



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Total Arsenic and Arsenic Speciation in Infant Foods, Alcoholic Beverages, Fish, Shellfish and Crustaceans - April 1, 2019 to March 31, 2020

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.

Arsenic is a naturally occurring element that can be found in the Earth's crust. It is expected to be present at very low levels in food as a result of natural accumulation from the environment¹. Arsenic can exist in both organic and inorganic forms in food; the inorganic forms are widely considered to be much more toxic to humans. The amount and forms of arsenic found in foods is dependent on a number of factors such as food type, growing conditions, and processing techniques. Chronic exposure to inorganic arsenic may lead to a variety of detrimental health effects in humans, including affecting the gastrointestinal tract, kidneys, liver, lungs and skin as well as contributing to the risk of certain cancers^{2,3,4}.

The CFIA's regular monitoring activities examine the levels of total arsenic in various commodities but have not examined speciated arsenic to a great extent. As such, there is a need for surveillance data on the presence and levels of total arsenic as well as the various forms of arsenic, specifically the levels of inorganic arsenic, in Canadian retail products.

A total of 343 samples of grape-based alcoholic beverages (wine, brandy, sherry, vermouth), rice-based infant foods, domestic fish and domestic shellfish and crustaceans were collected from retail locations in 11 cities across Canada and tested for arsenic. All of the survey samples contained traces of total arsenic while inorganic arsenic was detected in 81.6% of products tested. Focusing on the levels of only the inorganic species as these are noted to be much more toxic to humans than other forms of arsenic, fish had the lowest average levels, whereas rice-based infant food contained the highest average concentrations of inorganic arsenic. Inorganic arsenic was detected in all wine and infant food samples tested.

The levels of arsenic detected in ready-to-serve beverage samples (alcoholic beverages) met the existing tolerances of 100 parts per billion (ppb). Regulatory tolerances for arsenic in rice were established after the completion of this survey and the compliance was not assessed against these new levels as compliance is assessed at the time the samples were analysed. All infant food samples tested would have met the new maximum levels (MLs). There are no regulations in Canada for arsenic levels in the other products tested. Health Canada determined that none of the samples analyzed for arsenic 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

Arsenic is a naturally occurring element that can be found in the Earth's crust. Arsenic may be released into the air, water and/or soil through natural erosion/leaching or through man-made activities. The primary routes of human exposure to arsenic are through drinking water and food. The presence of arsenic in food is expected as a result of natural accumulation from the environment¹.

Arsenic can exist in both organic and inorganic forms in food; the inorganic forms are widely considered to be much more toxic to humans. The ratio of inorganic to organic arsenic species can vary widely depending on the source of contamination and the commodities in which it is present. While inorganic arsenic is the predominant species in drinking water, organic arsenic species are the main forms found in aquatic organisms (such as seaweed, fish, shellfish and crustaceans). Chronic exposure to inorganic arsenic may lead to a variety of detrimental health effects in humans, including affecting the gastrointestinal tract, kidneys, liver, lungs and skin as well as contributing to the risk of certain cancers^{2,3,4}.

The CFIA's regular monitoring activities examine the levels of total arsenic in various commodities but have not examined speciated arsenic to a great extent. As such, there is a need for surveillance data on the presence and levels of total arsenic as well as the various forms of arsenic, specifically levels of inorganic arsenic, in Canadian retail products.

What did we sample

A variety of domestic and imported grape-based alcoholic beverages (wine, brandy, sherry, vermouth) and rice-based infant foods, domestic fish and domestic shellfish and crustacean samples were sampled between April 1, 2019 and March 31, 2020. Samples 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. Domestic products may indicate that they are manufactured or processed in Canada with domestic and/or imported ingredients. 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	Total number of samples
Alcoholic beverages	20	27	47
Fish	115	0	115
Infant food	5	95	100
Shellfish and crustaceans	81	0	81
Total	221	122	343

How were samples analyzed and assessed

Samples were analyzed by a CFIA laboratory which is ISO/IEC 17025 accredited for food testing. 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 MLs. In 2014, Health Canada established regulatory tolerances for arsenic in a variety of ready-to-serve beverages, and upon the completion of this survey tolerances for inorganic arsenic in rice were established⁵. Compliance is assessed against the established tolerances available when the survey was carried out. In the absence of a specific ML, the levels of arsenic may be assessed by Health Canada on a case-by-case basis using the most current scientific data available.

What were the survey results

A total of 343 samples domestic and imported grape-based alcoholic beverages (wine, brandy, sherry, vermouth) and rice-based infant foods, domestic fish and domestic shellfish and crustacean samples were analysed for total arsenic and 6 arsenic species. All of the survey samples contained traces of arsenic. Inorganic arsenic was detected in 81.6% of products tested.

When considering the levels of only the inorganic species (noted to be much more toxic to humans than other forms of arsenic), fish had the lowest average levels, whereas rice-based infant food contained the highest average concentrations of inorganic arsenic. Inorganic arsenic was detected in all wine and infant food samples tested. The proportions of inorganic arsenic varied across the commodity types tested in this survey, with wines containing the highest proportions of inorganic arsenic.

Table 2. Detected levels of arsenic in selected foods

Product type	Number of samples	Samples with detectable total (inorganic) Arsenic	Average ^a total Arsenic (ppb)	Average ^a inorganic Arsenic (ppb)
Alcoholic beverages	47	47 (36)	4.28	2.18
Wine	28	28 (28)	2.90	2.21
Other	19	19 (8)	5.21	2.10
Fish	115	115 (65)	1528	1.48
Infant food	100	N/A ^b (100)	78.09 ^c	52.91
Shellfish and crustaceans	81	81 (79)	4810	23.08
Total	343	N/A^b (280)	1672	26.03

^a Average values were calculated using only results for samples with quantifiable metal levels

^b Not measured; all samples contained at least one of the 6 arsenic species

^c Sum of As³⁺ and As⁵⁺

Clams had higher inorganic arsenic levels than other types of shellfish and crustaceans. Highest levels of inorganic arsenic reported in this survey (up to 425 ppb) were in clam samples. All fish types had comparable average inorganic arsenic levels. The highest level of inorganic arsenic in fish (5.32 ppb) was found in a sample of mackerel, a filter feeding fish. As previously observed⁶, the ranges of total arsenic concentrations in fish and shellfish and crustaceans are much wider than the range of inorganic arsenic levels detected in these commodities. These differences reinforce that the majority of arsenic species in aquatic products are organic in nature.

What do the survey results mean

The detection rates and the levels recorded for total and inorganic arsenic in the products tested in this targeted survey were comparable to those previously found in similar product types (Table 3)^{6,7,8}. Some differences observed may be due to the specific type of product tested or sample size.

Levels of total arsenic observed in rice-based infant foods were within the range observed for rice-based products in previous survey years and closely matched the average level of arsenic of 78.62 ppm for infant foods containing rice that were tested as part of the 2019 Children's Food Project (CFP)⁹.

Upon completion of this survey, Health Canada established regulatory tolerances for inorganic arsenic in husked (brown) and polished (white) rice⁵. Although compliance is only assessed against the established tolerances available when the surveys are carried out, all infant food samples tested in 2019 would have met current MLs for inorganic arsenic in rice.

Table 3. Arsenic testing results from various survey years

Product type	Survey year	Number of samples	Samples with detectable total (inorganic) Arsenic	Average ^d total Arsenic (ppb)	Average ^d inorganic Arsenic (ppb)
Alcoholic beverages - Wine	2019	28	28 (28)	2.90	2.21
Alcoholic beverages - Wine	2018	155	155 (155)	4.16	3.19
Alcoholic beverages - Wine	2017	76	76 (75)	4.89	3.53
Alcoholic beverages - Other	2019	19	19 (8)	5.21	2.10
Alcoholic beverages - Other	2018	95	90 (37)	1.85	2.79
Alcoholic beverages - Other	2017	142	96 (48)	1.66	2.27
Fish	2019	115	115 (65)	1528	1.48
Fish	2018	92	92 (56)	1027	1.31
Infant food (rice based)	2019	100	N/A (100)	78.09 ^e	52.91
Rice products	2018	261	230 (N/A)	181	N/A
Rice products	2010 to 2015	975	904 (N/A)	123	N/A
Shellfish and crustaceans	2019	81	81 (79)	4810	23.08
Shellfish and crustaceans	2018	60	60 (60)	5832	34.28
Seaweed	2011	145	145 (145)	271 ^f	37.19

^d Average values were calculated using only results for samples with quantifiable metal levels

^e Sum of As³⁺ and As⁵⁺

^f A sum of 4 arsenic species; includes only 2 of the 4 possible organic arsenic species (DMA and MMA)

All survey results were forwarded to Health Canada for health risk assessment and were determined to pose no concern to human health.

References

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