Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

FOOD SAFETY ACTION PLAN

REPORT

2013-2014
TARGETED SURVEYS - CHEMISTRY

Bisphenol A in Canned Foods

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Table of Contents

Executive Summary

Targeted surveys are used by the Canadian Food Inspection Agency (CFIA) to focus its surveillance activities on areas of highest risk. The information gained from these surveys provides both support for the prioritization of the Agency's activities to areas of greater concern and scientific evidence to address areas of lesser concern. Originally started under the Food Safety Action Plan (FSAP), targeted surveys have been incorporated into the CFIA's regular surveillance activities as a valuable tool for generating essential information on certain hazards in foods, identifying/characterizing new and emerging hazards, informing trend analysis, prompting/refining human health risk assessments, assessing compliance with Canadian regulations, highlighting potential contamination issues, and promoting compliance.

The main objectives of this targeted survey were:

- to provide baseline data on the presence and levels of bisphenol A (BPA) in canned vegetables, fruits, juices/beverages, soft/energy/sports drinks, infant formula, pastas, soups, pie fillings, coconut milks, and curry sauces/products available on the Canadian retail market; and
- to compare the prevalence of the levels of BPA found in this survey with other Canadian and international data, where feasible.

Bisphenol A (BPA) is a chemical used in the production of polycarbonate and epoxy resins. Food and beverage packaging, particularly metal cans, may be internally coated with epoxy resins to protect food from direct contact with metal. BPA can migrate from the epoxy coatings into food, particularly at elevated temperatures (e.g., in hot-filled or heat-processed canned foods). Elevated BPA concentrations have been associated with food products contained in syrups, sauces (i.e., tomato sauce), and salted water.

Health Canada's Food Directorate has concluded that the current dietary exposure to BPA through food packaging is not expected to pose a health risk to the general population, including newborns and young children. This conclusion has been re-affirmed by other international food regulatory agencies, including those of Canada's major trading partners. As a result, the use of BPA in food packaging materials has not been prohibited in Canada. Health Canada has recommended that the general principle of ALARA (as low as reasonably achievable) be applied by food packaging manufacturers and food processors to limit dietary BPA exposure from food packaging, particularly for products consumed by infants and newborns. In this regard, Health Canada's Food Directorate found that BPA is generally not detectable in canned powdered infant

formula products available for sale in Canada and in December 2014 (subsequent to collection of the samples analyzed for the current survey), Health Canada confirmed that major manufacturers of infant formula had phased out the use of BPA-containing packaging for liquid infant formula.

A total of 391 domestic and imported samples were collected and analyzed in the 2013-2014 BPA targeted survey. Samples included 93 pastas/soups, 70 vegetables, 55 infant formula samples, 54 juices/beverages, 43 ready-to-consume energy/sports/soft drinks, 38 fruit products, 20 pie fillings, 13 coconut milks, and 5 curry products. Only canned products were sampled, as these products are likely to have epoxy coatings. Bisphenol A was not detected in 35.5% of the survey samples. The level of detection for all samples ranged from 0.001 ppm (found in a tropical fruit salad sample) to 0.565 ppm (detected in a single corn sample).

The current FSAP survey had similar detection rates of BPA in the commodities sampled in comparison to the previous FSAP surveys, international studies, and the NCRMP data. Overall, the results of the current targeted survey are similar to previous FSAP surveys, other Canadian studies, and international data.

There are no Canadian regulations or maximum levels (tolerances or standards) for BPA in foods sold in Canada, so compliance to a numerical standard could not be assessed. Health Canada's Bureau of Chemical Safety determined that none of the samples analyzed for BPA in this survey posed a concern to human health and therefore no product recalls were warranted.

The CFIA will continue its surveillance activities and inform the Canadian public and stakeholders of its findings.

1 Introduction

1.1 Targeted Surveys

The Canadian Food Inspection Agency (CFIA) monitors both domestic and imported foods for the presence of allergenic, microbiological, chemical, and physical hazards. One of the tools used to maintain this oversight are targeted surveys, which are a means to establish baseline information on specific hazards and to investigate emerging risks. Targeted surveys are part of the Agency's core activities along with other surveillance strategies, which include the National Chemical Residue Monitoring Program (NCRMP), the National Microbiological Monitoring Program (NMMP), and the Children's Food Project (CFP). The surveys are complementary to other CFIA surveillance activities in that they examine hazards and/or foods that are not routinely included in those monitoring programs.

Targeted surveys are used to gather information regarding the possible occurrence or prevalence of hazards in defined food commodities. These surveys generate essential information on certain hazards in foods, identify or characterize new and emerging hazards, inform trend analysis, prompt or refine human health risk assessments, assess compliance with Canadian regulations, highlight potential contamination issues, and/or influence the development of risk management strategies as appropriate.

Due to the vast number of hazard and food commodity combinations, it is not possible, nor should it be necessary, to use targeted surveys to identify and quantify all hazards in foods. To identify food-hazard combinations of greatest potential health risk, the CFIA uses a combination of scientific literature, the media, 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 main objectives of this survey were to generate baseline surveillance data on the levels of bisphenol A (BPA) in canned juice/beverage/fruit products, canned vegetables, infant formula and assorted non-fruit based canned food/beverage products available on the Canadian retail market. The results of this survey were compared with previous FSAP results[1,2,3,4], National Chemical Residue Monitoring Program (NCRMP)[5], Health Canada[6,7,8] and U.S. Food and Drug Administration (FDA)[9, 10] survey data, and to scientific literature[11, 12, 13, 14, 15], where feasible.

Bisphenol A (BPA) has garnered attention in recent years because of potential human health concerns, widespread human exposure, and limited dietary exposure information[16,17,18]. The purpose of this targeted survey was to complement and add to

existing baseline data on the levels of BPA in canned foods available at the Canadian retail level.

1.2 Acts and Regulations

The specific acts and regulations applicable to this survey are described below.

The *Food and Drugs Act* (FDA) is the legal authority that governs the sale of food in Canada. 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 *Food and Drug Regulations* (FDA and FDR).

Currently, no maximum level, tolerance, or standard has been established by Health Canada for BPA in food and therefore, compliance with Canadian regulations or standards was not evaluated in this survey.

Health Canada's Food Directorate[19,20] has recommended that the general principle of ALARA (as low as reasonably achievable) be applied by food packaging manufacturers and food processors to limit BPA exposure from food packaging applications, particularly for products consumed by infants and newborns. Similarly, Canada's major trading partners[21], and other international food safety authorities[22] have supported initiatives to reduce BPA exposure from food packaging applications, including development of alternative materials. In addition, the European Union has introduced a specific migration limit for BPA into food from packaging (0.6 mg bisphenol A per kg food)[23].

Levels of BPA in specific foods above historical levels may be assessed by Health Canada on a case-by-case basis using the most current scientific data available. 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 Bisphenol A (BPA)

Bisphenol A (BPA) is an industrial chemical used in the production of polycarbonate plastics and epoxy-phenolic resins[24,25]. It does not occur naturally in the environment. BPA is permitted for use in food-contact materials in many countries, including Canada[26]. However, Health Canada has banned the importation, sale, and advertising of polycarbonate baby bottles containing BPA, and many countries have since followed suit[27,28,29,30]. Food and beverage packaging, particularly metal cans, may be coated on the inside of the container with epoxy resins to prevent corrosion and protect food from direct contact with metal. BPA can migrate from the epoxy coating into food, especially at elevated temperatures (for example, in hot-filled or heat-processed canned foods)[31].

Various opinions remain as to whether BPA poses a health concern and uncertainty remains regarding BPA-related effects at low dose levels[32]. Some studies have shown that BPA is an estrogenic chemical, which acts as an endocrine disruptor, and may have other negative health effects[33,34,35,36,37]. Although various food regulatory agencies, including Health Canada, the United States Food and Drug Administration (US FDA), the European Food Safety Authority (EFSA), and Food Standards Australia New Zealand (FSANZ), recognize this uncertainty, each agency has indicated that current dietary exposure to BPA for the general population is not expected to represent a health concern. Given the concerns of consumers, and the continued efforts to limit BPA exposure from food packaging applications for newborns and infants, alternative BPA-free can coatings have been developed and made available by the can coating industry. These BPA-free can coatings have undergone a pre-market assessment by Health Canada[38], and in December 2014 (subsequent to collection of the samples analyzed for the current survey), Health Canada confirmed that major manufacturers of infant formula had phased out the use of BPA-containing packaging for liquid infant formula[39].

2.2 Rationale

In a recent health risk assessment, Health Canada concluded that current dietary exposure to BPA through food packaging is not expected to pose a health risk to the general population, including newborns and young children[19]. Uncertainties remain about BPA-related effects at low dose levels and opinions vary about the potential health effects associated with exposure to BPA[32].

Four CFIA targeted surveys[1,2,3,4], the CFIA National Chemical Residue Monitoring Program (NCRMP)[5], as well as several Health Canada surveys[19,] have generated baseline data on levels of BPA in various foods. These surveys indicated that BPA is present at

very low levels in some infant foods, ready-to-serve and concentrate infant formulas, tuna, pasta, soup, juice, and vegetables, particularly those in metal cans or glass jars with metal lids. Additionally, data published by Canada's major trading partners showed low levels of BPA in some canned fruits, canned vegetables, canned pastas, and canned soups[9]. Elevated BPA concentrations have been associated with products contained in syrups, sauces (i.e., tomato sauce), and salted water[40].

The purpose of this targeted survey was to generate additional baseline data on the levels of BPA in canned foods, in particular those packed in sauces, syrups, and salted water.

2.3 Sample Distribution

The 2013-2014 survey targeted domestic and imported canned products, as these products are likely to have epoxy coatings which may leach BPA. A total of 391 samples were collected from grocery and specialty stores in six Canadian cities between May 2013 and March 2014 by samplers under contract with the Government of Canada. The samples collected included 93 pastas/soups, 70 vegetables, 55 infant formula samples, 54 juices/beverages, 43 ready-to-consume energy/sports/soft drinks, 38 fruit products, 20 pie fillings, 13 coconut milks, and 5 curry products.

The 391 survey samples included 24 domestic products, 253 imported products, and 114 products of unspecified origin. In general, an unspecified country of origin refers to those samples for which the origin could not be determined from the product label or sample information. 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. The samples originated in at least 26 countries, including Canada, The distribution of samples collected in this survey with respect to the country of origin (as recorded on the sampling documentation or indicated on the product label) is presented in Table 1.

Table 1: Distribution of samples by category type and origin

Category	Number of Samples of Domestic Origin	Number of Imported Samples	Number of Samples of Unspecified Origin*	Total Number of Samples
Canned Curry Sauces/Products	-	5	-	5
Canned Coconut Milks	-	13	-	13
Canned Pie Fillings	2	5	13	20
Canned Fruits	-	38	-	38
Canned RTC Energy, Sports, and Soft Drinks**	-	19	24	43
Canned Fruit Juices/Beverages	1	48	5	54
Canned Infant Formula	5	39	11	55
Canned Vegetables	1	68	1	70
Canned Pastas/Soups	15	18	60	93
Grand Totals	**24**	**253**	**114**	**391**

*Unspecified refers to those samples for which the country of origin could not be assigned from the product label or available sample information
**RTC – Ready-to-Consume

2.4 Limitations

The current targeted survey was designed to provide a snapshot of the levels of BPA in selected canned foods available to Canadian consumers, and had the potential to highlight commodities that warrant further investigation.

Few inferences or conclusions were made regarding the data with respect to country of origin. Regional differences, impact of product shelf-life, packaging and storage conditions, or cost of the commodity on the open market were also not examined in this survey.

The limited sample sizes analyzed represent a small fraction of the products available to Canadian consumers. Therefore, care must be taken when interpreting and extrapolating these results.

3 Results and Discussion

3.1 Overview of BPA Results

The 2013-2014 BPA targeted survey consisted of testing 391 canned food samples obtained at the Canadian retail level. The samples included 135 canned fruit/juice/beverage products, 70 canned vegetables, 55 infant formula samples, and 131 mixed products from foods/beverages that are non-fruit-based (canned pastas/soups, pie fillings, coconut milk, and curry products). BPA was not detected in 35.5% of the survey samples. Bisphenol A was detected in 53 samples of canned fruit/juice/beverage products, 28 samples of infant formula, 59 samples of canned vegetables, and 112 samples of canned mixed products.

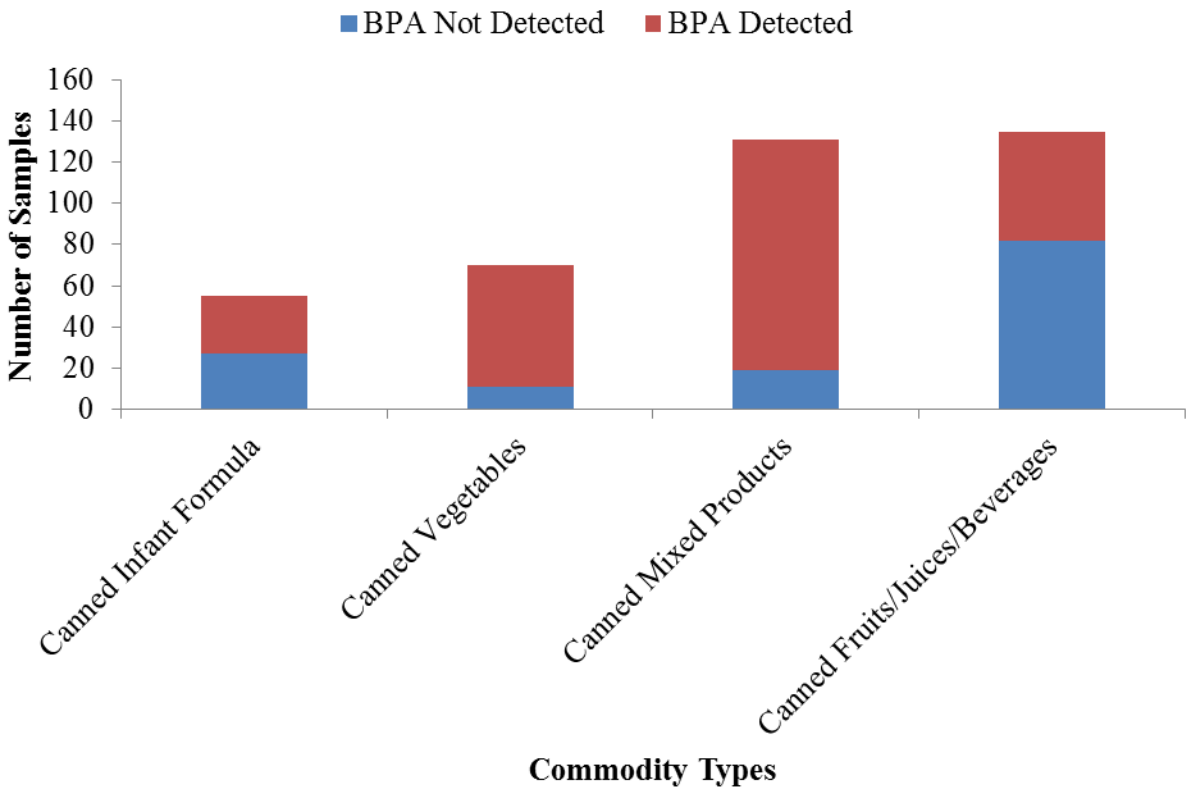
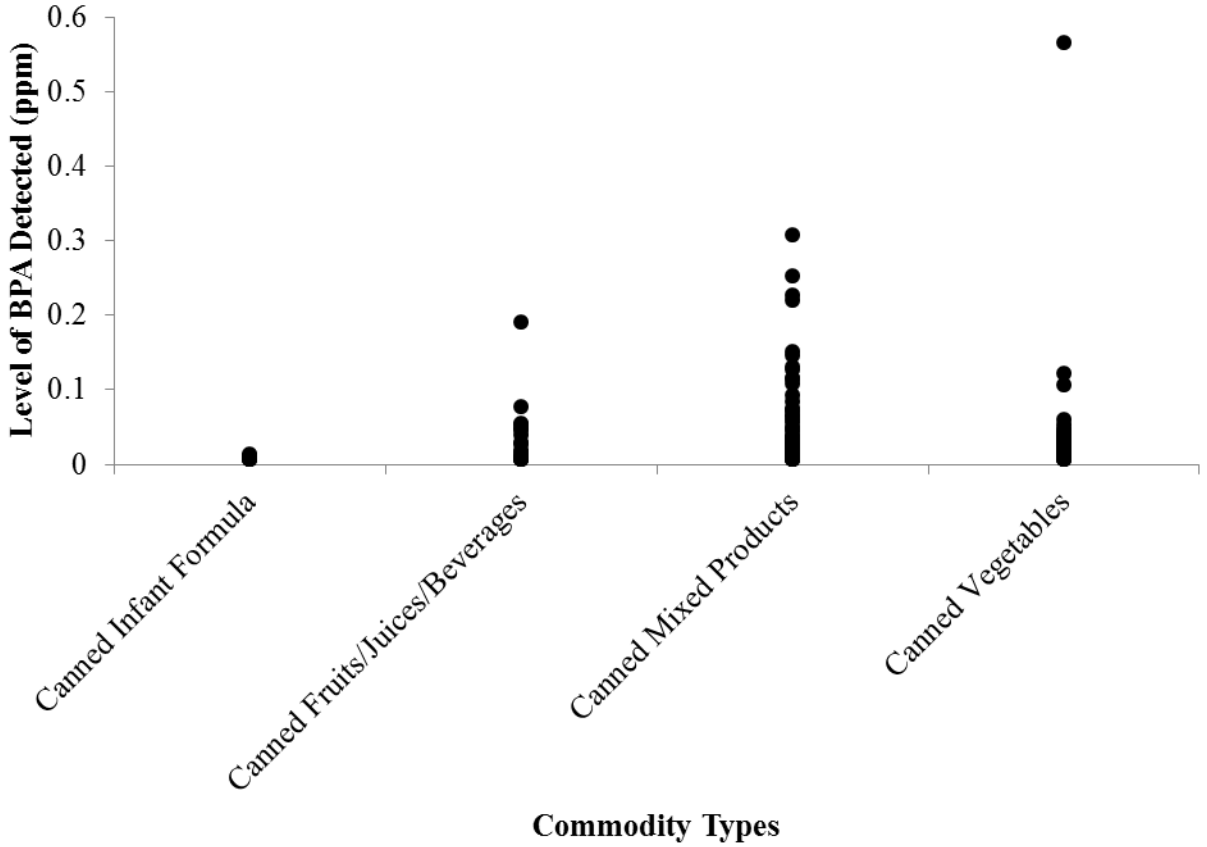


Figure 1: Distribution of samples by product type (arranged by increasing number of samples per commodity type)

From Figure 1, overall, canned mixed products had the highest positive detection rate for BPA (85.5%), whereas canned fruit/juice/beverage products had the lowest rate of detection (39.3%). The maximum level of BPA (0.565 ppm) was observed in a can of organic golden corn, and the minimum level of BPA (0.001 ppm) was found in a can of tropical fruit salad – see Figure 2 below. It should be noted that the average BPA results discussed below were calculated using only those samples for which BPA was detected (i.e., average of the positive results only). Average BPA levels ranged from 0.0048 ppm (infant formula) to 0.0842 ppm (coconut milk).



*Only the levels above the limit of detection are depicted in the graph.

Figure 2: Comparison of the levels of BPA detected by product type (arranged by increasing maximum level of BPA detected)

There are no Canadian regulations or maximum levels (tolerances or standards) for BPA in foods sold in Canada, so compliance to a numerical standard could not be assessed. Health Canada's Bureau of Chemical Safety determined that none of the samples analyzed for BPA in this survey posed a concern to human health.

3.2 BPA Results by Product Type

Results by product type are presented in the following sections. Comparisons were made with available data from previous FSAP surveys[1,2,3,4], NCRMP[5], Health Canada[6,7,8], FDA[9,10] and scientific literature, where feasible[11,12,13,14,15].

3.2.1 Canned Fruits/Juices/Beverages

One hundred and thirty-five canned fruit/juice/beverage samples were analyzed in this survey, including fruit beverages, canned fruits, energy drinks, soft drinks, fruit juice, and sports drink samples. BPA was detected in 39% of all canned fruit/juice/beverage products sampled in the current survey. The levels of BPA detected ranged from 0.001 ppm (in a canned tropical fruit salad) to 0.19 ppm (in a canned fruit punch). Canned juices and energy/soft/sports drinks all had lower rates of detection, maximum, and average values for BPA in comparison to the canned fruits and canned fruit beverages sampled in this survey. No relationship between BPA levels and the media used to package the fruit products (syrup, juice, or water) was noted.

Table 2: Overview of the Results of the Canned Juices/Beverages and Fruit Products sampled (arranged in increasing order of maximum level of BPA detected)

Commodity	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
Canned Sports Drinks	3	1 (33)	-	0.0011	-
Canned Soft Drinks	16	2 (13)	0.0011	0.0033	0.0022
Canned Energy Drinks	24	5 (21)	0.0019	0.0053	0.0036
Canned Juices	12	3 (25)	0.0027	0.0060	0.0039
Canned Fruits	38	19 (50)	0.0010	0.0536	0.0067
Canned Fruit Beverages	42	23 (55)	0.0014	0.1900	0.0186
Grand Totals	**135**	**53 (39)**	**0.0010**	**0.1900**	**0.0111**

*Average is calculated using only the results of the samples testing positive for BPA.

The detection rate of BPA in canned fruits/beverages/juices in this survey is higher than in the previous FSAP survey results[2,3,4], and the 2011-2012 National Chemical Residue Monitoring Program (NCRMP) data[5]. This difference is likely due to a higher LOD

(0.005 ppm; a 5-fold less sensitive than the current year's method) used in the previous surveys. The US FDA and Health Canada studies had similar LODs to the current study, and also had comparable detection rates. The levels of BPA in this targeted survey (range: 0.001-0.19 ppm) were higher than both the US FDA[9] and Health Canada[6] studies (ranges of 0.0027-0.019 ppm and 0.0012-0.00324 ppm, respectively). The reasons for the above discrepancies are unknown, but may reflect the typical variability of BPA levels in these types of products. Conversely, the average detected value of BPA in the current FSAP survey is comparable to a survey conducted in the United Kingdom[11].

Table 3: Comparison of the canned fruits and juices/beverages sampled in the 2013-2014 targeted survey to the scientific literature

Survey (Year)	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
FSAP (2013-2014)	92	45 (49)	0.001	0.19	0.029
FSAP[4] (2012-2013)	148	3 (2)	0.0059	0.012	0.009
FSAP[3] (2011-2012)	151	0 (0)	-	< LOD**	-
FSAP[2] (2010-2011)	107	0 (0)	-	< LOD**	-
NCRMP[5] (2011-2012)	9	1 (11)	-	0.0025	-
US FDA[9] (2011)	14	8 (57)	0.0027	0.019	0.008
Health Canada[6] (2008)	4	2 (50)	0.0012	0.00324	0.002
UK BPA Survey[11] (2002)	2	2 (100)	0.019	0.0375	0.028

*Average is calculated using only the results of the samples testing positive for BPA.

**LOD = 0.005 ppm

Note: The US FDA and Health Canada surveys included canned fruit products.

3.2.2 Canned Infant Formula

Fifty-five samples of infant formula were analyzed in this survey. The infant formula samples were in the form of liquid concentrates and powders (requiring water dilution prior to consumption), as well as in the form of ready-to-serve liquids. Please note that the samples were analysed as sold, and so were not prepared/diluted before analysis for BPA. Approximately half of the infant formula samples had detectable levels of BPA ranging from 0.0011 ppm (in powdered dairy-based and soy-based infant formula) to 0.0125 ppm (in dairy-based liquid concentrate infant formula). The maximum levels of BPA in infant formula were observed in the samples of liquid concentrates. BPA was detected almost twice as frequently in soy-based infant formulas, however dairy-based infant formula had a higher maximum concentration (0.0125 ppm). Dairy-based and soy-based infant formulas had similar average concentrations.

Table 4: Overview of the Results of the infant formula sampled (arranged in increasing order of maximum level of BPA detected)

Commodity	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
Dairy-based Infant Formula	**47**	**22 (47)**	**0.0011**	**0.0125**	**0.0046**
Powdered	7	1 (14)	-	0.0011	-
Ready-to-Serve	30	15 (50)	0.0022	0.0070	0.0036
Concentrate	10	6 (60)	0.0043	0.0125	0.0077
Soy-based Infant Formula	**8**	**6 (75)**	**0.0011**	**0.0092**	**0.0055**
Powdered	2	1 (50)	-	0.0011	-
Ready-to-Serve	1	1 (100)	-	0.0040	-
Concentrate	5	4 (80)	0.0047	0.0092	0.0070
Grand Totals	**55**	**28 (51)**	**0.0011**	**0.0125**	**0.0048**

*Average is calculated using only the results of the samples testing positive for BPA.

The results of this survey were compared to a previously conducted FSAP survey of BPA in infant food and formula along with studies from the scientific literature. By comparing this year's levels of BPA found in infant formula to the samples taken for the 2009-2010 FSAP survey, it can be observed from Table 5 that the minimum, maximum, and average values of detectable BPA in infant formula have remained consistent between the survey years[1]. Only the detection rate has been almost halved in the current year's survey,

despite a five-fold increase in sensitivity of the method. The findings of this survey are also consistent with results from similar Health Canada[7] and US FDA[10] surveys examining the levels of BPA in infant formula products. The HC study analyzed infant formulas as consumed rather than as sold so it is anticipated that their results will be different from this survey which examined foods as sold. The FDA study reported results for products as consumed and as sold. Only the FDA results for products tested as sold are included in Table 5 to make a more valid comparison to this targeted survey data.

Table 5: Comparison of the infant formula samples in the current FSAP targeted survey to the scientific literature

Survey (Year)	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average** Level of BPA Detected (ppm)
FSAP (2013-2014)	55	28 (51)	0.0011	0.0125	0.0048
FSAP[1] (2009-2010)*	77	70 (91)	0.0017	0.0092	0.0053
Health Canada[7] (2008-2009)	21	21 (100)	0.0023	0.0102	0.0051
US FDA[10] (2010)*	86	75 (87)	0.0004	0.0110	0.0055

*Only results of infant formula packaged in metal cans were used for comparison purposes.
**Average is calculated using only the results of the samples testing positive for BPA.

3.2.3 Canned Mixed Products

Ninety-three canned pasta/soup samples, 20 fillings, 13 of coconut milk, and five curry sauces/products (e.g. yellow or red curry pastes) were analyzed in this survey. BPA was detected in all samples except for one sample of coconut milk, six samples of soup, and twelve samples of pie fillings. The observed BPA levels ranged from 0.0012 ppm to 0.3070 ppm– see Table 6 below for more details.

Table 6: Overview of the Results of the Canned Mixed Product sampled as presented by product type (arranged in increasing order of maximum level of BPA detected)

Commodity	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
Pie Fillings	20	8 (40)	0.0034	0.0473	0.0223
Pastas	45	45 (100)	0.0067	0.0930	0.0195
Curry Products	5	5 (100)	0.0062	0.2260	0.0755
Coconut Milk	13	12 (92)	0.0048	0.2530	0.0842
Soups	48	42 (88)	0.0012	0.3070	0.0426
Grand Totals	**131**	**112 (85)**	**0.0012**	**0.3070**	**0.0378**

*Average is calculated using only the results of the samples testing positive for BPA.

Of the 87 samples of pasta/soup found with detected levels of BPA, 21required adding water before consumption and the remaining 66 were ready-to-consume. Comparing the results of the current targeted survey to similar surveys conducted by the US FDA[9], and by Health Canada[6,8], it was found that observed average levels of BPA detected in this survey were lower than the levels found in literature, especially as the FDA, UK and HC studies analysed samples as consumed whereas the FSAP surveys examined samples as sold – see Table 7 below for more details.

Table 7: Comparison of the canned soups and pastas sampled in the 2012-2013 Targeted Survey to the scientific literature

Survey (Year)	Commodities Examined in the Survey	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
FSAP (2013-2014)	Pastas and Soups	93	87 (94)	0.0012	0.3070	0.062
FSAP[4] (2012-2013)	Pastas and Soups	224	93 (42)	0.0052	0.2770	0.045
FSAP[3] (2011-2012)	Pastas	101	1 (1)	-	0.0730	-
US FDA[9] (2011)	Pastas and Soups	12	12 (100)	0.0120	0.0740	0.038
Health Canada[8] (2010)	Pasta and Soups	42	42 (100)	0.0021	0.0945	0.041
Health Canada[6] (2008)	Soups	4	3 (75)	0.0222	0.0444	0.032
UK Study[11] (2002)	Soups	10	4 (40)	0.0075	0.0210	0.015

*Average is calculated using only the results of the samples testing positive for BPA.

The coconut milks sampled in this survey were compared to two academic studies and to the previous year's (2012-2013) FSAP survey results. The positive detection rate of BPA in canned coconut milk samples more than doubled in the 2013-2014 FSAP survey year compared to the previous year. Unfortunately, due to the limited sample size of the Kawamura and Thompson studies[12,13], the positive detection rates cannot be compared. The average and maximum BPA values in the current survey are within the range of the other three comparative surveys.

Table 8: Comparison of coconut milk sampled in the 2012-2013 FSAP Targeted Survey to the scientific literature

Survey (Year)	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
FSAP (2013-2014)	13	12 (92)	0.0048	0.253	0.084
FSAP[4] (2012-2013)	50	19 (38)	0.0054	0.381	0.063
Kawamura[12] (2013)	1	1 (100)	-	0.200	-
Thomson[13] (2005)	3	2 (67)	0.0290	0.192	0.111

*Average is calculated using only the results of the samples testing positive for BPA.

Only five samples of curry sauces/products were analyzed in this targeted survey. In the 2012-2013 FSAP BPA in Canned Foods survey[4], 25 samples of curries were tested for BPA. Because of a five-fold difference in sensitivity of the method from year to year, only the maximum observed level value was compared; the maximum levels are similar for the two survey years.

Table 9: Comparison of curry sauces/products sampled in the 2013-2014 FSAP Targeted Survey to the 2012-2013 FSAP BPA Survey

Survey (Year)	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
FSAP (2013-2014)	5	5 (100)	0.0062	0.226	0.076
FSAP[4] (2012-2013)	25	3 (12)	0.0880	0.298	0.227

*Average is calculated using only the results of the samples testing positive for BPA.

3.2.4 Canned Vegetables

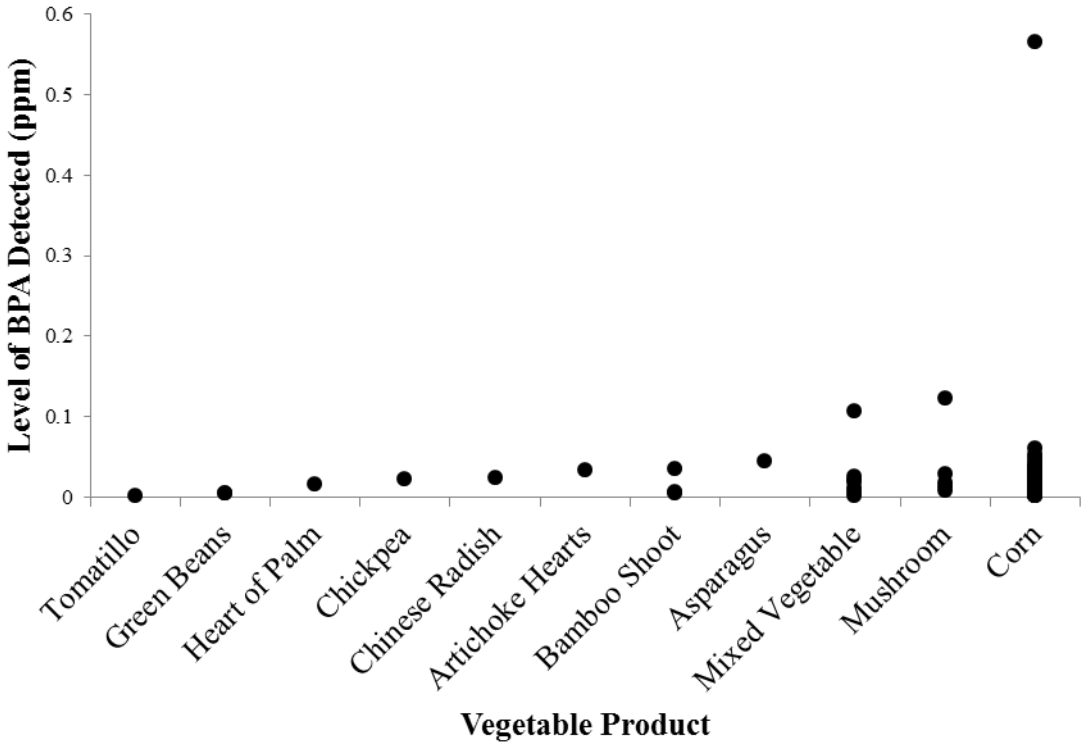
Seventy canned vegetable samples were analyzed in this survey, including chickpeas, heart of palm, tomatillo, artichoke hearts, mushrooms, asparagus, bamboo shoots, Chinese radish, green beans, and mixed vegetables. The majority of the canned vegetable samples (84%) had detectable levels of BPA ranging from 0.0011 ppm to 0.565 ppm (both values are from samples of canned corn).

Table 10: Overview of the results of the canned vegetable products sampled as presented by product type (arranged in increasing order of average level of BPA detected)

Vegetable Product	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
Tomatillo	1	1 (100)	-	0.0014	-
Heart of Palm	1	1 (100)	-	0.0162	-
Chickpeas	1	1 (100)	-	0.0226	-
Chinese Radish	1	1 (100)	-	0.0230	-
Artichoke Hearts	1	1 (100)	-	0.0327	-
Asparagus	1	1 (100)	-	0.0446	-
Green Beans	2	2 (100)	0.0042	0.0051	0.0046
Bamboo Shoots	5	3 (60)	0.0050	0.0340	0.0149
Mixed Vegetables	9	7 (78)	0.0018	0.1060	0.0269
Corn	43	36 (84)	0.0011	0.5650	0.0362
Mushrooms	5	5 (100)	0.0070	0.1220	0.0376
Grand Totals	**70**	**59 (84)**	**0.0011**	**0.5650**	**0.0318**

*Average is calculated using only the results of the samples testing positive for BPA.

BPA was detected in all samples except two samples each of bamboo shoots and mixed vegetables, and seven samples of canned corn– see Figure 3 below for more details. Three samples (one each of corn, mushrooms, and mixed vegetable) had elevated levels of BPA relative to the other canned vegetable products.



*Only the levels above the limit of detection are depicted in the graph.

Figure 3: Levels of BPA detected in the canned vegetables sampled during the 2013-2014 Targeted Survey

Comparing the canned vegetable results of the current targeted survey to similar surveys conducted by the United States[9,14], Health Canada[8], Japan[15] and the UK[11], as well as NCRMP surveillance data[5], it was found that both the observed detection rate and average levels of BPA and maximum level of BPA in canned vegetables analyzed in this survey fall within the levels reported in the literature. The maximum BPA level in the current survey was higher than in all the other studies reported, including the FDA study.

Table 11: Comparison of the canned vegetable products sampled in the 2013-2014 Targeted Survey to the scientific literature

Survey (Year)	Total Number of Samples	Number of Samples with Detectable levels of BPA (Percentage)	Minimum Level of BPA Detected (ppm)	Maximum Level of BPA Detected (ppm)	Average* Level of BPA Detected (ppm)
FSAP (2013-2014)	70	59 (84)	0.0011	0.565	0.032
FSAP[4] (2012-2013)	143	30 (21)	0.0055	0.103	0.035
FSAP[3] (2011-2012)	151	5 (3)	0.0180	0.307	0.121
NCRMP[5] (2011-2012)	13	4 (31)	0.0079	0.112	0.046
US FDA[9] (2011)	25	23 (92)	0.0026	0.500	0.095
Texas BPA Study[14] (2010)	12	12 (100)	0.0004	0.065	0.014
Japanese BPA Study[15] (2001)	9	8 (89)	0.0184	0.095	0.047
UK BPA Study[11] (2002)	10	10 (100)	0.0090	0.048	0.024
Health Canada[8] (2010)	15	15 (100)	0.0043	0.092	0.021

*Average is calculated using only the results of the samples testing positive for BPA.

4 Conclusions

The present survey generated additional baseline surveillance data on the levels of bisphenol A (BPA) in domestic and imported canned products available on the Canadian retail market.

A total of 391 products were sampled, which included 135 juice/beverage/fruit products, 93 pastas/soups, 70 vegetables, 55 infant formula samples, 20 pie fillings, 13 coconut milks, and 5 curry sauces/products. Only canned products were sampled, as these products are likely to have epoxy coatings.

Bisphenol A was not detected in 35.5% of the survey samples. BPA was detected in 39% of canned juices/beverages/fruit products samples, 40% of pie fillings, 51% of infant formulas, 84% of canned vegetables, 94% of pasta/soups, and 100% of coconut milk and curry sauces/products samples. The observed BPA levels ranged from 0.001 ppm to 0.565 ppm.

In comparing the detection rates for BPA, the previous NCRMP and FSAP survey results are comparable to the current FSAP survey's findings. Along with publications from the

US FDA, Health Canada, the UK and Japan, the current targeted survey generally found comparable concentrations of BPA.

Currently, no tolerances, standards, regulations or maximum levels exist in Canada for BPA in foods that are sold in Canada; therefore compliance could not be assessed to a numerical standard. The results of the BPA in Selected Foods survey were evaluated, and Health Canada's Bureau of Chemical Safety was consulted on the observed BPA levels. Health Canada determined that none of the samples posed a concern to human health. No product recalls were carried out.

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