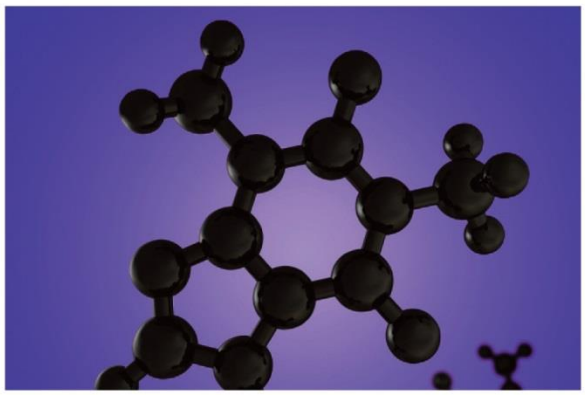
Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2011-2013 Targeted Surveys

Chemistry



Mercury in Selected Foods

Canada

Table of Contents

Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and enhance Canada's food safety system. As part of the FSAP enhanced surveillance initiative, targeted surveys are used to generate data in order to evaluate various foods for specific hazards.

Mercury is a naturally occurring metal that can be present in the environment through natural sources such as volcanoes, soils, undersea vents, and mercury-rich geological zones. It can also be released through human activities like combustion and industrial processes (such as coal-fired power generation, mining, smelting, and waste incineration). The use of mercury in batteries, fluorescent tube lighting, thermometers, and other manufactured items is also a source of mercury release into the environment.

Mercury is considered a global contaminant due to its toxicity, its ability to persist in the environment, and its ability to be transported long distances within the atmosphere.

The main objectives of the 2011-2013 Mercury in Selected Foods Targeted Survey were to:

- establish baseline information on mercury levels in specific commodities, namely beverages/juices, dried tea, and other products containing sugar, high fructose corn syrup, and other sweeteners.
- compare current survey results with those obtained in the 2009-10 and 2010-11 CFIA Mercury Surveys to assess year-to-year variability, when commodity types have been repeated.

A total of 958 samples were collected from 11 cities across Canada between April 2011 and March 2013. Samples consisted of beverages/juices, dried teas, syrups/toppings, and other products that contained sweeteners.

Overall, 58% of the samples tested did not contain any detectable level of mercury. Of the remaining 42% of samples containing measurable levels of mercury, dried teas had the highest prevalence of mercury (96% of dried tea samples contained a detectable level of mercury), and also exhibited the highest concentration of mercury observed in any of the samples tested (0.0565 parts per million). Syrups/toppings and the "other sweetened products" categories exhibited 25% and 12% detection rates, respectively. With the exception of one topping sample, there appeared to be consistently low levels of mercury detected in syrups/toppings and in other sweetened products. Beverages/juices contained the lowest prevalence of detectable mercury, with only 2% of samples containing detectable levels.

Comparison of samples common to the current and previous CFIA Mercury Surveys showed that when the analytical parameters were similar, both the prevalence and levels of mercury detected in dried tea, corn syrup and soft drinks were relatively consistent.

There are currently no mercury guidelines or tolerances established in Canada for the commodities tested in this survey. Health Canada's Bureau of Chemical Safety assessed the data collected for this targeted survey and found that the mercury concentrations reported are not expected to pose an unacceptable health risk. No product recalls were warranted given the lack of a health concern.

1. Introduction

1.1. Food Safety Action Plan

In 2007, the Canadian government launched a five-year initiative in response to a growing number of product recalls and concerns about food safety. This initiative, called the Food and Consumer Safety Action Plan (FCSAP), aims to modernize and strengthen Canada's safety system for food, health, and consumer products. The FCSAP initiative unites multiple government partners in ensuring safe food for Canadians.

The Canadian Food Inspection Agency's (CFIA's) Food Safety Action Plan (FSAP) is one element of the government's broader FCSAP initiative. The goal of FSAP is to identify risks in the food supply, limit the possibility that these risks occur, improve import and domestic food controls, and identify food importers and manufacturers. FSAP also looks to verify that the food industry is actively applying preventive measures, and that there is a rapid response when/if these measures fail.

Within FSAP, there are 12 main areas of activity, one of which is risk mapping and baseline surveillance. The main objective of this area is to better identify, assess, and prioritize potential food safety hazards through risk mapping, information gathering, and testing of foods from the Canadian marketplace. Targeted surveys are one tool used to analyze for the presence and level of a particular hazard in specific foods.

Within the current regulatory framework, some commodities (such as meat products) traded internationally and interprovincially are regulated by specific Acts. These are referred to as federally registered commodities. Under the current regulatory framework, the non-federally registered commodities encompass 70% of domestic and imported foods that are regulated solely under the *Food and Drugs Act* and the *Food and Drug Regulations*. Targeted surveys are primarily directed towards commodities produced in non-federally registered facilities.

1.2. Targeted Surveys

Targeted surveys are used to gather information regarding the possible occurrence of chemical residues, contaminants, and/or natural toxins in defined food commodities. The surveys are designed to answer specific questions; therefore, unlike monitoring activities, testing of a particular chemical hazard is targeted to commodity types and/or geographical areas.

Due to the vast number of chemical hazards and food commodity combinations, it is not possible, nor should it be necessary, to use targeted surveys to identify and quantify all chemical

hazards in foods. To identify food-hazard combinations of greatest potential health risk, the CFIA uses a combination of scientific literature, media reports, and/or a risk-based model developed by the Food Safety Science Committee, a group of federal, provincial, and territorial subject matter experts in the area of food safety.

The CFIA regularly monitors a variety of metals, including mercury, in federally registered commodities under the National Chemical Residue Monitoring Program (NCRMP) and the Children's Food Project (CFP). Targeted surveys focus mainly on products not monitored under these two programs. The purpose of this targeted survey was to establish baseline data on the level of mercury in foods produced in non-federally registered establishments available on the Canadian retail market. The scope of this survey is complementary to the NCRMP and CFP, in that it includes additional commodities not examined under these programs, such as beverages/juices, dried teas, and various sweetened products.

1.3. Acts and Regulations

The *Canadian Food Inspection Agency Act* stipulates that the CFIA is responsible for enforcing restrictions on the production, sale, composition, and content of foods and food products as outlined in the *Food and Drugs Act* and the *Food and Drug Regulations*.

Health Canada establishes the health-based standards for levels of chemical residues and contaminants in food sold in Canada. Certain standards for chemical contaminants in food appear in the Canadian *Food and Drug Regulations*, where they are referred to as tolerances. Tolerances are established as a risk management tool and generally only for foods that significantly contribute to the total dietary exposure. There are also a number of maximum levels that do not appear in the regulations and are referred to as standards, which are available on Health Canada's website.

While there is a mercury standard established for fish, as well as mercury guidelines for drinking water quality in Canada, there are no specific Canadian tolerances or standards established for mercury in any of the commodities tested in this survey. In the absence of applicable tolerances or standards, elevated levels of mercury in food may be assessed by Health Canada's Food Directorate on a case-by-case basis. If Health Canada identifies a potential safety concern, the Canadian Food Inspection Agency can exercise follow-up actions. Follow-up actions are initiated in a manner that reflects the magnitude of the health concern. Actions may include further analysis, notification of the producer or importer, follow-up inspections, additional directed sampling, and recall of products.

2. Survey Details

2.1. Mercury

Mercury can be found in various forms throughout the environment (air, water, soil, and biota). It is commonly found in combination with other elements. Inorganic mercury is formed when mercury combines with oxygen, chlorine, or sulphur. Organic mercury compounds are formed when mercury combines with carbon and hydrogen, which may occur as a result of plant or animal metabolism.

Mercury contamination of the environment is often related to human activities, such as mining/smelting, burning of fossil fuels and other wastes, as well as the industrial production of chemicals. Historically, mercury was used as a component of thermometers, scientific equipment, fluorescent lamps, and dental amalgam material. However, due to health and safety concerns, many of these applications have been phased out. Once mercury is dispersed in the environment, it does not readily break down and may be transported over long distances. Once deposited in soils or water, it can accumulate in plants and be transferred to animals that ingest these plants.

The adverse health effects of mercury depend on many factors, including the form of mercury ingested, the route of exposure (ingested, inhaled, absorbed through the skin), and the magnitude of the exposure[i]. Acute (short-term) exposure can take the form of physical/visual disturbances, mental/cognitive disturbances and respiratory effects, kidney damage[ii]. Long-term exposures, either directly or prenatally, have been linked to decreased cognitive function, delays achieving physical milestones, blindness, and lack of muscle coordination[ii]. Infants and children are especially vulnerable to mercury exposure, and their developing nervous system is particularly sensitive to its effects[i].

2.2. Rationale

The human health risks associated with exposure to mercury have been well documented. It has been shown that children are especially vulnerable to the effects of mercury, with the potential for delayed or stunted neurological development[i]. Based on reports finding detectable mercury levels in products containing high fructose corn syrup (HFCS)[iii,iv], and the unexpected prevalence of detectable mercury in dried tea samples analyzed in a 2009-2010 CFIA FSAP targeted survey[vi], a survey devoted specifically to examining mercury levels in these and similar commodities was initiated.

Tea is a highly consumed beverage in Canada; in 2008, the per capita consumption of tea was 79.4 litres[v]. There is limited information available in the academic literature regarding mercury levels in dried tea. Two previous FSAP targeted surveys have examined the levels of mercury in dried tea[vi,vii]. This survey will provide more information on the prevalence and level of mercury in dried tea leaves.

Consumption of refined sugars reached 23.1 kg refined sugar/year in Canada in 2008[v]. There have been media reports of measurable levels of mercury being detected in high fructose corn syrup (HFCS), possibly as a result of the use of non-food grade additives used in the manufacture of HFCS[3,4]. There are a significant number of products containing this ingredient available on the Canadian market, including many of the products tested for this survey (e.g. beverages, syrups/toppings, juices).

As mentioned above, a previous FSAP targeted survey[vii], examined soft drinks and corn syrups and the current survey looks to expand on the results of previous the survey by examining products with different types of sweeteners (e.g. beet/cane sugar, sugar substitutes) to examine the prevalence and levels of mercury in these highly sweetened products.

From this survey, the CFIA will gain a better perspective on the baseline levels of mercury found in the commodity types tested herein, and this information may be used by Health Canada's Food Directorate in future health risk assessments conducted on mercury exposure.

2.3. Sample Distribution

The 2011-2013 Mercury in Selected Foods Survey targeted beverages/juices, dried teas, syrups/toppings, and other products that contained sweeteners. See Table 1 for a detailed description of the sample types covered under each product category. A total of 958 samples were collected in grocery and specialty stores in 11 Canadian cities between April 2011 and March 2013.

Table 1. Distribution of samples by product type

Product Type	Sample Type
Beverages/Juices	Includes organic and conventional beverages, juices/nectars (both single fruit and mixed fruit), soft drinks, energy drinks, sports/electrolyte drinks, and cocktail mixes
Dried Tea	Includes organic and conventional black, green, herbal (e.g. blueberry, mint, chamomile, lemon), oolong, white, and other (e.g. rooibos, wulong, flavored teas)
Syrups/Toppings	Includes organic and conventional corn syrup, molasses, desert toppings (e.g. chocolate sauce, caramel sauce), fruit based toppings (e.g. raspberry coulis, blueberry syrup), pancake/table syrup, agave and golden syrups (*Excluded pure maple syrup*)
Other Sweetened Products	Includes candied cherries, canned fruit (e.g. peach, apricot, mango cranberry sauce), coffee whitener, icing, Jam/jelly, nut butter, cashew milk, pie filling, pudding, organic and conventional sugar (e.g. icing sugar, brown sugar, sugar cubes), sugar substitute (i.e. saccharin, sucralose and aspartame), and marinades

The 958 samples collected included 245 domestic products, 687 imported products (from at least 39 countries), and 26 products of unspecified origin, meaning the country of origin could not be confirmed based on the available information recorded during sampling. It is important to note that the products sampled often contained the statement "imported for Company A in Country Y" or "manufactured for Company B in Country Z", and though the labelling meets the intent of the regulatory standard, it does not specify the true origin of the product ingredients. Only those products labelled with a clear statement of "Product of", "Prepared in", "Made in", "Processed in", and "Manufactured by" were considered as being from a specific country of origin.

2.4. Analytical Method

Survey samples were analyzed for mercury by an ISO 17025 accredited laboratory under contract with the Government of Canada. Total mercury was determined using cold vapour atomic fluorescence spectroscopy. The method had a limit of detection that ranged from 0.0001 ppm in wet processed foods to 0.0005 ppm in dry processed foods.

2.5. Limitations

The current targeted survey was designed to provide a snapshot of the levels of mercury in beverages/juices, dried teas, syrups/toppings, and other sweetened products available to Canadian consumers, and had the potential to highlight commodities that warrant further

investigation. The limited survey sample size represents a small fraction of the products available to Canadian consumers. Therefore, care must be taken when interpreting and extrapolating these results.

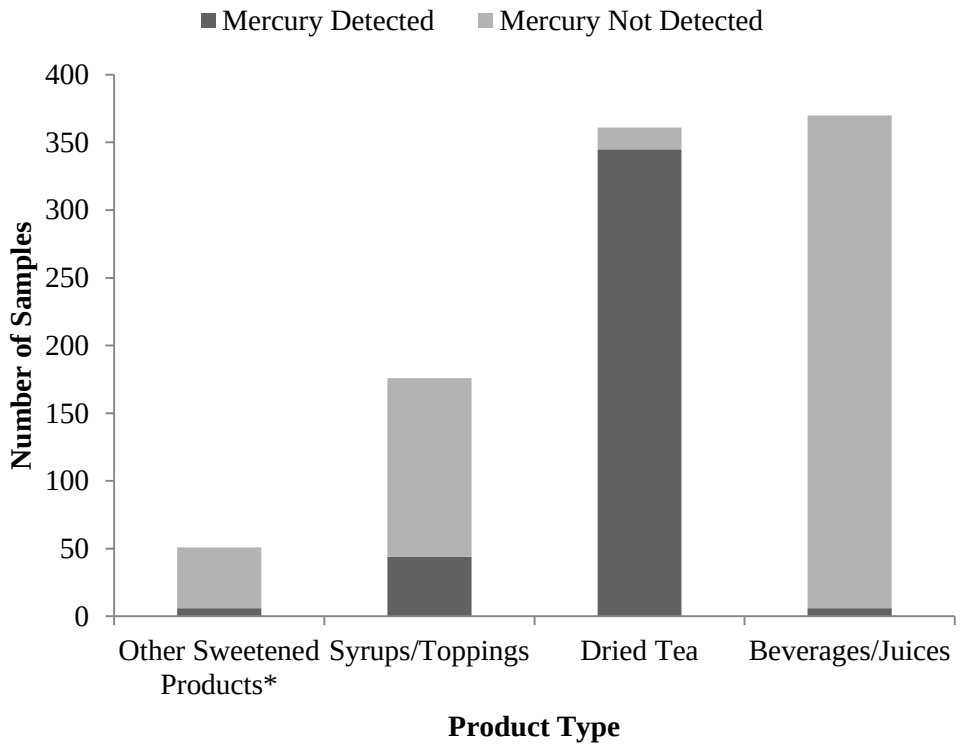
Analysis was completed on products as available on the Canadian retail market. Some of the products sampled in this survey are intended to be used as ingredients (e.g. syrups and toppings) or require preparation prior to consumption (e.g. brewing of dried tea prior to consumption). The results should only be interpreted as finished food products available as sold and not as they would be consumed.

Country of origin was assigned for the samples collected based on information provided by the sampler or as indicated on the product label; however, no inferences or conclusions were made regarding the data with respect to country of origin. Regional differences, impact of product shelf-life, storage conditions, or cost of the commodity on the open market were not examined in this survey.

3. Results and Discussion

3.1. Overview of Mercury Results

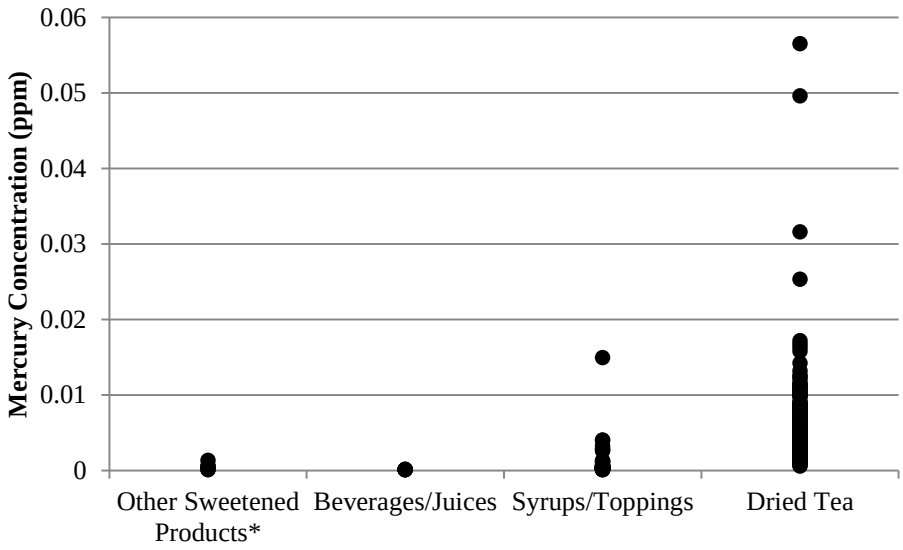
The 2011-2013 Mercury in Selected Foods Targeted Survey consisted of testing 958 samples obtained at the Canadian retail level. Overall, 58% of the samples tested did not contain any detectable level of mercury. Mercury was detected in 42% of the samples tested in the current survey and the detected levels ranged from 0.0001 ppm to 0.0565 ppm. Figure 1 shows the number of survey samples per product type and includes the number of samples for which mercury was detected.



*Other sweetened products included canned fruit, non-dairy coffee whitener, jam/jelly/spreads, sugar, sugar substitutes and other confectionary products. Refer to Table 1 for a complete listing of sample types.

Figure 1. Distribution of samples by product type (arranged by increasing number of samples)

Figure 2 illustrates the range of mercury concentrations detected in survey samples. Only samples with a detectable level of mercury are displayed. Overall, dried teas had the highest maximum and average levels of mercury detected. Beverages/juices, syrups/toppings, soft drinks, and other sweetened products all contained considerably lower mercury concentrations than the dried tea samples.



*Other sweetened products included canned fruit, non-dairy coffee whitener, jam/jelly/spreads, sugar, sugar substitutes and other confectionary products. Refer to Table 1 for a complete listing of sample types.

Figure 2. Concentration of mercury in samples by product type (arranged by increasing number of samples with a detectable residue of mercury)

The results of this survey are summarized by product type in Table 2 below. It should be noted that the average mercury results discussed throughout were calculated using only those samples for which mercury was detected (i.e., the average of the positive results only).

Table 2. Minimum, maximum, and average mercury levels in foods in which mercury was detected (arranged in order of decreasing average mercury concentration)

Product Type	Number of Samples	Number of Positive Samples	Percentage of Positive Samples	Minimum (ppm)	Maximum (ppm)	Average* (ppm)
Dried Tea	361	345	95.6%	0.0006	0.0565	0.0045
Syrups/Toppings	176	44	25.0%	0.0001	0.0149	0.0011
Other Sweetened Products**	51	6	11.8%	0.0001	0.0013	0.0005
Beverages/Juices	370	6	1.6%	0.0001	0.0002	0.0001
TOTAL	**958**	**401**	**41.9%**	**0.0001**	**0.0565**	**0.0040**

*Average of positive results only.

**Other sweetened products included canned fruit, non-dairy coffee whitener, jam/jelly/spreads, sugar, sugar substitutes and other confectionary products. Refer to Table 1 for a complete listing of sample types.

All results were shared with, and evaluated by, Health Canada, which determined that the mercury concentrations reported in the 2011-13 FSAP survey are not expected to pose an unacceptable health risk.

3.2. Mercury Results by Product Type

Each of the four product types are discussed in the following sections. Where feasible, Section 3.3 provides a comparison of the survey results to ranges of mercury levels reported in previous FSAP mercury surveys.

3.2.1. Dried Tea

In the current survey, 361 dried tea samples of domestic and imported origins were analyzed for mercury. Teas originated from a wide variety of countries; the top five countries of origin being China, Canada, USA, England, and Taiwan. Tea samples were analyzed as sold, not as they would be consumed (i.e. not brewed/prepared as per the package instructions). Concentrations in brewed tea would be expected to be lower, given that the solubility of mercury is low. A total of 345 samples (95.6%) contained a detectable level of mercury. Mercury concentrations ranged from 0.0006 ppm to 0.0565 ppm. Compared to the range of concentrations observed, the average concentrations of mercury by tea type were relatively similar, with average mercury concentrations ranging from 0.0021 ppm in miscellaneous tea types (called “Tea – Other” in Figure 3) to 0.0063 ppm in herbal teas. With the exception of four samples, all of the dried tea samples exhibited a similar range of mercury concentrations. See Figure 3 for the concentrations of mercury detected in dried tea samples. There did not appear to be any relationship between tea type and the level of mercury detected.

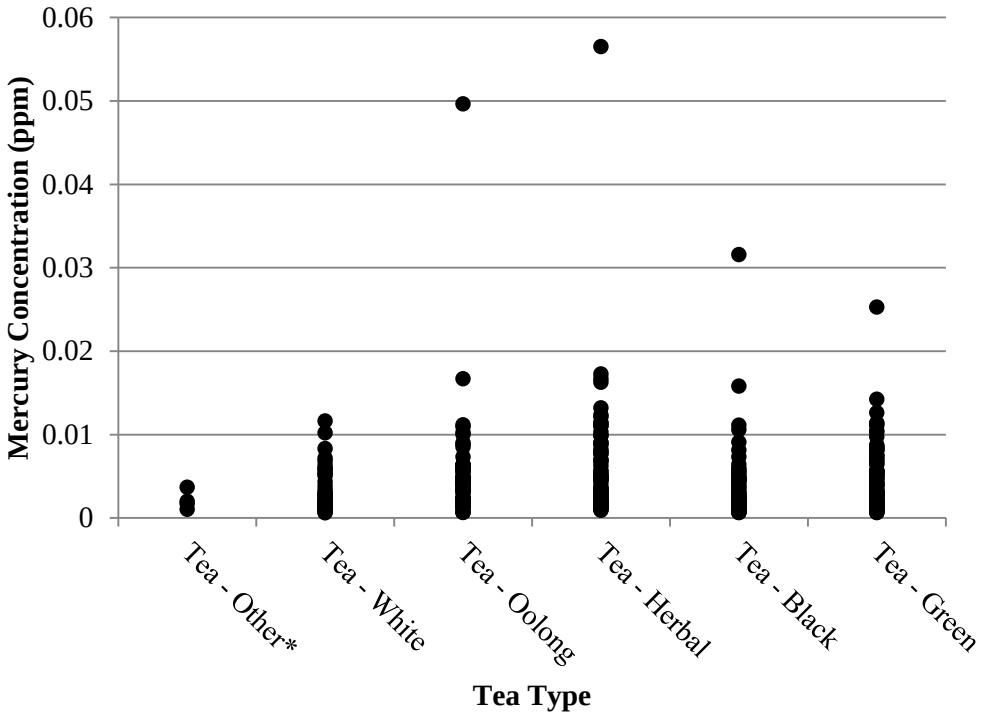


Figure 3. Concentration of mercury in dried tea samples (arranged by increasing number of samples with detectable concentrations of mercury)

3.2.2. Syrups/Toppings

One-hundred and seventy-six samples of syrups and toppings were analyzed, and a total of only 44 syrup/topping samples (25%) contained a detectable level of mercury. The highest maximum mercury value (0.0149 ppm) was detected in a topping sample, which was four times greater than the next highest concentration, and was considered an isolated occurrence. The concentrations of mercury detected were fairly consistent across syrup/topping types regardless of the source of sugar (i.e., corn-based sweeteners versus sugar cane-based or beet-based sugar). Figure 4 shows the concentrations of mercury detected in each of the syrup/topping samples tested.

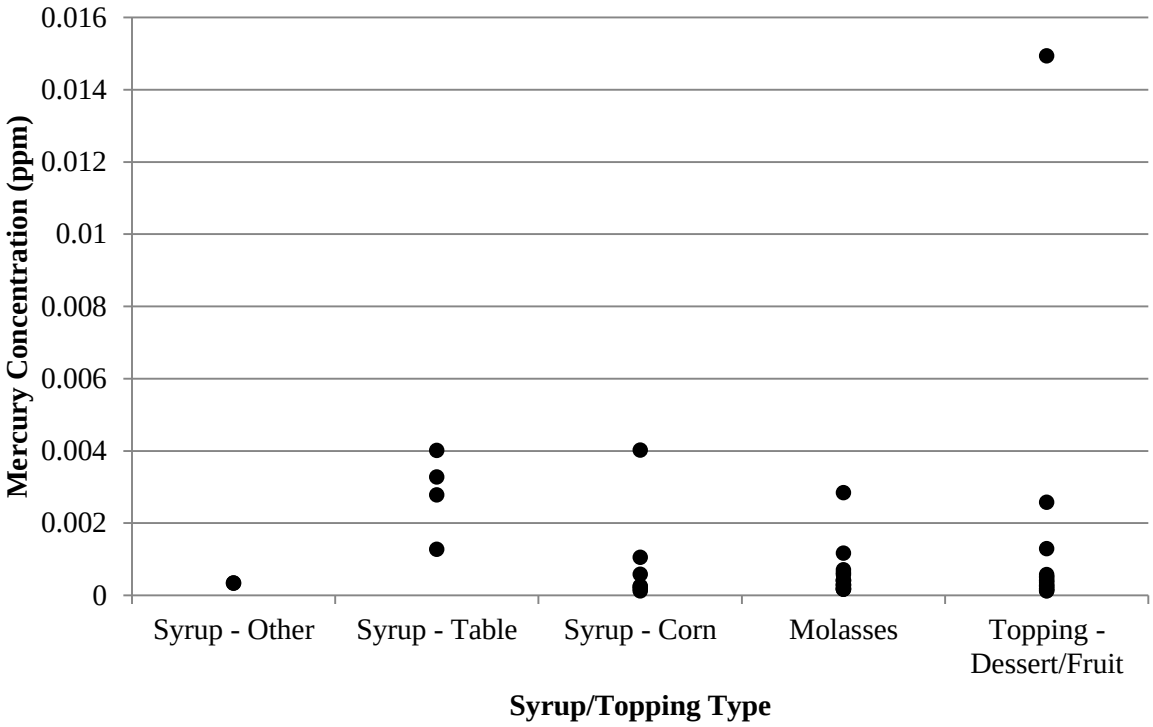


Figure 4. Concentration of mercury in syrup/topping samples by product type (arranged by increasing number of samples with detectable concentrations of mercury)

3.2.3. Other Sweetened Products

This product category included a variety of highly sweetened products which were intended to examine whether differences in concentrations of mercury could be related to the presence of HFCS. A total of fifty-one samples were analyzed, and overall, the prevalence of mercury in the various other product types tested was low (six samples; 12%). Both sugar and sugar substitute samples (which included saccharin, aspartame, and sucralose-based sweeteners) did not have a detectable level of mercury. Products in which mercury was detected at very low concentrations included three coffee whitener products (maximum mercury concentration detected was 0.0013 ppm), one canned fruit sample (0.0001 ppm), one single jam sample (0.0001ppm), and one marinade product (0.0002 ppm). No relationship between the presence of HFCS in the list of ingredients and mercury concentration was apparent in the six samples with detectable levels of mercury.

3.2.4. *Beverages/Juices*

Three-hundred and seventy beverage/juice samples were analyzed for this survey. Samples consisted of beverages, nectars, drinks, juices, soft drinks, energy drinks, sports/electrolyte beverages and cocktail mixes. Of the 370 products analyzed, only six were found to contain a

detectable level of mercury. Detectable levels were very low, ranging from 0.0001 ppm to 0.0002 ppm.

3.3. Mercury Results Compared to Previous Mercury Data

Two previous CFIA FSAP targeted surveys have examined the levels of mercury in corn syrups, soft drinks, and dried tea[6,7]. Common sample types were compared across survey years where possible.

Corn Syrups

In 2010-2011, 50 samples of corn syrup were collected and analyzed for mercury. Only 5 samples had a detectable level of mercury, with a maximum concentration of 0.0003 ppm and an average concentration of 0.0002 ppm. In the current survey, 40 samples of corn syrup were sampled and analyzed. Seven samples had a detectable level of mercury with a maximum concentration of 0.0040 ppm and an average concentration of 0.0009 ppm. Based on frequency of detection and even the concentrations positive samples, results from 2011-13 are consistent with those from previous surveys. See Figure 5 for a comparison of mercury levels detected in the two surveys.

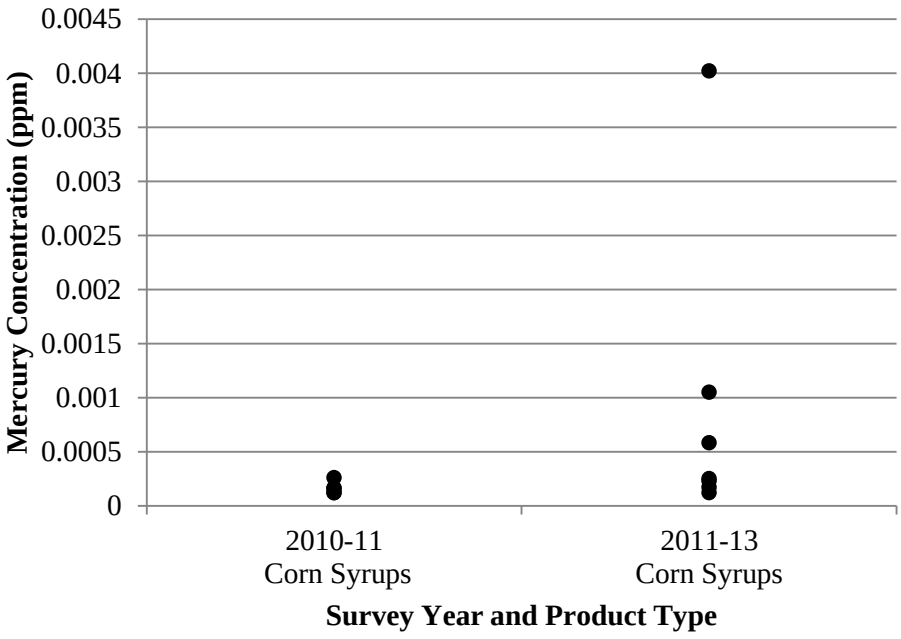


Figure 5. Comparison of mercury concentrations in corn syrups sampled in 2010-2011 and 2011-2013

Soft Drinks

In the 2010-2011 survey, a total of 143 soft drink samples were collected and analyzed for mercury. Eight of the 143 samples (6%) were found to contain a detectable level of mercury. The maximum and average mercury concentrations were 0.00038 ppm and 0.0002 ppm, respectively. In the 2011-2013 survey, only five of the 183 samples of soft drinks (3%) collected and analyzed had a detectable level of mercury. The maximum (0.00015 ppm) and average values (0.0001 ppm) detected were comparable to those reported in the previous survey. There was no apparent trend regarding soft drink type/flavour and mercury concentration. See Figure 6 for a comparison of mercury concentrations detected in the two survey years.

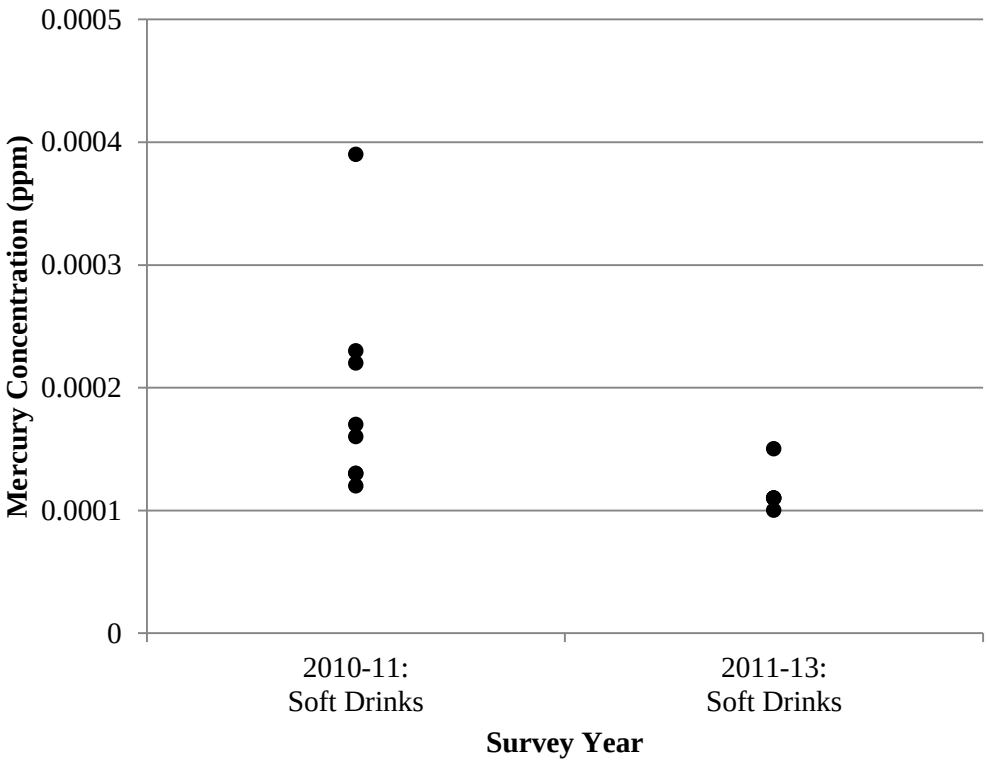


Figure 6. Comparison of mercury concentrations in soft drinks sampled in 2010-2011 and 2011-2013

Tea

Metals in dried tea have been the subject of two previous FSAP targeted surveys. The first survey performed in 2009-2010, examined levels of pesticides and metals in 100 dried tea samples. It was found that 32% of samples contained mercury concentrations ranging from 0.0050 ppm to 0.0303 ppm, and the average mercury concentration in the samples was 0.0081 ppm. As a result of finding appreciable levels of mercury in dried tea, a second survey was initiated in 2010-2011 to further examine mercury occurrence in tea in more detail. In that

survey, 193 samples of dried tea were collected and analyzed. 86.5% of these samples had a mercury concentration ranging from 0.0005 ppm to 0.0233 ppm. The average mercury concentration was lower in the 2010-2011 survey, 0.0047 ppm; this may be due to differences in the analytical methods' detection limit between the two years.

In the current 2011-2013 survey, 361 samples of dried tea were collected and analyzed, and 95.6% of these samples had a detectable level of mercury. The maximum value detected was 0.0565 ppm, and the average was comparable to that of the 2010-2011 survey year (for which the analytical methods' detection limit were consistent) at 0.0045 ppm. The percentage of samples with detectable levels of mercury increased from 32% of 2009-10 samples containing detectable levels of mercury, to 86.5% in 2010-11; and 95.6% of samples from 2011-13 containing a detectable level of mercury. The cause of this increase is related to a reduction in the limit of detection for the 2010-11 and 2011-13 survey years. There were no discernible trends related to tea types in any of the survey years or from year to year. See Figure 7 for a comparison of mercury levels detected in dried tea by survey year.

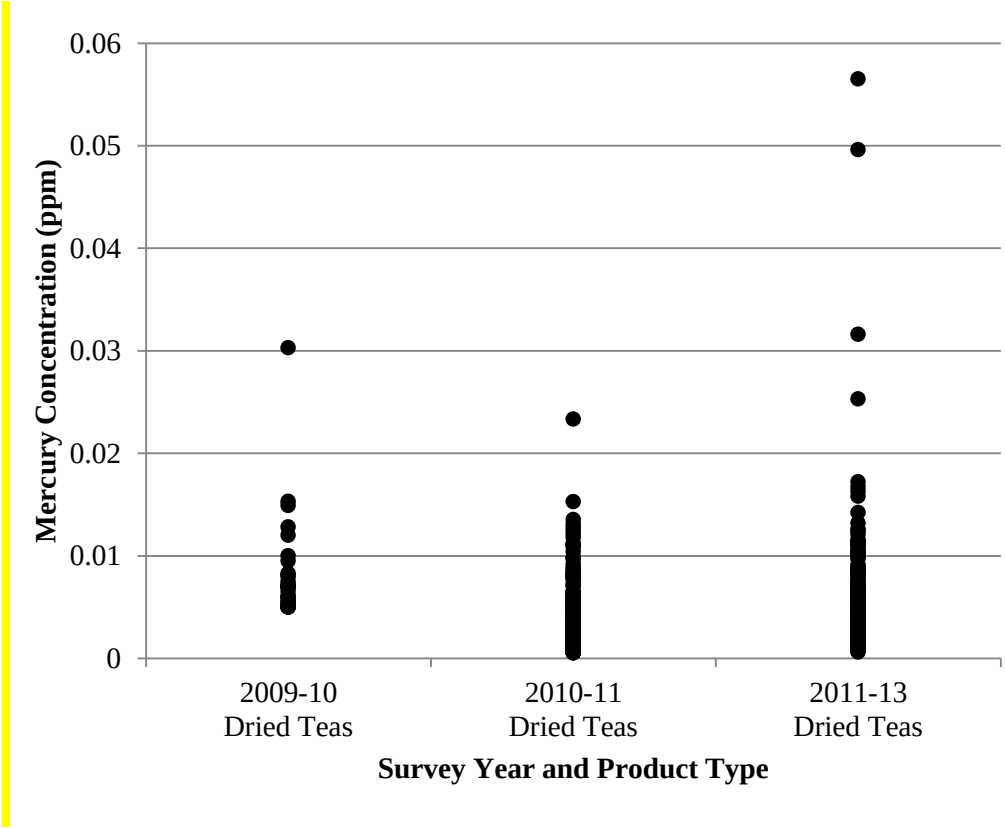


Figure 7. Comparison of mercury concentrations in dried tea samples sampled in 2009-2010, 2010-2011, and 2011-2013 surveys

4. Conclusions

The 2011-2013 Mercury in Selected Foods Targeted Survey generated baseline surveillance data on the prevalence and concentration of mercury in domestic and imported food products.

Nine-hundred and fifty-eight products were sampled for this survey, including beverages/juices, dried teas, syrups/toppings, and other sweetened products. A total of 58% of samples tested did not have a detectable level of mercury. The highest maximum and average mercury concentrations were found in dried teas, which also had the highest prevalence of mercury detected (96%). Beverage/juice samples exhibited the lowest prevalence of mercury, with only 2% of samples analyzed having a detectable level of mercury; as well as exhibiting the lowest maximum and average mercury concentrations.

Comparison of the data from the current survey with previous FSAP targeted survey data found that the average concentrations of mercury in dried tea samples was relatively consistent from year to year, but the prevalence of mercury detected had increased over each survey year which is explained by the lower limit of detection of the analytical method in more recent surveys. Comparison of corn syrups found that the prevalence of mercury and the average concentration of mercury detected were reasonably consistent. Comparison of soft drinks showed that the prevalence and levels of mercury detected were consistently low between survey years.

As no maximum level, tolerance, or standard has been established by Health Canada for mercury in foods examined in this survey, compliance with Canadian regulations was not evaluated. All data generated were shared with Health Canada for use in human health risk assessments. Health Canada's Food Directorate determined that the levels of mercury found in these surveys were not expected to pose an unacceptable health concern and therefore no follow-up actions were needed.

5. References

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