Toxic Baby Bottles in Canada

Bisphenol A Leaching from Popular Brands of Polycarbonate Baby Bottles

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Executive Summary

Bisphenol A, a hormone-disrupting chemical used in polycarbonate plastic, has been found to leach out of six major brands of popular baby bottles. Toxic Baby Bottles in Canada: Bisphenol A Leaching from Popular Brands of Polycarbonate Baby Bottles, commissioned by Environmental Defence, tested plastic baby bottles in the United States and Canada, including products made by Gerber, Avent, Playtex, Evenflo, Disney and Dr. Brown, for leaching of bisphenol A. We found these popular bottle brands leach significant levels of bisphenol A (5-8 parts per billion) when heated. Our findings are important to every parent in this country.

Bisphenol A is found in hard, clear plastics, as well as the epoxy resins used in the lining of some food containers, dental fillings and a slew of other products. The chemical can cause damage to reproductive and developmental systems during vulnerable states of human development, such as early childhood and in the womb.

The objectives of this report are to, a) determine whether bisphenol A leaches at measurable levels from widely available baby bottles in Canada and the United States; b) add to the growing body of knowledge on the extent of human exposure to bisphenol A; c) identify a responsible and precautionary legislative approach to managing bisphenol A; and, d) help parents decrease their children's exposure to bisphenol A and other harmful chemicals.

Canada's federal government and the Ontario provincial government are currently considering whether to regulate bisphenol A and other toxic chemicals. The test results of our study indicate that Canada's current lack of regulation of bisphenol A is exposing infants and children to potentially dangerous levels of the chemical.

Key Findings

- The laboratory tests detected 5-8 ng/ml (parts per billion) bisphenol A leached from all bottles when heated;
- The results of Avent brand bottles showed the overall highest levels of bisphenol A, while Playtex brand bottles showed the overall lowest levels of leaching in Canadian bottles; and,
- The levels of bisphenol A leaching increased exponentially when the bottles were heated, with higher concentrations reported from Avent brand bottles. These findings are significant as the general use of baby bottles includes heating them and using them to store warm liquids.

This report calls on the Government of Canada to acknowledge the growing evidence and to act to ensure Canadians are protected from exposure to bisphenol A. We urge all provincial governments to also act on this issue, including timely action by the Province of Ontario in passing its promised *Toxic Use Reduction Act*, as soon as possible.

Background

Bisphenol A was synthesized in the 1890s and then discovered in the 1930s to be an estrogen mimic. Later in the 1950s it was discovered to be a useful compound that can be bonded together to produce commercially valuable plastics.[1] Bisphenol A is used to make polycarbonate plastics — a clear, thick and resilient material found in products such as baby bottles, reusable water bottles, CDs, DVDs and eyewear. Other products containing bisphenol A include dental sealants, and epoxy resins used in the lining of some food and beverage containers. Worldwide production of bisphenol A exceeds six billion pounds per year and demand for the compound has risen significantly in recent years.

Most human exposure to bisphenol A is suspected to be through ingestion. The Government of Canada has recommended an acceptable daily intake for bisphenol A at 25 µg/kg bodyweight/day. The European Food Safety Authority recently set their Tolerable Daily Intake at 50 µg/kg bodyweight/day, with the United States Environmental Protection Agency using the same reference dose. Although biomonitoring studies have found exposure to bisphenol A is below the allowable daily doses, new research has shown that even doses below the 'safe' daily intake levels can alter cell function and show significant health effects in animal studies (see "Health Effects" below), which favors a reassessment of the current levels set by government.

Currently, some 90 per cent of plastic baby bottles in the market are made with bisphenol A, but new scientific research and consumer concern over the safety of polycarbonate and studies have pressured manufacturers and retailers to make changes. Glass baby bottles are widely available, and there is now a clear plastic baby bottle on the market that is bisphenol A-free. Similarly, there are metal drinking water bottles consumers can choose over hard plastic ones, and products such as sippy cups and food cans are often made with material that does not include bisphenol A. Retailers like Mountain Equipment Co-op and Lululemon have removed polycarbonate drinking bottles from their store shelves, responding to consumer awareness.

But consumer pressure, while important, is not enough. Consumers should not have to carry the burden of having to avoid exposure to these chemicals every time they walk down a store aisle. Moreover, for many products, including unlabelled plastics and food cans, it is difficult or impossible to know if the packaging is made with bisphenol A. Government and the private sector must be part of the solution.

Although the Canadian government does not limit the use of bisphenol A in consumer products, Health Canada recently chose bisphenol A (along with 200 other substances in the Chemicals Management Plan) for more careful study to assess the health and environmental effects. Launched in May 2007, the Plan requires industry to provide data on bisphenol A and other substances.

In late December 2007, Health Canada sampled baby bottles, sippy cups and polycarbonate water bottles (for child or adult use) from Ottawa area retail outlets. The bottles were tested for leaching levels of bisphenol A and the results will be provided to the risk assessment group of the Chemicals Management Plan. Based on this data and industry information, a final decision on whether to regulate bisphenol A is expected to be published by Health Canada around May 2008. A previous government assessment found bisphenol A to be inherently toxic and high-potential for exposure to Canadians.

The federal government will also measure bisphenol A in the bodies of 5,000 Canadians as a part of the Canadian Health Measures Survey, expected to reach completion in 2009.

The Ontario government has initiated its own process to review bisphenol A and other priority chemicals, establishing an expert panel to make recommendations that the government has committed to acting on before the end of 2008. It is very likely that, if the federal government fails to act to protect Canadians in this instance, there will be action at the provincial level.

The federal government, using its authority under the *Hazardous Products Act*, should immediately ban bisphenol A from food and beverage containers. There are safe and available alternatives for virtually all such uses of the chemical. For other products containing bisphenol A, the government should employ the *Canadian Environmental Protection Act* to undertake an analysis of available substitutes in establishing a schedule for a longer term phase-out.

Health Effects

The evidence is growing on just how bisphenol A might be changing our bodies. International organizations and scientists have identified bisphenol A as a potential reproductive and developmental toxin, as well as a hormone disrupting chemical leading to a variety of adverse health effects. In addition, two recent panels in the U.S. have pointed to potential health effects of exposure to bisphenol A.[2, 3]

As a hormone disruptor, bisphenol A causes a response in cells similar to the effect of estradiol (estrogen hormone). Bisphenol A strongly binds with estrogen-related receptors but does not replace the activity of estrogen.[4] As a result, bisphenol A may be adding a 'false' estrogen effect in the body, off-setting the hormonal balance required for healthy human development.

Reproductive and Developmental Effects

A recent review of scientific literature affirms that bisphenol A can alter brain chemistry and structure, behavior, reproductive systems, and the immune system in a variety of animals.[5] Some research also indicates that the sexual behavior and sexual development of mice can be impaired and variably altered from bisphenol A-induced hormone disruption.[6] Another study found that female mice exposed to short -term, low doses of bisphenol A experienced sudden and significant increases in genetic abnormalities.[7]

Bisphenol A has been reported to suppress the activation of thyroid hormone-regulated genes in rats.[8] These results show that low doses of bisphenol A can disrupt hormone action within cells by competitively displacing naturally occurring hormones. These hormones regulate the rate of metabolism and the growth of many systems in the body. Thyroid hormones play a significant role in brain development during pregnancy. In preliminary research based on these genetic abnormalities, women with a history of recurrent miscarriage had higher blood serum levels of bisphenol A than women with successful pregnancies.[9]

Low doses of bisphenol A have been shown to have a greater negative effect on fertility than relatively high doses of pesticides.[10] Other studies have shown that bisphenol A can, at low doses, significantly stimulate the release of the hormone prolactin and activate breast cancer cells.[11]

Low Dose Can be Dangerous

Recent studies have challenged the current acceptable daily intake level of bisphenol A, as new scientific evidence shows that even low doses of this chemical can disrupt development. This new research contests the common assumption that high-dose tests reveal health problems that might occur at low dose exposures. Instead, bisphenol A causes different effects at different levels. For example, an experiment involving cells from prostate tumors detected the strongest response to bisphenol A at a low dose, and a decreasing response as the dose increased.[12]

The current acceptable level of bisphenol A is set by Health Canada at 25 µg/kg bodyweight/day, which is a measure in parts per billion (ppb). While research done by Health Canada measured bisphenol A leaching in levels below the 25 µg/kg/day safe daily intake from polycarbonate baby bottles, a number of other scientific studies have shown that bisphenol A levels in parts per trillion have been found to alter cell function. [13] Parts per trillion express a concentration 1,000 times smaller than parts per billion, indicating even low-dose effects of bisphenol A can be potent.

Exposure

With over six billion pounds of bisphenol A imported and used by Canadian industries, we are widely exposed to bisphenol A in our daily lives. Testing of Americans done by the U.S. Centers for Disease Control and Prevention found that 95 per cent of adults studied had bisphenol A in their urine. [14] This is particularly stunning given how little time bisphenol A spends in the body (approximately 10 hours), [15] and indicates that we are continuously being exposed to bisphenol A from the sources around us. Animal studies suggest that bisphenol A is quickly absorbed and eliminated, but some residual remains in the intestines, liver and kidneys for a period of several days. [16]

A U.S. National Institute of Environmental Health Sciences expert panel of 38 leading scientists, released in November 2007, [17] found that most people are exposed to bisphenol A at levels higher than those that cause health effects in animal studies. The Washington, D.C.-based Environmental Working Group found high levels of bisphenol A in canned food, including infant formula, ravioli and chicken soup. [18]

Children

Children are especially vulnerable to bisphenol A because endocrine disruptors affect how their bodies grow and develop. Young children still have immature organ systems, high metabolic rates, relatively low bodyweight, and are going through rapid physical development; therefore, even low levels of repeated exposure may eventually lead to adverse health effects. [19]
An expert panel of the U.S. National Toxicology Program concluded recently that bisphenol A exposure to fetuses and to children could have behavioural and neural system impacts. [20]
Exposure in the womb is particularly worrisome as fetuses have immature detoxification systems and they are at a delicate stage of development. Looking at the potential health effects in vulnerable young bodies, with the knowledge that even low doses of bisphenol A can have a wide range of adverse effects, we obviously need to revaluate the assumptions that calculate our safe daily consumption of bisphenol A. [21]

Bisphenol A is very much present in children's lives. A recent investigation of bisphenol A exposure in preschool children in North Carolina and Ohio (2000-2001) over a 48-hour period found that more than 68 per cent of children's liquid food and more than 83 per cent of their solid food samples contained bisphenol A.[22]

Real World Laboratory

Linking the experimental evidence for bisphenol A with human health effects is difficult for many reasons, including a lack of concrete data on human exposure, other factors contributing to diseases, and the delay between exposure and some health effects. What cannot be disputed is that a number of tests have detected bisphenol A in human tissue and indicate widespread exposure.[23] Coupled with the knowledge of increasing rates of infertility, prostate and breast cancer and other diseases such as diabetes and even obesity, the possible effects of hormone disruptors like bisphenol A cannot be brushed aside. Given the emerging science and growing concern, government needs to strengthen regulations and re-evaluate the acceptable human intake of bisphenol A, otherwise we risk become guinea pigs in our own real world laboratory.

Results

Nine new plastic baby bottles were purchased from a variety of retailers in Toronto, Ontario in November 2007 (see Appendix 1: Purchasing Locations). We selected the most popular, easily available brands from well-known retail outlets. The three Gerber bottles were different sizes of the ComfortHold Premium feeding system bottle package. The Avent Naturally bottles tested were Natural Feeding Bottles with extra soft silicon nipples. The Playtex Avance bottles were from the Bubble-free system.

Table 1. Baby bottles bought in Canada for testing

Brand	Retailer
Gerber	Pharma Plus
	Zellers
	Shoppers Drug Mart
Avent Naturally	Sears
	Shoppers Drug Mart
	The Bay
Playtex	Zellers
	Shoppers Drug Mart
	Pharma Plus

Dr. Frederick S. vom Saal at the University of Missouri-Columbia, a leading researcher on bisphenol A, conducted the analysis for this study. Each bottle was filled with water, sealed and allowed to sit for 24 hours. The 24-hour tests were performed on all bottles for levels of bisphenol A leaching: first at room temperature and then in an oven at 80˚C. The 80˚C treatment simulates repeated washing of the bottles (approximately 60-100 washes) and indicates how much bisphenol A would leach from a well-used bottle.

Table 2. Results of bisphenol A concentrations in baby bottles bought in Canada
nanogram bisphenol A / ml liquid (ng/ml) or ppb

Bottle Sample	Room temperature	Heated (80˚C)
Gerber	ND	7.568
	ND	7.805
	ND	6.495
Avent	0.012	7.439
	ND	8.323
	0.009	7.029
Playtex	0.044	4.294
	0.037	6.578
	0.063	5.004

The average leaching for each bottle when heated:

Gerber 6.78 ng/ml
Avent 7.07 ng/ml
Playtex 4.92 ng/ml

The bottles did not show notable levels of leaching at room temperature but all bottles showed significant levels of leaching in the range of 5-8 ng/ml (ppb) when heated (Table 2).

All reported values of 0.00 ng/ml indicate concentrations that could not be detected (ND) or fell below the limit of detection of the analytical equipment. Nanogram bisphenol A / ml liquid (ng/ml) or ppb

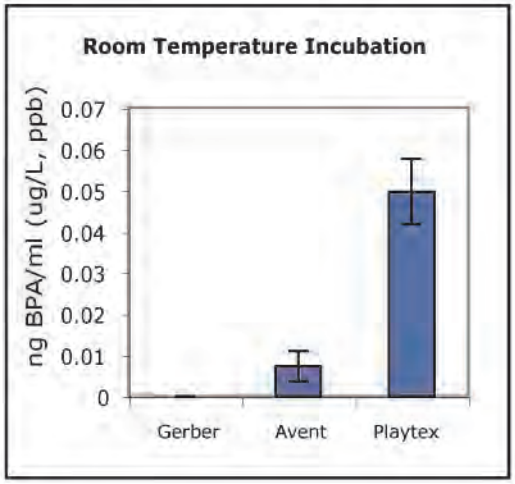

Figure 1. Concentration at room temperature

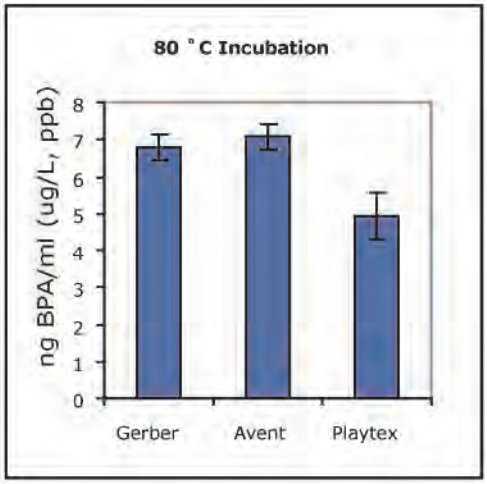

Figure 2. Concentration at 80˚ C

Similar results were observed with the same analysis procedure used on 10 plastic baby bottles purchased from a variety of retailers in the U.S. Four different bottle brands (Avent, Dr. Brown, Evenflo, Disney) were bought from Walgreens, CVS, Target, Wal-Mart, Babies R Us and Toys R Us.

Table 3. Results of bisphenol A concentrations in baby bottles bought in the U.S.

Sample	Room Temperature	Heated 80˚C
Avent	ND	4.775
	ND	5.159
	ND	6.981
Dr. Brown	ND	5.756
	ND	8.307
	ND	7.167
Evenflo	ND	6.189
	ND	7.010
	ND	5.579
Disney	ND	6.405

The average leaching for each bottle when heated:

Avent	5.64 ng/ml
Dr. Brown	7.08 ng/ml
Evenflo	6.26 ng/ml
Disney	6.41 ng/ml

nanogram bisphenol A / ml liquid (ng/ml) or ppb

Based on Dr. vom Saal's large body of research, as well as over 130 peer-reviewed journal articles on bisphenol A,[24] we conclude that the amount leaching from heated bottles is within the realm of harm in animal studies and is a significant health concern.[25]

Additional Findings

While the bottles tested for this report were brand new, leaching from plastic increases with wear and tear and repeated washing. Over time, as polycarbonate plastics are washed and reused, they can be subjected to washing conditions which degrade the plastic.[26] The common practice of using plastics in microwave ovens can lead to uneven heating and the creation of focal areas of high heat, also leading to degradation. [27] According to Dr. vom Saal and others, preliminary evidence suggests that the amount of bisphenol A released from a new bottle over 24 hours at 80˚C is similar to the amount released at room temperature by bottles that have been washed 60 to 100 times.

After a polycarbonate plastic bottle goes through repeated washing in the dishwasher, or simply with hot water, the plastic degrades and the amount of bisphenol A leaching from the bottle increases. Scientific studies have simulated repeated and long-term use of polycarbonate bottles and found higher rates of bisphenol A leaching over time. This indicates that polycarbonate plastic products degrade over time, especially after exposure to heat.

Polycarbonate plastic also degrades with the help of high or low pH substances.[28] Acidic materials with a low-pH, such as apple juice, break apart the bonds that hold bisphenol A molecules together.[29] The chemical ester bonds in bisphenol A interact with the free hydrogen in acids and break apart. Similarly, studies have also shown that polycarbonate plastic can degrade when exposed to very basic materials with a high-pH.[30] Therefore it is possible that bisphenol A can also leach from bottles during dishwashing because detergents are generally alkaline or basic in nature.

Bisphenol A is primarily hydrophobic, meaning it does not tend to dissolve in water but is more soluble in alcohol or fatty materials. Given this characteristic, once polycarbonate plastic breaks down and bisphenol A is released the chemical is likely to dissolve more in milk than in water.[31] Our testing was conducted using only water and not apple juice or milk, but further laboratory analysis would be useful.

Conclusions and Recommendations

Environmental Defence is calling on the Canadian government to provide safeguards against toxic chemicals, both home-grown and imported. Based on our recent findings of bisphenol A leaching from baby bottles, regulation should focus on making consumer products safe for the next generation of Canadians.

Environmental Defence recommends an immediate ban on the use of bisphenol A in baby bottles, water bottles and other food and drink containers by federal and provincial governments. There should be a phase-out of other non-essential uses of bisphenol A, taking into account how essential each use is, and the availability of safe alternatives.

Environmental Defence supports retailers choosing to pull plastic baby bottles and other polycarbonate plastic drinking bottles from their shelves. Consumers should also reduce their personal exposure to toxic chemicals wherever possible, by choosing safer alternatives. Sources of toxic exposure are varied and numerous, and small changes in lifestyle and purchasing habits can make a difference in the level of pollutants each person carries. Environmental Defence encourages people to visit the Toxic Nation web site (www.ToxicNation.ca) to learn more about reducing exposure to harmful chemicals in the home.

However, the Canadian government has great power to influence the health of all Canadians. The evidence revealed in this report clearly shows that babies are exposed to dangerous levels of a hormone disruptor and this cannot be ignored by legislators. To protect people today and safeguard the health of future generations, the Canadian government must set a course to ensure that children, and all citizens, will not be exposed to bisphenol A and other toxic substances in food and drink containers and other consumer products.

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Appendix 1: Purchasing Locations

1. **Gerber,** Premium feeding system, 166ml ComfortHold bottle, 3 pack
Pharma Plus, 1545 Dupont Street, Toronto, Ontario

2. **Gerber**, Premium feeding system, 148ml ComfortHold bottle, 3 pack
Zellers, 1245 Dupont Street, Toronto, Ontario

3. **Gerber**, Premium feeding system, 148ml ComfortHold bottle, 3 pack
Shoppers Drug Mart, 467 Parliament Street, Toronto, Ontario

4. **Avent Naturally**, Natural Feeding Bottle with extra soft Newborn naturally shaped silicon nipple, 125ml
Sears, 290 Yonge Street, Toronto, Ontario

5. **Avent Naturally**, Natural Feeding Bottle with extra soft new born naturally shaped silicon nipple, 125ml
Shoppers Drug Mart, 465 Yonge Street, Toronto, Ontario

6. **Avent Naturally**, Natural Feeding Bottle with extra soft slow flow naturally shaped silicon nipple 260ml
The Bay, 176 Yonge Street, Toronto, Ontario

7. **Playtex Avance**, Bubble free system, 266ml
Zellers, 1245 Dupont Street, Toronto, Ontario

8. **Playtex Avance**, Bubble free system, 177ml
Shoppers Drug Mart, 467 Parliament Street, Toronto, Ontario

9. **Playtex Avance**, Bubble free system, 266ml
Pharma Plus, 1245 Dupont Street, Toronto, Ontario

Appendix 2: Sampling and Analytical Methodology

Laboratory:
Division of Biological Sciences, University of Missouri-Columbia, XenoAnalytical LLC, conducted the analysis for bisphenol A for the Toxic Baby Bottles report.

Sample preparation date: 11/20/2007, 11/26/2007

Assay date: 11/28/2007

Baby bottles were analyzed for bisphenol A by HPLC with CoulArray detection. The detection limit was 0.05 nanograms. The standard curve ranged from 0.05 – 4 nanograms.

Bottles were rinsed five times with chlorine-free water, and then filled with water and incubated for 24 hours. Two tests were conducted; all bottles were first tested at room temperature and then placed at 80˚C. Water in glass bottles, either untreated or spiked with bisphenol A (8.5 ng/ml), were run as negative and positive controls, respectively. The 24-hour leachates were concentrated using C18 Sep-pak vac cartridges, and the eluted material was examined using high performance liquid chromatography with CoulArray detection.

Bisphenol A concentrations expressed as ng/mL, equivalent to parts per billion (ppb), in liquid of filled bottle. Recoveries in positive controls (Cp1-3) averaged 104 per cent at room temperature, 93 per cent when heated. Data values are corrected to 100 per cent recovery.

Appendix 3: Scientific Data (Baby Bottles bought in Canada and the U.S.)

	Individual data for baby bottles bought in Canada		
		ng BPA / ml liquid	
Assay controls	**Sample**	**Room Temperature**	**Heated**
	Cn1	ND	ND
	Cn2	ND	ND
	Cn3	ND	ND
	Cp1	6.806	5.694
	Cp2	5.880	6.838
	Cp3	6.513	6.668
Bottle samples	Gerber1	ND	7.568
	Gerber2	ND	7.805
	Gerber3	ND	6.495
	Avent1	0.012	7.439
	Avent2	ND	8.323
	Avent3	0.009	7.029
	Playtex1	0.044	4.294
	Playtex2	0.037	6.578
	Playtex3	0.063	5.004

ND represents non-detected concentrations.
Cn represents negative control values
Cp represents positive control values

AVERAGE VALUES FOR EACH BOTTLE TYPE				
	Room Temperature, ng/ml		Heated, ng/ml	
Sample	**Mean**	**SEM**	**Mean**	**SEM**
Gerber	ND	ND	6.78	0.38
Avent	0.01	ND	7.07	0.36
Playtex	0.05	0.01	4.92	0.63

ND represents non-detected concentrations.

Appendix 3: Scientific Data (Baby Bottles bought in Canada and the U.S.)

	Individual data for baby bottles bought in the U.S.		
		ng BPA / ml liquid	
	Sample	**Room Temperature**	**Heated**
Assay controls	Cn1	ND	
	Cn2	ND	
	Cn3	ND	
	Cp1	8.820	
	Cp2	7.620	
	Cp3	8.440	
Bottle samples	G1	ND	4.775
	G2	ND	5.159
	G3	ND	6.981
	A1	ND	5.756
	A2	ND	8.307
	A3	ND	7.167
	P1	ND	6.189
	P2	ND	7.010
	P3	ND	5.579
	D1	ND	6.405

ND represents non-detected concentrations.

Cn represents negative control values.

Cp represents positive control values.

AVERAGE VALUES FOR EACH BOTTLE TYPE				
	Room Temperature, ng/ml		Heated, ng/ml	
Sample	**Mean**	**SEM**	**Mean**	**SEM**
Avent	ND	ND	5.64	0.68
Dr. Brown	ND	ND	7.08	0.74
Evenflo	ND	ND	6.26	0.41
Disney	ND		6.41	

ND represents non-detected concentrations.

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toxic nation

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