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

Bisphenol A and BPA Alternatives in Selected Canned Foods and Infant Formula - April 1, 2018 to March 31, 2019

Food chemistry - Targeted surveys - Final report

Summary

Targeted surveys provide information on potential food hazards and enhance the Canadian Food Inspection Agency's (CFIA's) routine monitoring programs. These surveys provide evidence regarding the safety of the food supply, identify potential emerging hazards, and contribute new information and data to food categories where it may be limited or non-existent. They are often used by the Agency to focus surveillance on potential areas of higher risk. Surveys can also help to identify trends and provide information about how industry complies with Canadian regulations.

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 componds[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 381 samples were collected from retail stores in 6 cities across Canada. The samples collected included coconut milk, pie filling, and tomato-based sauces stored in cans, as well as infant formulas stored in cans and plastic containers. BPA was detected in 43% of the survey samples and BADGE was detected in 12%. No samples had detected levels of BPF or BPS. The highest average and maximum BPA levels were reported in coconut milk samples, and the lowest in infant formula. All of the samples that contained BADGE were coconut milk samples. All of these samples also contained BPA. The results from this survey were comparable to those found in international surveys and a variety of scientific studies.

The levels of BPA, BADGE, BPF and BPS observed in this survey were evaluated by Health Canada (HC) 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 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 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]. 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]. Health Canada (HC) 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 tested for 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 canned products including coconut milk, infant formula, pie filling and tomato-based sauces were sampled between April 1, 2018 and March 31, 2019. Samples of products were collected from local/regional retail locations located in 6 major cities across Canada. These cities encompassed 4 Canadian geographical areas: Atlantic (Halifax), Quebec (Montreal), Ontario (Toronto, Ottawa) and the West (Vancouver, and Calgary). The number of samples collected from these cities was in proportion to the relative population of the respective areas. The shelf life, storage conditions, and the cost of the food on the open market were not considered in this survey.

Table 1. Distribution of samples based on product type and origin

Product type	Number of domestic samples	Number of imported samples	Number of samples of unspecified[a] origin	Total number of samples
Coconut milk	0	49	0	49
Infant formula	1	134	0	135
Pie filling	1	94	3	98
Tomato-based sauces	57	16	22	95
Grand total	**59**	**293**	**25**	**377**

[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 HC on a case-by-case basis using the most current scientific data. Any high results of BPA and BADGE were reviewed by Health Canada's Bureau of Chemical Safety to determine if the levels are harmful to consumers.

What were the survey results

Of the 377 samples tested, 164 (44%) had detected levels of BPA, and 12 (3%) had detected levels of BADGE. Table 2 illustrates the range of concentrations detected in the survey samples by product type. Among all product types, there was no significant relationship between brand and BPA or BADGE level. No samples contained detected levels of BPF or BPS.

Bisphenol A (BPA)

Coconut milk products had the highest maximum and average BPA levels of all product types, as well as the highest detection rate of 76%. The detection rate among sampled infant formulas was 13%, the lowest of all product types. All infant formulas included in this survey were liquid and milk-based. Of the 135 infant formulas sampled, 81 were stored in plastic bottles and the remainder in cans. BPA levels in bottled infant formulas were comparable to those of canned infant formulas.

Table 2. Results of bisphenol A testing in coconut milk, infant formula, pie filling and tomato-based sauces.

Product type	Number of samples	Number of samples (%) with detected levels	Minimum (ppb)	Maximum (ppb)	Average[b] (ppb)
Coconut milk	49	37 (76)	1.42	367	47.0
Infant formula	135	17 (13)	0.92	2.24	1.4
Pie filling	98	62 (63)	0.97	101	11.2
Tomato-based sauces	95	48 (51)	1.01	95.9	9.78
Grand total	**377**	**164 (44)**	**0.92**	**367**	**17.8**

[b] Only positive results were used to calculate averages

Bisphenol A diglycidyl ether (BADGE)

Only 12 samples had detected levels of BADGE, of which all were coconut milk samples. Of these samples, 2 contained the highest levels at 209 ppb and 524 ppb. The remaining 10 samples reported levels of less than 63 ppb. The overall average concentration of BADGE was 81.9 ppb.

All samples that contained BADGE also contained BPA. Among these samples, products containing higher-than-average BPA levels tended to have lower-than-average BADGE levels.

What do the survey results mean

In comparison to previous survey years, the maximum BPA levels in all commodity types collected were consistent (Table 3). A slight increase in the detection rates and the reported average BPA levels for products in the 2018 to 2019 survey can be attributed to increase in the method sensitivity. Some differences observed may also be due to decisions made by manufacturers to reduce BPA migration such as using BPA-free epoxy resins and plastics as well as controlling processing temperature[9,10]. Among products packaged in plastic bottles, manufacturers can also affect BPA migration by changing the pH of the product[11].

The wide range of maximum and average BPA levels observed maybe due to the wide range of factors that can affect BPA's migration into foods. Process temperature as well as the presence of sodium chloride, vegetable oils and sugar have been shown to influence the migration of BPA from cans into food[12].

Table 3 includes BPA levels reported in similar tomato-based products, as limited data is available on BPA levels in tomato-based sauces[13].

Table 3. Minimum, maximum and average concentration of BPA across various studies

Product type	Study	Number of samples	Minimum (ppb)	Maximum (ppb)	Average (ppb)
Coconut milk	CFIA survey, 2018 to 2019	49	1.42[d]	367	47.0[c,d]
Coconut milk	CFIA survey, 2013 to 2014	13	4.8	226	75.5[c]
Coconut milk	CFIA survey, 2012 to 2013	48	5.4	381	63[d]
Infant formula	CFIA survey, 2018 to 2019	138	0.92[d]	5.89	1.65[c,d]
Infant formula	CFIA survey, 2013 to 2014	31	2.2	7	3.63[c]
Infant formula	CFIA survey, 2010 to 2011	127	0	0	0
Infant formula	Cao et al. (2007)	21	2.27	10.23	5.12
Pie filling	CFIA survey, 2018 to 2019	98	0.97[d]	101	11.2[c,d]
Pie filling	CFIA survey, 2013 to 2014	20	3.4	47.3	22.3[c]
Tomato-based sauces	CFIA survey, 2018 to 2019	96	1.01[d]	95.9	9.78[c,d]
Canned pasta	CFIA survey, 2013 to 2014	45	6.7	93	19.5[c]
Tomato paste	Cao et al. (2009)	6	0.79	2.1	1.22[c]

[c] Only positive results were used to calculate the average BPA levels
[d] In 2018 to 2019 new improved detection method was used

Only 3% of the samples in this survey reported detected levels of BADGE, all of which were coconut milk samples. This is not unexpected as coconut milk has the highest fat content of foods included in this survey, and BADGE is known to migrate readily into fats[14].

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.

References

1. Bisphenol A (BPA). (2018). Canada. Health Canada.
2. Survey of Bisphenol A in Canned Food Products from Canadian Markets. (2010). Canada. Health Canada.
3. Munguia-Lopez, E.M., Soto-Valdez, H. (2001). Effect of Heat Processing and Storage Time on Migration of Bisphenol A (BPA) and Bisphenol A-Diglycidyl Ether (BADGE) to Aqueous Food Simulant from Mexican Can Coatings. Journal for Agricultural and Food Chemistry, 49(8), pp. 3666-3671.
4. Konieczna, A., Rachon, D., Rutkowska, A. (2015). Health risk of exposure to Bisphenol A (BPA). Rocz Panstw Zakl Hig, 66(1), pp. 5-11.
5. Depledge, M., Galloway, T.S., Henley, W.E., Lang, A.I., Melzer, D., Wallace, R.B. (2008). Association of Urinary Bisphenol A Concentration With Medical Disorders and Laboratory Abnormalities in Adults. JAMA, 300(11), pp. 1303-1310.
6. Re-evaluation of Some Organic Chemicals, Hydrazine and Hydrogen Peroxide. (1999). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, 71, pp. 1285-1289.
7. Draft Screening Assessment Epoxy Resins Group. (2018). Canada. Health Canada.
8. Lehmler, H.-J., Liu, B., Badogbe, M., Bao, W. (2018). Exposure to Bisphenol A, Bisphenol F, and Bisphenol S in U.S. Adults and Children: The National Health and Nutrition Examination Survey 2013–2014. American Chemical Society Omega, 3(6), pp. 6523-6532.
9. Pedersen, G.A., Hvilsted, S., Petersen, J.H. (2015). Migration of bisphenol A from polycarbonate plastic of different qualities: Environmental project No. 1710, 2015. Copenhagen. Danish Ministry of the Environment.
10. Wang, L., Wu, Y., Zhang, W., Kannan, K. (2012). Widespread Occurrence and Distribution of Bisphenol A Diglycidyl Ether (BADGE) and its Derivatives in Human Urine from the United States and China. Environ. Sci. Technol., 46(23), pp. 12968-12976.
11. Mercea., P. (2009). Physicochemical processes involved in migration of bisphenol A from polycarbonate. Journal of Applied Polymer Science, 112, pp. 579-593.
12. Kang, J.-H., Kito, K., Kondo, F. (2003). Factors Influencing the Migration of Bisphenol A from Cans. Journal of Food Protection, 66(8), pp. 1444-1447.
13. Cao, X.-L., Dufresne, G., Belisle, S., Clement, G., Falicki, M., Beraldin, F., Rulibikiye, A. (2008). Levels of Bisphenol A in Canned Liquid Infant Formula Products in Canada and Dietary Intake Estimates.
14. Summerfield, W., Goodson, A., Cooper, I. (1998). Survey of bisphenol A diglycidyl ether (BADGE) in canned foods. Food additives and contaminants, 15(7), pp. 818-830.