



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Toxic metals in selected foods – April 1, 2023, to March 31, 2024

Food chemistry – Targeted surveys – Final report



© His Majesty the King in Right of Canada, as represented by the Minister of Health, 2026.

Catalogue No.: A104-247/1-2026E-PDF

ISBN: 978-0-660-97674-7

Aussi disponible en français.

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 exposure¹.

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 levels of metals observed in foods in this survey with those of previous targeted surveys and literature.

A total of 957 samples of cassava products, salt, balsamic vinegar and plain bottled water were purchased 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 (69%) of the survey samples contained 1 or more toxic metals, however none of the samples contained traces of all 4 toxic metals. While none of the bottled water samples had detectable levels of toxic metals, 99.5% of cassava products and 97% of balsamic vinegars contained traces of at least 1 toxic metal. At least 1 of the toxic metals was detected in 76% of salt samples. The detection rates and the levels of metals reported in this targeted survey were comparable to the levels previously found in similar product types and reported in scientific literature.

Arsenic and lead were not detected in any bottled water samples, hence, the compliance rate for those products 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/sources¹. 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 levels of metals observed in foods in this survey with those of previous targeted surveys and scientific literature. 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 cassava products (flour and starch), salts (plain and specialty), balsamic vinegars and plain bottled water samples were collected between April 1, 2023 and March 31, 2024. 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
Cassava products	1	183	77	261
Salt	20	167	11	198
Vinegar (balsamic)	17	229	3	249
Water	88	146	15	249
Total	126	725	106	957

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. Health Canada established regulatory tolerances for total arsenic and lead in a variety of products including ready-to-serve beverages, and infant formula when ready-to-serve². Maximum Levels (MLs) for total arsenic and lead in water in sealed containers were set at 0.01 ppm. 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 957 samples of cassava products, salts, balsamic vinegars and plain bottled water samples were analysed for arsenic, cadmium, lead and mercury. Most (69%) of the survey samples contained 1 or more toxic metal, however none of the samples contained traces of all 4 toxic metals. While none of the bottled water samples had detectable levels of toxic metals, 99.5% of cassava products and 97% of balsamic vinegars contained traces of at least 1 toxic metal. At least 1 of the toxic metals was detected in 76% of salt samples.

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)
Cassava products	261	26	0.011 (<LOD-0.065)	10	0.010 (<LOD-0.042)	98	0.278 (<LOD-1.40)	0.4	0.0052 (<LOD-0.0052)
Salt	198	44	0.040 (<LOD-0.159)	3	0.009 (<LOD-0.012)	71	0.129 (<LOD-0.670)	1	0.0091 (<LOD-0.0107)
Vinegar (balsamic)	249	76	0.009 (<LOD-0.021)	0	0	94	0.028 (<LOD-0.127)	0.4	0.0021 (<LOD-0.0021)
Water	249	0	ND	0	ND	0	ND	0	ND

Table notes

<LOD = Below the limit of detection (0.002 - 0.005 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 36% of samples tested in this targeted survey. Although arsenic was detected in most (76%) vinegar samples, the levels observed were low. The average level of arsenic was relatively low in all product types. The maximum level was observed in a sample of Himalayan salt at 0.159 ppm. None of the bottled water samples had detectable levels of arsenic, therefore the compliance rate was 100%.

Cadmium

Cadmium was detected in only 3% of samples tested in this targeted survey. Relatively low levels of cadmium were detected in 8% of cassava products and 2% of salt samples. The highest level of cadmium was observed in a sample of cassava flour at 0.042 ppm.

Lead

Lead had the highest overall detection rate; it was detected in 66% of samples tested. Cassava products had the highest detection rate (98%) and highest observed lead levels. Lead was not

detected in any bottled water samples; the compliance rate was 100%. The highest level of lead was observed in a sample of cassava flour at 1.40 ppm.

Mercury

Mercury had the lowest overall detection rate; it was detected in only 4 samples tested at or above the LOD of 0.002 ppm. The highest level of mercury (0.0107 ppm) was observed in a sample of imported table salt.

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 and reported in the scientific literature^{3,4,5,6,7,8,9,10}. The differences observed may be due to the sample size and the specific type of product tested, as well as the sensitivity of the method used.

Table 3 illustrates the level of these metals found in the products tested. One of the objectives of this targeted survey was to generate baseline surveillance data on the level of metals in casava products and table salt, as elevated levels were reported in literature^{5,8}. The levels of toxic metals observed in these product types were comparable or lower than those reported in the literature. Elevated levels of lead were observed in samples of cassava flour, suggesting the cassava may have been grown in lead polluted areas^{5,6}, however the lead levels were still within levels observed in other vegetables known to naturally uptake lead from the soil they are grown in^{6,9}.

The levels observed for vinegars were comparable to those observed in the previous survey year⁹. A larger number of products was tested this survey year to generate additional baseline surveillance data. The survey focused on balsamic vinegar since this type was shown to have higher detection rates⁹. Although most (97%) of the vinegar samples were positive for toxic metals, it was confirmed that levels of toxic metals in vinegars are relatively low.

Detectable levels of toxic metals were not found in the samples of bottled water collected. Most of the levels reported in previous survey years were below this survey's LODs¹⁰. Arsenic and lead were not detected in any bottled water samples; hence, all those samples met the existing tolerances of 0.01 ppm. 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.

Table 3. Metal testing results from various studies

Product type	Study	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)
Cassava products	CFIA survey, 2023	261	26	0.011 (0.065)	10	0.010 (0.042)	98	0.278 (1.40)	0.4	0.0052 (0.0052)
Cassava products	Ajiwe, et al., 2018	4	N/A	N/A	100	0.23 (0.43)	100	0.83 (1.20)	N/A	N/A
Cassava products	Omotoso, et al., 2018	5	5	0.009 (0.012)	5	0.048 (0.065)	N/A	N/A	N/A	N/A
Salt	CFIA survey, 2023	198	44	0.040 (0.159)	3	0.009 (0.012)	71	0.129 (0.670)	1	0.0091 (0.0107)
Salt	Di Salvo, et al., 2023	10	N/A	N/A	N/A	N/A	100	7.25 (9.24)	100	0.01 (0.04)
Salt	Mamavation, 2023	26	N/A	N/A	62	0.018 (0.073)	88	1.08 (5.53)	ND	ND
Vinegar (balsamic)	CFIA survey, 2023	249	76	0.009 (0.021)	0	0	94	0.028 (0.127)	0.4	0.0021 (0.0021)
Vinegar	CFIA survey, 2022	40	40	0.018 (0.106)	3	0.025 (0.025)	58	0.026 (0.179)	0	ND
Water	CFIA survey, 2023	249	0	ND	0	ND	0	ND	0	ND
Water	CFIA survey, 2015	173	24	0.008 (0.014) ^b	2	0.0007 (0.0009) ^b	6	0.0026 (0.0062) ^b	7	0.00016 (0.0004) ^b

Table notes

^b LOD 0.0001 - 0.0004 ppm, depending on the laboratory (lower than in the current survey)

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

ND: not detected above LOD

N/A: not applicable

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. Ajiwe, V.I.E, Chukwujindu, K.C., Chukwujindu, C.N. [Heavy metals concentration in cassava tubers and leaves from Galena mining area in Ishiaqu, Ivo L.G.A. of Ebonyi State, Nigeria \[PDF\].](#) (2018). ISOR J. Appl. Chem. 11(3), pp.54-58.
4. Jacob, O.A, Anuoluwa, O.E., Raimi, M.O. [The notorious daredevils: potential toxic levels of cyanide and heavy metals in cassava flour sold in selected markets - taken Oke Ogun Community, Oyo State as an example.](#) (2023). Front. Sustain. Food Syst. 7:1165501.
5. Nwawuiké, N., Nwawuiké, I.M., [Investigating the Impact of Proximity to Dumpsite on Mercury and Arsenic Levels in Cassava \(Manihot esculenta\).](#) (2024). African journal of environment and natural science research, 7(2), 23-34.
6. Udiba, U., Udofia, U., Akpan, R.,Antai, E. [Assessment of lead \(Pb\) uptake and hazard potentials of cassava plant \(Manihot esculentus cranz\), Dareta Village, Zamfara, Nigeria.](#) (2019). Int. Res. J. Pub. Environ. Health 6(6), pp. 115-126.
7. Di Salvo, E., Tardugno, R., Nava, V., Naccari, C., Virga, A., Salvo, A., Corbo, F., Clodoveo, M. L., and Cicero, N. [Gourmet Table Salts: The Mineral Composition Showdown.](#) (2023). Toxics, 11(8), 705.
8. [Sea salt & Himalayan salt tested for heavy metals like lead & micorplastics – guide.](#) (2023). Mamavation.
9. 2022 to 2023 Toxic Metals in Selected Foods. (2024). Canada. Canadian Food Inspection Agency.
10. [2015 to 2016 Pesticides and Metals in Beverages.](#) (2019). Canada. Canadian Food Inspection Agency.