234	1	0.010 (0.010)	0	ND	1	0.010 (0.010)	29	0.0002 (0.0019)
Juices and nectars	**2022**	**85**	**4**	**0.007 (0.007)**	**0**	**ND**	**0**	**ND**	**0**	**ND**
Juices	2021 (CFP)	68	0	ND	0	ND	0	ND	0	ND
Juices	2017 (CFP)	51	12	0.001 (0.031)	0	ND	4	0.0003 (0.009)	0	ND
Juices	2015 (pesticides and metals survey)	292	34	0.009 (0.064)	25	0.0030 (0.0162)	58	0.0053 (0.142)	9	0.00015 (0.0003)
Juices	2011 (arsenic survey)	245	80	0.007 (0.056)	N/A	N/A	N/A	N/A	N/A	N/A
Mushrooms	**2022**	**69**	**99**	**0.384 (1.31)**	**97**	**0.588 (1.71)**	**100**	**0.157 (1.92)**	**96**	**0.216 (3.38)**
Mushrooms (canned)	2022 (pesticides and metals survey)	116	**69**	0.011 (0.032)	**19**	0.022 (0.155)	**27**	0.021 (0.079)	**48**	0.005 (0.025)
Mushrooms	2020 (pesticides and metals survey)	31	**71**	0.492 (3.79)	**71**	0.740 (1.42)	**71**	0.090 (0.498)	**100**	0.213 (3.38)
Spices	**2022**	**115**	**95**	**0.070 (0.642)**	**92**	**0.066 (0.390)**	**97**	**0.189 (1.51)**	**37**	**0.010 (0.049)**
Herbs and spices	2017	320	88	0.0859 (1.160)	91	0.089 (0.609)	93	0.204 (3.58)	87	0.00574 (0.0664)
Herbs and spices	2016	1	100	N/A (0.150)	0	N/A	100	N/A (0.020)	100	N/A (0.00200)
Herbs and spices	2013	138	81	0.112 (0.738)	91	0.0930 (0.704)	99	0.246 (1.62)	43	0.0142 (0.0608)
Herbs and spices	2012	149	93	0.148 (2.19)	97	0.144 (4.37)	100	0.368 (4.39)	63	0.0124 (0.0689)
Herbs and spices	2011	148	92	0.198 (1.31)	92	0.208 (5.66)	100	0.469 (8.48)	89	0.00674 (0.0423)
Sugar and syrups	**2022**	**67**	**28**	**0.038 (0.127)**	**0**	**ND**	**24**	**0.029 (0.128)**	**3**	**0.007 (0.009)**
Sugar/Molasses	2021	45	38	0.0252 (0.110)	2	0.010 (0.010)	18	0.0801 (0.490)	18	0.0029 (0.0063)
Corn syrup/Molasses	2013	21	48	0.0653 (0.111)	5	0.057 (0.057)	62	0.0277 (0.272)	0	ND
Sugar/Corn syrup/Molasses	2011 to 2013 (mercury survey)	126	N/A	N/A	N/A	N/A	N/A	N/A	31	0.0026 (0.0423)
Sweets	**2022**	**78**	**19**	**0.014 (0.047)**	**3**	**0.009 (0.010)**	**40**	**0.012 (0.056)**	**5**	**0.007 (0.008)**
Sweets	2013	184	17	0.0434 (0.111)	13	0.0367 (0.294)	60	0.0150 (0.272)	1	0.00870 (0.0121)
Sweets	2012	148	8	0.0359 (0.0800)	6	0.0171 (0.0546)	70	0.0129 (0.0546)	2	0.0117 (0.0151)
Sweets	2011	150	11	0.074 (0.170)	3	0.0117 (0.0147)	37	0.0305 (0.206)	25	0.00098 (0.00282)
Vinegar	**2022**	**40**	**40**	**0.018 (0.106)**	**3**	**0.025 (0.025)**	**58**	**0.026 (0.179)**	**0**	**ND**
Vinegar	2013	9	0	ND	0	ND	0	ND	0	ND

Table notes

Note: Average values were calculated using only results for samples with quantifiable metal levels.
ND: not detected above LOD.
N/A: not applicable.

The levels of arsenic detected in all beverage samples met the existing tolerances of 0.1 parts per million (ppm). Lead was not detected in any juice and nectar samples. The compliance rate was 100%. There are no regulations in Canada for metal levels in the other products tested. Health Canada determined that none of the samples analyzed for metals in this survey posed a concern to human health.

References

1. Hutton, M. Human Health Concerns of Lead, Mercury, Cadmium and Arsenic. In Lead, Mercury, Cadmium and Arsenic in the Environment. (1987). John Wiley & Sons Ltd., pp. 53-68.
2. List of Contaminants and other Adulterating Substances in Foods. (2018). Canada. Health Canada.
3. National Chemical Residue Monitoring Program and Chemistry Food Safety Oversight Program Annual Report 2021 to 2022. (2024). Canada. Canadian Food Inspection Agency.
4. Children's Food Project – Annual Report 2021. (2023). Canada. Canadian Food Inspection Agency.
5. Children's Food Project – Annual Report 2017. (2020). Canada. Canadian Food Inspection Agency.
6. 2015 to 2016 Pesticides and Metals in Beverages. (2019). Canada. Canadian Food Inspection Agency.
7. 2022 to 2023 Pesticides and Metals in Selected Foods. Canada. Canadian Food Inspection Agency. [unpublished results]
8. 2011 to 2012 Arsenic Speciation in Selected Foods. (2018). Canada. Canadian Food Inspection Agency.
9. 2020 to 2021 Pesticides and Metals in Selected Foods. Canada. Canadian Food Inspection Agency. [unpublished results]
10. 2013 to 2017 Toxic Metals in Selected Foods. Canada. Canadian Food Inspection Agency. [unpublished results]
11. 2012 to 2013 Lead in Candy, Chocolate, Dried Herbs and Spices. (2018). Canada. Canadian Food Inspection Agency.
12. 2011 to 2012 Lead in Candy, Chocolate and Cocoa Powder. (2014). Canada. Canadian Food Inspection Agency.
13. 2011 to 2013 Mercury in Selected Foods. (2018). Canada. Canadian Food Inspection Agency.