Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Bisphenol A and BPA Alternatives in Selected Foods - April 1, 2016 to March 31, 2017

Food chemistry - Targeted surveys - Final report

Canada

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.

Bisphenol A (BPA) is a chemical used to make Bisphenol A diglycidyl ether (BADGE) epoxy resins and hard plastic containers[1]. Its use in the food industry is common, as BADGE epoxy resins are often coated on the inside of cans to prevent direct contact between the food and the metal. These compounds can migrate into food, particularly at elevated temperatures (for example, in hot-filled or heat-processed canned foods) [2,3].

To prevent these adverse health effects of these compounds[4,5,6,7], some manufacturers have turned to BPA alternatives such as Bisphenol F (BPF) and Bisphenol S (BPS)[8]. Limited data is available concerning the use of BPA alternatives in canned and bottled foods, therefore they were included in this survey.

A total of 491 samples were collected from retail stores in 6 cities across Canada. The samples collected included a variety of 9 product types in various packaging materials. Products tested included: beverages, coconut milk, fruit, infant formulas, pastas, pie fillings, sauces, soups and vegetables. The majority of samples (464) collected were canned products, while the remaining samples (27) were packaged in: glass jars or bottles, plastic bottles or pouches, or Tetra Pak®.

All samples surveyed were tested for the presence of BPA, BADGE, BPF and BPS. BPA was detected in 361 (74%) of all samples surveyed, BADGE was detected in 5 (1%), BPF was detected in 3 (0.6%), and none tested positive for BPS. BADGE, BPF and BPS were not detected in any infant formula products.

The average level of BPA detected in all products was 87.2 parts per billion (ppb), The average and maximum levels detected in canned products were 91.6 ppb and 2240 ppb. The average level detected in samples packaged in other materials was 15.2 ppb, with a maximum level observed of 188 ppb. The results from this survey were comparable to those found in literature.

The levels of BPA, BADGE and BPF observed in this survey were evaluated by Health Canada who determined that none of the samples would pose an unacceptable human health concern, therefore there were no recalls resulting from this survey.

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

The main objectives of this targeted survey were to generate baseline surveillance data on the prevalence of BPA, BADGE and its alternatives in foods on the Canadian retail market, and to compare the prevalence of these compounds in foods targeted in this survey with that of similar products in previous targeted surveys and in scientific literature. BPA is an industrial chemical used to make BADGE epoxy resins and clear hard plastic known as polycarbonate. It can be found in many items including tableware, storage containers, and food packaging. BADGE epoxy resins are also used as protective linings on the inside of metal containers and metal lids to prevent the corrosion of the metal and subsequent contamination of foods and beverages by dissolved metals. However, as a result of the use of these liners, chemical components of food packaging like epoxy resins and polycarbonate come in contact with food. Residues of BPA can then migrate from the liners into the food, especially at elevated temperatures (such as in hot-fill or heat-processed canned foods)[1,2,3].

The negative health effects of BPA are well-documented. Exposure at high levels has been shown to be associated with infertility, breast cancer, prostate cancer[4], and some evidence suggests that it can also contribute towards heart problems, liver problems and diabetes[5]. BPA is a known endocrine disrupting chemical (EDC) that can contribute to the development of various diseases such as reproductive dysfunction[9]. It is also a nervous system disruptor that impacts hormone function[10]. The International Agency for Research on Cancer (IARC) has found some evidence of BADGE's carcinogenic effects in animals, although there is not enough evidence to conclude that it is carcinogenic in humans[6]. Current studies suggest that BADGE may also be an endocrine disruptor, but further evidence is needed for conclusive

corroboration[11,12]. Health Canada has stated that the health risk associated with BADGE is considered moderate based on available toxicological information[7].

Due to these adverse health effects, manufacturers have supported initiatives to reduce BPA exposure from food packaging applications, including development of alternative materials. This targeted survey also looked at the presence of 2 BPA alternatives: BPF and BPS. These compounds are generally considered to be safer than BPA, although their toxicity is not well-known and some evidence suggests exposure to these compounds can have adverse health effects[8]. Limited data is available on the extent of their usage by manufacturers, which is why the CFIA considered it important to include these compounds in this survey.

What did we sample

A variety of domestic and imported products including canned meat, fish and seafood were sampled between April 1, 2016 and March 31, 2017. 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 (Ottawa, Toronto)
- West (Calgary and Vancouver)

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 packaging type and origin

Product type	Number of domestic samples	Number of imported samples	Number of samples of unspecified[a] origin	Total number of samples
Canned products	76	287	101	464
Other packaging materials	3	13	11	27
Total	**79**	**300**	**112**	**491**

[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. The results are based on the food products as sold and not necessarily as they would be consumed.

In the absence Maximum Limits (MLs) for BPA and BADGE, levels were assessed by Health Canada on a case-by-case basis using the most current scientific data.

What were the survey results

Tables 2 and 3 below, illustrate the range of BPA concentrations detected in the survey samples by canned products and other packaging respectively. BPA was detected at an average level of 140 ppb in canned products and 6.7 ppb in products in other packaging. BPA was detected in 340 (73%) of 464 canned products and in 21 (78%) of 27 products in other packaging.

Table 2. Results of Bisphenol A (BPA) testing in canned products in ppb

Product type	Number of samples	Number of samples (%) with detected levels	Minimum	Maximum	Average[b]
Canned beverages	135	91 (67)	1.7	639	40.8
Canned coconut milk	14	12 (86)	24.2	1370	306
Canned fruit	50	34 (68)	2.0	1160	62.1
Canned infant formula	66	46 (70)	2.3	44.0	8.7
Canned pasta	48	39 (81)	1.6	270	86.7
Canned pie filling	20	16 (80)	8.5	2240	281
Canned sauce	13	5 (38)	1.9	1120	228
Canned soup	46	39 (85)	2.5	410	107
Canned vegetables	72	58 (81)	5.3	751	139

[b] Only positive results were used to calculate averages

Table 3. Results of Bisphenol A (BPA) testing in products in other packaging in ppb

Product type	Number of samples	Number of samples (%) with detected levels	Minimum	Maximum	Average[c]
Plastic bottle beverages	8	6 (75)	1.1	4.1	2.2
Plastic pouch beverages	1	1 (100)	6.7	6.7	N/A[d]
Tetra Pak® beverages	5	4 (80)	1.5	1.9	1.6
Glass bottle infant formula	1	1 (100)	2.2	2.2	N/A[d]
Plastic bottle infant formula	6	5 (83)	3.1	45.7	17.4
Tetra Pak® infant formula	3	3 (100)	2.2	8.5	5.4
Glass jar sauce	1	0 (0)	N/D[e]	N/D[e]	N/A[e]
Plastic pouch sauce	1	1 (100)	188.0	188.0	N/A[d]
Soup (Tetra Pak®)	1	0 (0)	N/D[e]	N/D[e]	N/A[e]

[c] Only positive results were used to calculate averages
[d] Average not available (N/A) as only one value was obtained
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[e] Not detected (N/D) at or above the minimum method detection level

Bisphenol A (BPA)

Within the canned products category, 340 of 464 samples tested contained BPA. Maximum levels in canned product categories exceeded those in other packaging, with the exception of infant formula which was detected in plastic bottles at 45.7 ppb and 44.0 ppb in canned products. The highest levels were detected in canned pie filling, coconut milk, fruit and sauces.

The highest BPA level was found in an imported canned pumpkin filling product at 2240 ppb. This sample was significantly higher than the next highest canned pie filling sample at 530 ppb. Neither of these products contained other BPA analogues. In this survey, 19 of the 20 canned pie filling samples tested were imported products, while 1 was of unknown origin. No domestic canned pie filling or pie filling in other packaging were sampled.

All 14 of the coconut milk samples tested were imported canned products, 12 of which were positive for BPA. The highest level of BPA found in canned coconut samples was 1370 ppb. This samples was significantly higher than the next highest canned coconut milk product which was 478 ppb. This sample contained no other BPA analogues.

All of the fruit samples tested (50) were imported canned products. The highest level detected was found in an organic pineapple slices in organic pineapple juice product at 1160 ppb. This was significantly higher than the next highest canned fruit sample at 186 ppb.

Of the 5 canned sauces that tested positive for BPA, the highest level of 1120 ppb was found in an imported green curry paste. This was significantly higher than the next highest canned sauce sample which tested positive at 7.5 ppb. This product was a tomato sauce of unknown origin that also tested positive for BADGE. Of the 5 domestic tomato sauce samples tested, 1 tested positive for BPA.

A larger number of samples were collected in each of the remaining canned product categories of beverages (135), infant formula (66), pasta (48), soup (46), and vegetables (72) and produced comparable average BPA levels ranging from 8.7 ppb in canned infant formula to 138 ppb in canned vegetables. The maximum level of BPA detected in canned infant formula was similar to the highest level detected in other packaging at 44.0 ppb and 45.7 ppb respectively. Only 9 infant formula samples in other packaging contained BPA. Overall, average levels of BPA detected in canned infant formula and in other packaging materials were similar.

Bisphenol A diglycidyl ether (BADGE), Bisphenol F (BPF) and Bisphenol S (BPS)

Table 4 shows the results of survey sample testing for BADGE, BPF and BPS in canned products. No canned product samples were reported to contain detectable levels of BPS at the minimum testing detection level and no samples in other packaging materials tested positive for BADGE, BPF or BPS.

Table 4. Positive results of BADGE and BPF testing in canned products in ppb

Product type	Number of samples	Analyte	Number of samples (%) with detected levels	Minimum	Maximum	Average[g]
Coconut milk	14	BADGE	4 (29)	16.1	224	109
Sauces	13	BADGE	1 (8)	14.3	14.3	N/A[h]
Vegetables	72	BPF	3 (4)	2.4	3.8	3.3

[g] Only positive results were used to calculate averages

[h] Average not available (N/A) as an individual value was obtained

There were 5 samples containing BADGE, 4 of which also contained BPA. Of the 4 samples that tested positive for both BADGE and BPA, 3 were imported coconut milk products of different product brands, while the fourth was a tomato sauce product of unknown origin. The highest level of BADGE was 224 ppb and detected in an imported canned coconut milk sample that did not contain BPA. All 3 survey samples that contained BPF were imported bamboo shoots that also tested positive for BPA. Two of the samples that tested positive for BPF were from the same product brand, but from different lot numbers.

Of the 491 samples surveyed, BADGE and BPF were only detected in 5 (1%) and 3 (0.6%) of samples respectively. while none tested positive for BPS. Neither BADGE, BPF or BPS were detected in the majority (6 of 9) of product types. No infant formula products surveyed contained BADGE, BPF or BPS regardless of packaging type.

What do the survey results mean

The current survey of 464 canned products tested was compared with data from targeted surveys conducted in previous years for a total of 1390 samples surveyed. Overall, BPA levels detected in this survey were comparable to amounts found in similar commodities in previous years (Table 5). Across all nine product categories and survey years, BPA was detected at average values that ranged from 4.8 ppb in infant formula to 306 ppb in coconut milk. The majority of commodities surveyed (19 of 24) contained average levels of BPA that were consistently below 100 ppb across all survey years. Any elevated maximum levels in coconut milk, fruit, pie filling and sauces observed in the current survey were attributed to individual samples as noted in the previous Bisphenol A (BPA) discussion.

There are a wide range of factors that can affect BPA levels in foods. BPA research shows that differences can be attributed to the specific type of product tested, sample size, or the composition of the internal polymeric can lining[14,15]. Processing temperature as well as the presence of sodium chloride, glucose, fats and vegetable oils have also been shown to influence the transfer of BPA from can linings into food[13,16,17]. A current research study in canned vegetables further evidences that migration of BPA is affected by food type, product brand, pH, fat and water content[18]. Therefore, some differences observed between maximum and average BPA levels between commodities and product types are expected due to the variation of sample numbers included in each study.

Table 5. Minimum, maximum and average concentration of BPA in canned products across previous survey years in ppb

Product type	CFIA Survey year	Number of samples	Number of samples (%) with detected levels	Minimum	Maximum	Average[i]
Beverages	2016	135	91 (67)	1.7	639	40.8
Beverages	2013	97	34 (35)	1.1	190	13.6
Beverages	2012	72	2 (3)	5.9	12.0	9.0
Coconut milk	2016	14	12 (86)	24.2	1370	306
Coconut milk	2013	13	12 (92)	4.8	253	84.2[d]
Coconut milk	2012	46	17 (37)	5.4	381	63.0[d]
Fruit	2016	50	34 (68)	2.0	1160	62.1
Fruit	2013	38	19 (50)	1.0	53.6	6.7[d]
Fruit	2012	73	1 (1)	8.6	8.6	N/A[j]
Infant formula	2016	66	46 (70)	2.3	44.0	8.7
Infant formula	2013	55	28 (51)	1.1	12.5	4.8
Infant formula	2010	37	0 (0)	N/D[k]	N/D[k]	N/D[k]
Pasta	2016	48	39 (81)	1.6	270	86.7
Pasta	2013	34	45 (100)	6.7	93.0	19.5
Pasta	2012	52	52 (100)	5.2	157	21.9
Pie filling	2016	20	16 (80)	8.5	2240	281
Pie filling	2013	20	8 (40)	3.4	47.3	22.3
Sauces (curry, tomato)	2016	13	5 (38)	1.9	1120	228
Sauces (curry)	2013	5	5 (100)	6.2	226	75.5
Sauces (curry)	2012	24	3 (12)	88.0	298	227
Soup	2016	46	39 (85)	2.5	410	107
Soup	2013	48	42 (88)	1.2	307	42.6
Soup	2012	98	39 (40)	5.7	277	76.2
Canned vegetables	2016	72	58 (81)	5.3	751	138
Canned vegetables	2013	70	59 (84)	1.1	565	31.8
Canned vegetables	2012	144	30 (21)	5.5	103	34.0

[i] Only positive results were used to calculate the average BPA levels

[j] Average not available (N/A) as only one value was obtained

[k] Not detected (N/D) at or above the minimum method detection level

There are no regulations in Canada for BPA or BADGE levels in food. All levels of BPA and BADGE found in the products tested in this survey were evaluated by HC who determined that

none of the samples would pose an unacceptable human health concern, therefore there were no recalls resulting from this survey.

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