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

Toxic 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.

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 985 samples of beverages were collected from retail locations in 6 cities across Canada and tested for metals. Only the results of the metals of highest concern (arsenic, cadmium, lead, and mercury) are presented in this report. Mercury and arsenic had the lowest and the highest detection rate, respectively. Of all product types sampled, protein powders and rice products were the commodities with the highest detected content of these metals. Infant formulas had the lowest frequency of detection and the lowest average levels of arsenic, cadmium, lead and mercury. The levels of arsenic and lead detected in ready-to-serve beverage samples (meal replacement products) and ready-to-serve infant formula met the existing tolerances. There are no regulations in Canada for metal levels in the other products tested. HC determined that none of the samples analyzed for metals in this survey posed a 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. 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 did we sample

A variety of domestic and imported bran products, infant formula, meal replacement products (ready-to-serve beverage and beverage mixes), protein powders and rice products 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
Bran products	23	41	35	99
Infant formula	0	386	9	395
Meal replacement	16	135	47	198
Protein powders	72	34	89	195
Rice products	77	19	2	98
Grand total	**188**	**615**	**182**	**985**

[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 or by a CFIA laboratory. The results are based on the food products as sold and not necessarily as they would be consumed.

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

What were the survey results

A total of 985 samples of domestic and imported bran products, infant formula, meal replacement products, protein powders and rice products were analysed for arsenic, cadmium, lead and mercury. Most (70%) of the survey samples contained one or more metals, while 12% of the samples contained traces of all four toxic metals.

Table 2. Detected levels of metals in selected foods

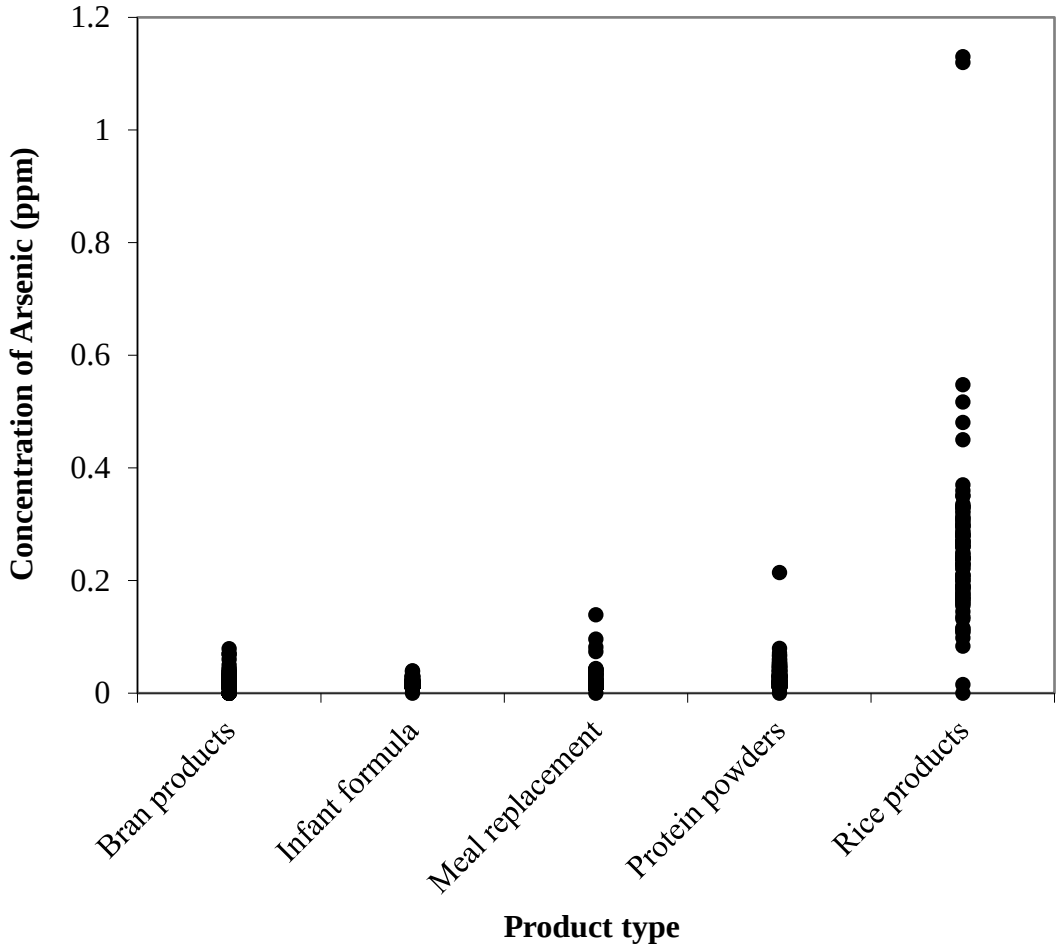
Product type	Number of samples	% pos for arsenic	Average level (range) of arsenic (ppm)	% pos for cadmium	Average level (range) of cadmium (ppm)	% pos for lead	Average level (range) of lead (ppm)	% pos for mercury	Average level (range) of mercury (ppm)
Bran products	99	78	0.024 (<LOD-0.079)	71	0.043 (<LOD-0.186)	24	0.023 (<LOD-0.130)	4	0.0013 (<LOD-0.002)
Infant formula	395	52	0.016 (<LOD-0.040)	9	0.011 (<LOD-0.020)	13	0.012 (<LOD-0.020)	1	0.002 (<LOD-0.003)
Meal replacement	198	44	0.022 (<LOD-0.139)	31	0.037 (<LOD-0.190)	40	0.024 (<LOD-0.231)	9	0.002 (<LOD-0.006)
Protein powders	195	84	0.028 (<LOD-0.214)	82	0.060 (<LOD-0.219)	71	0.035 (<LOD-0.237)	50	0.003 (<LOD-0.022)
Rice products	98	95	0.263 (<LOD-1.130)	63	0.016 (<LOD-0.056)	37	0.018 (<LOD-0.050)	71	0.003 (<LOD-0.006)

<LOD = Below the limit of detection (0.001 - 0.01 ppm, depending on the laboratory and the analyte)
Note: Average values were calculated using only results for samples with quantifiable metal levels

Arsenic

Arsenic had the highest overall detection rate; it was detected in 64% of samples tested in this targeted survey. Meal replacement products had the lowest (44%) and rice products the highest (95%) percentage of samples with detectable arsenic. Figure 1 illustrates the range of arsenic levels by product type. Rice products had the widest range of arsenic levels detected, while infant formula had the lowest average arsenic level. The highest levels of arsenic (1.12 and 1.13 ppm) were detected in 2 samples of brown rice bran and germ powder. The levels of arsenic detected in ready-to-serve beverage samples (meal replacement products) met the existing tolerances.

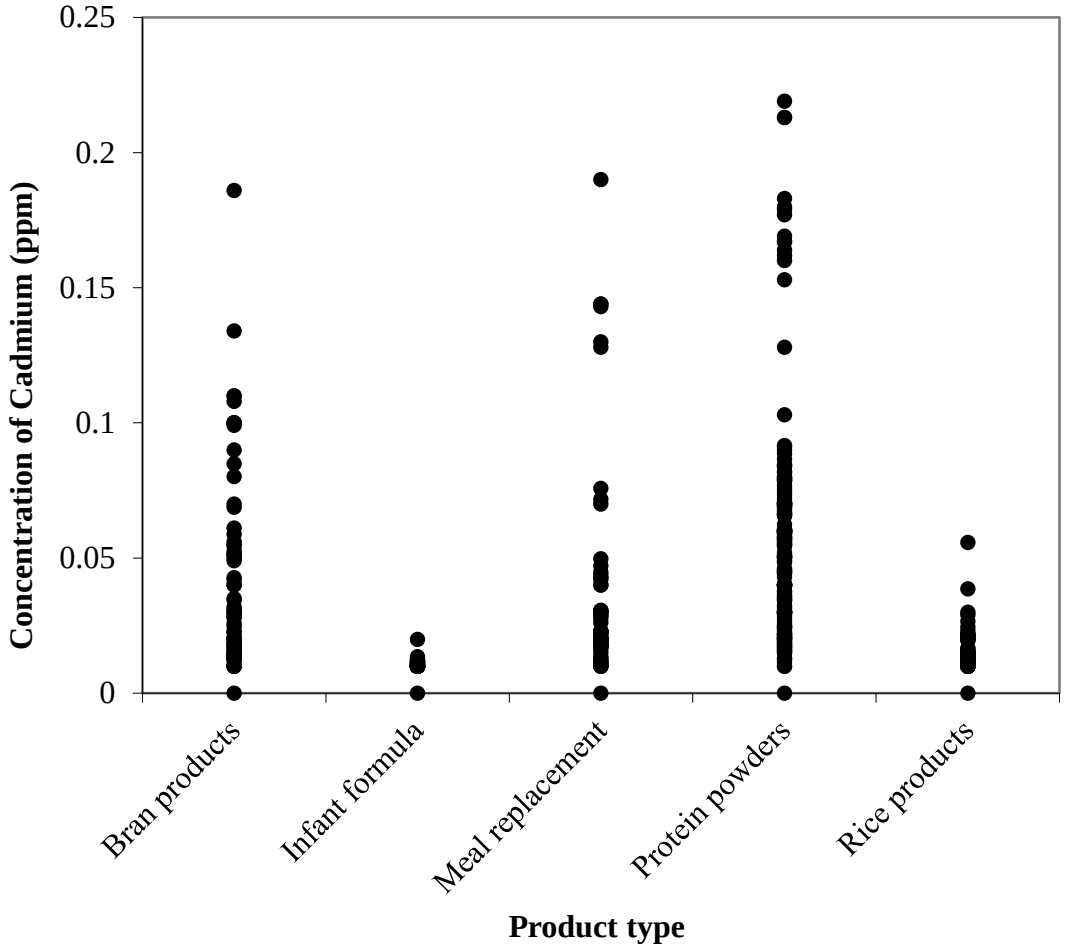
Figure 1. Distribution of arsenic levels by product type



Cadmium

Of the 985 samples tested, a total of 596 (61%) did not contain a detectable level of cadmium. Cadmium levels in this targeted survey ranged from 0 ppm to 0.219 ppm. Figure 3 illustrates the range of cadmium levels by product type. Protein powders were associated with the highest detection rate, maximum levels and average cadmium levels. Infant formula had the lowest cadmium levels.

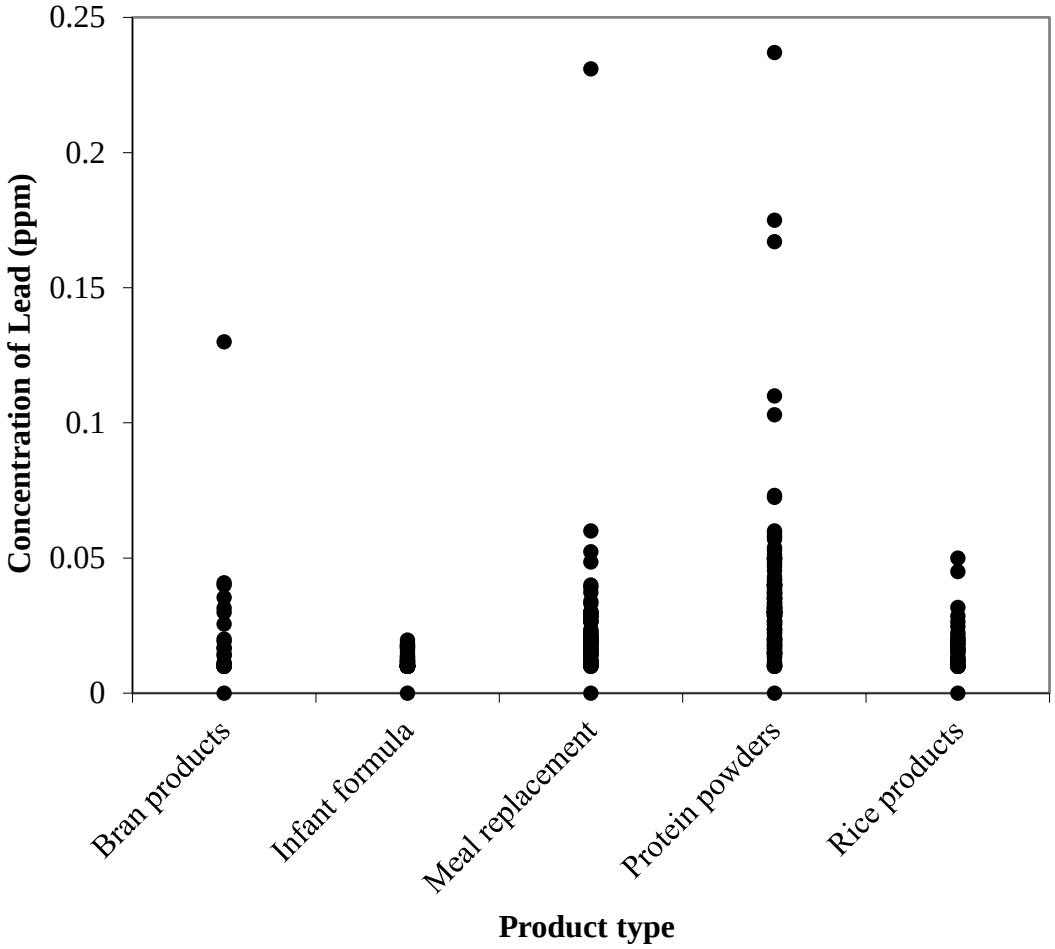
Figure 2. Distribution of cadmium levels by product type



Lead

Of the 985 samples tested in this survey, 656 (67%) did not contain a detectable level of lead. The detection rate was lowest for infant formula (13%), and highest for protein powders (71%). The lead levels ranged from 0 ppm to 0.237 ppm. Figure 4 illustrates the range of lead levels detected by product type. Protein powders had a wider range of lead levels detected than other product types. The levels of lead detected in ready-to-serve beverage samples (meal replacement products) and ready-to-serve formula met the existing tolerances.

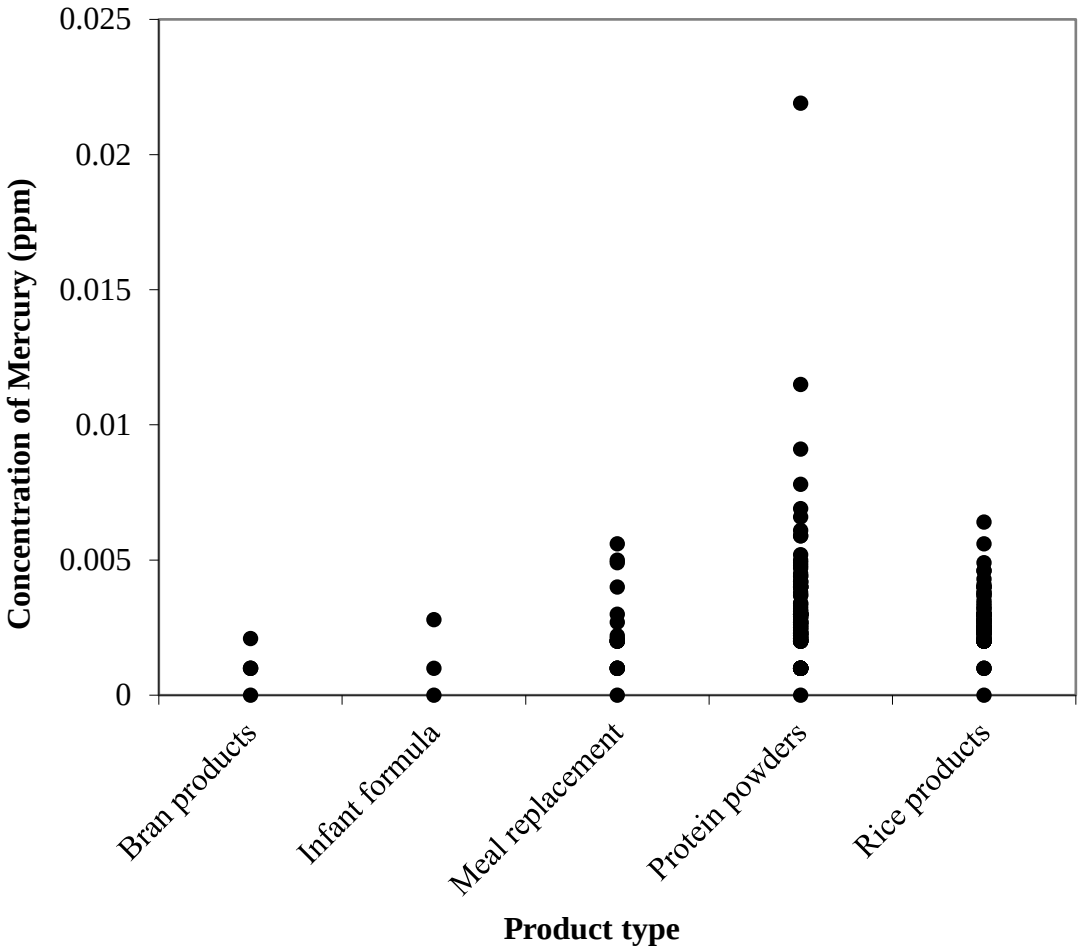
Figure 3. Distribution of lead levels by product type



Mercury

Mercury had the lowest overall detection rate; it was detected in 19% of samples tested in this survey. Only 2 infant formula samples contained a detectable level of mercury. Rice products had the highest detection rate (71%), followed by protein powders (50%). Figure 5 illustrates the range of mercury levels detected by product type. Protein powders were associated with the highest mercury levels detected in this survey. A single sample of brown rice protein powder contained 0.022 ppm of mercury, the highest in this survey.

Figure 4. Distribution of mercury levels by product type



What do 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]. Some differences observed may be due to the sample size and the specific type of product tested, as well as the method sensitivity (LODs).

As previously observed in other CFIA surveys, there were minimal differences between the occurrences of metals in dairy-based and soy-based formulas. Metals were rarely detected in liquid and ready-to-serve formula samples.

The average metal levels reported for protein powders in this survey are lower than those recorded in 2012 to 2013 since a smaller selection of rice-based protein powders was tested. Of

the various protein types, rice-based protein powders have the highest levels of metals, especially cadmium.

The levels recorded for cadmium, lead and mercury in rice products tested in this survey were lower than in rice products tested in 2009 to 2015 since fewer products with high bran content were sampled[6]. Two samples of brown rice bran and germ powder included in the survey tested had high arsenic content, therefore the arsenic levels reported in this survey are higher than those previously found. Bran products include a selection of products containing oat, corn and wheat bran. The average levels of metals reported for that food category is lower than that in rice products.

Table 3. Metal testing results from various survey years

Product type	Year	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)
Bran products	2018 to 2019	99	78	0.024 (<LOD-0.079)	71	0.043 (<LOD-0.186)	24	0.023 (<LOD-0.130)	4	0.0013 (<LOD-0.002)
Infant formula	2018 to 2019	395	52	0.016 (<LOD-0.040)	9	0.011 (<LOD-0.020)	13	0.012 (<LOD-0.020)	1	0.002 (<LOD-0.003)
Infant formula	2017 to 2018	177	54	0.016 (<LOD-0.040)	25	0.011 (<LOD-0.020)	21	0.011 (<LOD-0.046)	8	0.0013 (<LOD-0.005)
Infant formula	2012 to 2013	144	28	0.013 (<LOD-0.023)	31	0.005 (<LOD-0.008)	40	0.004 (<LOD-0.011)	o	-
Meal replacement	2018 to 2019	198	44	0.022 (<LOD-0.139)	31	0.037 (<LOD-0.190)	40	0.024 (<LOD-0.231)	9	0.002 (<LOD-0.006)
Meal replacement	2017 to 2018	88	55	0.019 (<LOD-0.128)	43	0.030 (<LOD-0.163)	63	0.022 (<LOD-0.063)	38	0.003 (<LOD-0.013)
Meal replacement	2012 to 2013	46	24	0.021 (<LOD-0.044)	43	0.027 (<LOD-0.055)	87	0.018 (<LOD-0.078)	13	0.007 (<LOD-0.011)
Protein powder	2018 to 2019	195	84	0.028 (<LOD-0.214)	82	0.060 (<LOD-0.219)	71	0.035 (<LOD-0.237)	50	0.003 (<LOD-0.022)
Protein powder	2017 to 2018	87	76	0.027 (<LOD-0.089)	75	0.058 (<LOD-0.579)	79	0.040 (<LOD-0.182)	64	0.004 (<LOD-0.029)
Protein powder	2012 to 2013	101	57	0.040 (<LOD-0.141)	59	0.181 (<LOD-1.717)	82	0.047 (<LOD-0.318)	27	0.026 (<LOD-0.130)
Rice products	2018 to 2019	98	95	0.263 (<LOD-1.130)	63	0.016 (<LOD-0.056)	37	0.018 (<LOD-0.050)	71	0.003 (<LOD-0.006)
Rice products	2009 to 2015	975	93	0.132 (<LOD-0.98)	57	0.027 (<LOD-1.78)	48	0.022 (<LOD-0.491)	23	0.003 (<LOD-0.0139)

<LOD = Below the limit of detection (0.0004 - 0.01 ppm, depending on the laboratory and the analyte)
Note: Average values were calculated using only results for samples with quantifiable metal levels

All survey results were forwarded to HC for health risk assessment and determined to pose no 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. 2017-2018 Pesticides and Metals in Selected Foods. [unpublished results]. Canada. Canadian Food Inspection Agency.
4. 2012-2013 Arsenic, Cadmium, Lead, and Mercury in Infant Formulas, Meal Replacements, and Nutritional Supplements. (2014). Canada. Canadian Food Inspection Agency.
5. 2009-2015 Toxic Metals in Rice Products. [unpublished results]. Canada. Canadian Food Inspection Agency.
6. Thielecke, F., Nugent, A.P. (2018) Contaminants in Grain - A Major Risk for Whole Grain Safety? (PDF). Nutrients, 10(9). pp. 1213.