



Canadian Food  
Inspection Agency

Agence canadienne  
d'inspection des aliments

# Dioxins and Dioxin-Like Compounds in Selected Foods - April 1, 2012 to March 31, 2014

## 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 CFIA 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.

The main objective of this targeted survey was to generate information on the presence and levels of dioxins and dioxin-like compounds in vegetable oils and fats, dairy-containing foods, dairy butter/lard, cheese, meal replacements, protein supplements and infant formulas available on the Canadian retail market.

A total of 1096 samples were collected from retail. Detectable levels dioxins and/or dioxin-like compounds were found in 98% of samples tested. This is expected given their widespread presence and persistence in the environment, their ability to accumulate in fatty tissues, their ability to increase in concentration up the food chain, and the improved sensitivity of current analytical methods.

Canada's *Food and Drugs Act* prohibits the sale of food that is adulterated, and the Canadian *Food and Drug Regulations* (FDR) state that food, with the exception of fish, which contains chlorinated dibenzo-*p*-dioxins is adulterated. This tolerance was established many years ago and is considered by Health Canada to be unattainable and out of date. Health Canada is doing a comprehensive reassessment of the risks posed by dioxins and is currently using the Joint Expert Committee on Food Additives' (JECFA) tolerable monthly intake of 70 picograms of dioxins and dioxin-like compounds per kg of body weight per month as a guideline for Canadians.

The levels of dioxins and dioxin-like compounds observed in this survey were reviewed by Health Canada's Bureau of Chemical Safety to determine if they are harmful to consumers. Levels found in this survey were considered safe for consumption by Canadians and no product recalls were required.

## 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 the CFIA's 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. The CFIA works with federal, provincial, territorial and municipal governments and provides 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?

Dioxins and dioxin-like compounds are chemical contaminants found in the environment and consequently in food products. The compounds are separated into three groups of chemicals with toxicological and chemical similarities. These groups are dioxins (also known as polychlorinated dibenzo-p-dioxins or PCDDs), polychlorinated dibenzofurans (PCDFs or furans) and polychlorinated biphenyls (dioxin-like PCBs). Dioxins and dioxin-like compounds are found mainly in dairy products, animal tissues/fats and eggs<sup>1</sup>. They can also be found in products made from oily plants due to their accumulation in soil and on plant surfaces<sup>2</sup>. These compounds accumulate in the liver and fat tissues of humans through consumption of food products containing dioxins and dioxin-like compounds<sup>1,3,4,5</sup>. This survey focused on products that have the highest probability of containing these compounds.

Dioxins and furans are mainly formed as by-products of industrial processes (manufacturing of chemicals, pulp and paper bleaching processes, exhaust emissions and incineration, etc.), but can also occur naturally (such as through volcanic activity or forest fires)<sup>3</sup>. These contaminants are not deliberately manufactured. PCBs are man-made, and often contain furan contaminants. PCBs were historically used in many industrial applications (such as for their electrical insulating properties), but their production is now banned globally. PCBs are still present in certain types of electrical equipment and, despite strict controls on handling, storage and disposal of existing PCBs, accidental release into the environment is still possible. When released into the environment, dioxins, furans, and PCBs can be transported long distances from their source<sup>2</sup>.

There are 419 different structural forms of dioxins and dioxin-like compounds, but only 29 of these compounds are of most concern to human health. These 29 forms (also known as targeted congeners) are the focus of this report. These compounds are not destroyed by heating or cooking. Additionally, specific food ingredients (such as raw materials containing

dioxins) or permitted food additives (for example, guar gum, known to have dioxin contamination issues in the past) may be the source of dioxins in finished foods<sup>6</sup>. The best method of minimizing dietary exposure to dioxins and dioxin-like compounds is prevention and reduction of contamination in foods and animal feeds<sup>7</sup>.

Dioxins and dioxin-like compounds are associated with various health effects such as skin disorders (for example, chloracne), liver and thyroid problems, impairment of the endocrine, nervous, reproductive and immune systems, developmental effects and certain types of cancers<sup>8</sup>. The type and occurrence of these health effects typically depend on the level and duration of exposure.

## What did we sample?

A variety of domestic and imported vegetable oils and fats, dairy-based products, meal replacements, protein supplements, dairy butter/lard, cheese and infant formulas were sampled between April 1, 2012 and March 31, 2014. Samples of products were collected from local/regional retail locations located in 11 cities across Canada at various times. These cities encompassed four geographical areas: Atlantic (Halifax, Saint John), Quebec (Montreal, Quebec City), Ontario (Toronto, Ottawa) and the West (Vancouver, Kelowna, Calgary, Winnipeg, Saskatoon). The number of samples collected from these cities was in proportion to the relative population of the respective areas. Refer to Table 1 for the product types collected 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 with unspecified <sup>a</sup> origin	Total number of samples
Infant formulas	1	106	13	120
Vegetable oils and fats	33	206	43	282
Dairy-based products	8	16	41	65
Protein supplements	13	7	26	46
Dairy butter/lard	45	13	112	170
Meal replacements	1	16	9	26
Cheese	0	380	7	387
<b>Grand total</b>	<b>101</b>	<b>744</b>	<b>251</b>	<b>1096</b>

<sup>a</sup>Unspecified refers to those samples for which a 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 ISO 17025 accredited food testing laboratories under contract with the Government of Canada. The samples were tested as sold, which means the product was tested as is and not prepared according to package instructions.

The list of compounds reported as part of this survey are shown in [Table A-1](#) in the Appendix of this report. The concentration of each dioxin or dioxin-like compound detected in a sample is multiplied by its respective World Health Organization (WHO) consensus Toxic Equivalency Factors (TEFs)<sup>9</sup>. Refer to Table A-1 in the Appendix for the TEFs used in this survey. Each of the calculated individual toxic equivalency (TEQ) concentrations are then added together to arrive at a total TEQ concentration, which is an estimate of the total relative potency of all the dioxins and dioxin-like compounds detected in the sample.

There are no Canadian regulations for dioxin-like compounds (furans and PCBs). Currently, Health Canada is using the JECFA tolerable monthly intake of 70 picograms of dioxins and dioxin-like compounds per kilogram of body weight per month while updating their risk assessments for these compounds<sup>3</sup>.

The information from tests on each food product was assessed on a case-by-case basis. When dioxins and dioxin-like compounds were found at elevated levels, the follow-up actions were based on the seriousness of the contamination and the resulting health concern. These actions could range from increased testing, to inspecting the facility where the product was processed or sold. It could also result in recalling the product from the Canadian market place and foreign food safety authorities could be notified of potentially hazardous products. Any high results of dioxins and dioxin-like compounds are reviewed by Health Canada's Bureau of Chemical Safety to determine if the levels are harmful to consumers. Levels found in this survey were considered safe for consumption by Canadians and no product recalls were required.

## What were the survey results?

Of the 1096 samples analyzed in this survey, 98% (1076) contained detectable levels of dioxins and dioxin-like compounds. The range of levels found is presented in Table 2. Comparing the 7 product types in the survey, the average total TEQ value was highest in cheese and meal replacements and lowest in infant formula and vegetable oils. These findings are consistent with plant fats and low fat products containing fewer dioxins and dioxin-like compounds than animal fats.

**Table 2. Levels of dioxins and dioxin-like compounds in selected foods**

Product type	Total number of samples	Number of samples with detectable levels (%)	Minimum TEQ value (pg TEQ/g fat)	Maximum TEQ value (pg TEQ/g fat)	Average TEQ value <sup>b</sup> (pg TEQ/g fat)
Infant formulas	120	113 (94)	0	0.5387	0.0291
Vegetable oils and fats	282	273 (97)	0	1.0113	0.0301
Dairy-based products	65	62 (95)	0	0.4016	0.0433
Protein supplements	46	45 (98)	0	0.9011	0.0886
Dairy butter/lard	170	170 (100)	0.0007	1.8689	0.1603
Meal replacements	26	26 (100)	0.0001	4.5640	0.2684
Cheese	387	387 (100)	0.0032	2.9656	0.2980

<sup>b</sup>Only positive results were used to calculate average dioxins/dioxin-like compound levels

### Infant formulas

Dioxins and dioxin-like compounds were found in 113 (94%) of infant formula samples. These included dairy-based (powder and liquid) and soy-based formulas. Soy based infant formulas had the highest average concentration and liquid dairy infant formula had the lowest. This is the first year of testing for dioxin and dioxin-like compounds in infant formula so comparison of results to previous surveys was not possible. While there are no established limits in Canada, the levels are well below the EU's limit of 5.5 pg TEQ/g fat for milk and dairy products<sup>10</sup>.

### Vegetable oils and fats

Detectable levels of dioxins and dioxin-like compounds were found in 97% of vegetable oil and fat samples. Vegetable oils included a variety of single oil types (for example, olive, sesame, canola), as well as blends. Solid vegetable shortenings and margarines were also sampled. Sunflower oil had the highest average levels of dioxins/dioxin-like compounds and grape seed oil had the lowest average.

### Dairy butter/lard

All dairy butter and lard samples contained detectable levels of dioxins and dioxin-like compounds.

### Cheese

All cheeses sampled in this survey had detectable levels of dioxins and dioxin-like compounds. Cheeses were separated into categories based on moisture/fat content such as hard, semi-hard, soft, semi-soft, fresh and other. Semi-hard cheeses such as mozzarella and cheddar had the highest average concentration and the lowest concentrations were found in hard cheeses such as parmesan and other cheeses such as cream cheese.

### **Dairy-based products**

A total of 95% of dairy-based products sampled contained detectable levels of dioxins and dioxin-like compounds. Dairy-based products included yogurt (regular/frozen/drinkable), dairy-based salad dressing, frozen dairy desserts (cheesecake, dairy-based pies, ice cream, ice cream bars/sandwiches, pizza products (pizza pops, frozen pizzas, etc.), pudding and baked goods containing dairy. Levels of dioxins/dioxin-like compounds were highest in pudding and lowest in yogurt.

### **Meal replacements**

A total of 26 samples of meal replacements were collected in this survey. All meal replacement samples had detectable levels of dioxins/dioxin-like compounds. Liquid meal replacement samples had a higher average concentration than powder meal replacement samples.

### **Protein supplements**

A total of 46 protein supplement samples were collected in this survey. Dioxins/dioxin-like compounds were detected in 98% of samples. Protein powder supplements had a slightly higher average concentration than liquid protein supplements.

## **What do the survey results mean?**

In this survey, 98% of samples of vegetable oils and fats, cheese, dairy products, meal replacements, protein powders, infant formulas and dairy butter/lard analyzed contained detectable levels of dioxins and dioxin-like compounds. The levels and frequency at which dioxins and dioxin-like compounds were detected in the food products covered in this survey were similar to those found in previous CFIA surveys.

Table 3 presents the comparison of levels of dioxins/dioxin-like compounds in the commodities sampled in this survey in comparison to past CFIA surveys. This was the first year that infant formula and dairy butter/lard were tested for these compounds and there was limited literature for comparison.

**Table 3. Minimum, maximum and average concentration of dioxins and dioxin-like compounds across various studies**

Product type	Study	Year	Total number of samples	Number of positive samples (%)	Minimum TEQ value (pg TEQ/g fat)	Maximum TEQ value (pg TEQ/g fat)	Average TEQ value <sup>c</sup> (pg TEQ/g fat)
Vegetable oils and fats	CFIA	Current (2012-2014)	282	273 (97)	0	1.0113	0.0330
	CFIA <sup>12</sup>	2011-2012	92	90 (98)	0	0.86357	0.0230
	CFIA <sup>11</sup>	2010-2011	167	167 (100)	0.0002	0.6697	0.1027
Dairy-based products	CFIA	Current (2012-2014)	65	62 (95)	0	0.4016	0.0413
	CFIA <sup>12</sup>	2011-2012	52	52 (100)	0.00027	2.52189	0.1723
Protein powders/liquids	CFIA	2012-2014	46	45 (98)	0	0.9011	0.0886
	CFIA <sup>12</sup>	2011-2012	25	9 (36)	0	0.2577	0.0929
Meal replacements	CFIA	Current (2012-2014)	26	26 (100)	0.0001	4.5640	0.2684
	CFIA <sup>11</sup>	2011-2012	15	12 (80)	0	1.56032	0.1237
Cheese	CFIA	Current (2012-2014)	387	387 (100)	0.0032	2.9656	0.2980
	CFIA <sup>11</sup>	2010-2011	284	284 (100)	0.00096	3.2476	0.2421

<sup>c</sup>Only positive results were used to calculate average levels

In comparison to previous survey years, vegetable oils and fats and cheese samples show comparable results. Vegetable oils and fats had 97% of samples with detected levels of dioxins/dioxin-like compounds for the current survey and 98% in 2011 to 2012. All samples of cheese were found to have detectable levels of dioxins/dioxin-like compounds in both survey years.



Dairy-based products had a similar proportion of samples with detected levels of dioxins/dioxin-like compounds; however the maximum and average concentrations were lower in the current survey than the 2011 to 2012 survey. This could be due to a difference in dairy-based products tested. The current survey sampled pizza and frozen dairy products and the 2011 to 2012 survey did not. In general, TEQ values reported were similar to the 2011 to 2012 CFIA survey in which pudding had the highest average total TEQ and levels in salad dressing were comparable as well<sup>12</sup>.

In general, TEQ values reported had similar trends to the 2011 to 2012 survey in which meal replacements had higher min TEQ values than protein powder<sup>12</sup>.

The existing Canadian regulations for the complete absence of chlorinated dibenzo-*p*-dioxins in foods, with the exception of fish, was established many years ago and is considered by Health Canada to be outdated. The regulations do not take into account the improvements made to analytical methods which can detect lower levels of these substances. A “zero tolerance” approach is not practical and is not applied by Canada or any of its major trading partners.

Detectable levels of dioxins and/or dioxin like compounds were detected in 1076 samples tested in the 2012 to 2014 targeted survey. This is not surprising as these compounds are commonly found in the environment. Since there are no updated limits for dioxins/dioxin-like compounds in these products, all positives were assessed on a case by case basis by Health Canada.

The levels observed in this survey were evaluated by Health Canada’s Bureau of Chemical Safety and none of the samples were determined to pose a safety concern to human health. There were no follow-up actions resulting from this survey. Future targeted surveys will focus on nuts, seeds, nut and seed butters and ready-to-eat meals as these are known to have detectable levels of dioxins and dioxin-like compounds.

# References

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11. [2010-2011 Dioxins and Dioxin-like Compounds in Vegetable Oils and Cheese.](#) (2018). Canada. Canadian Food Inspection Agency.
12. [2011-2012 Dioxins and Dioxin-like Compounds in Selected Foods.](#) (2018). Canada. Canadian Food Inspection Agency.

# Appendix

**Table A-1. Limits of detection and WHO Toxic Equivalency Factors (TEFs) for dioxins and dioxin-like compounds**

Compound	Congener	LOD <sup>d</sup> (pg/g fat)	TEF <sup>e</sup>
Dioxins	2,3,7,8-TCDD	0.1	1
	1,2,3,7,8-PeCDD	0.1	1
	1,2,3,4,7,8-HxCDD	0.2	0.1
	1,2,3,6,7,8-HxCDD	0.2	0.1
	1,2,3,7,8,9-HxCDD	0.2	0.1
	1,2,3,4,6,7,8-HpCDD	0.2	0.01
	1,2,3,4,6,7,8,9-OCDD (or OCDD)	0.5	0.0003
Furans	2,3,7,8-TCDF	0.1	0.1
	1,2,3,7,8-PeCDF	0.2	0.03
	2,3,4,7,8-PeCDF	0.1	0.3
	1,2,3,4,7,8-HxCDF	0.1	0.1
	1,2,3,6,7,8-HxCDF	0.2	0.1
	1,2,3,7,8,9-HxCDF	0.2	0.1
	2,3,4,6,7,8-HxCDF	0.2	0.1
	1,2,3,4,6,7,8-HpCDF	0.2	0.01
	1,2,3,4,7,8,9-HpCDF	0.2	0.01
	1,2,3,4,6,7,8,9-OCDF (or OCDF)	0.2	0.0003
Dioxin-like PCBs	3,3',4,4'-TeCB (PCB 77)	0.5	0.0001
	3,4, 4',5'-TeCB (PCB 81)	0.5	0.0003
	2,3,3',4,4'-PeCB (PCB 105)	0.5	0.00003
	2,3,4,4',5'-PeCB (PCB 114)	0.5	0.00003
	2,3',4,4',5'-PeCB (PCB 118)	0.5	0.00003
	2',3,4,4',5'-PeCB (PCB 123)	0.5	0.00003
	3,3',4,4',5'-PeCB (PCB 126)	0.1	0.1
	2,3,3',4,4',5'-HxCB (PCB 156)	0.5	0.00003
	2,3,3',4,4',5'-HxCB (PCB 157)	0.5	0.00003
	2,3',4,4',5,5'-HxCB (PCB 167)	1	0.00003
	3,3',4,4',5,5'-HxCB (PCB 169)	0.1	0.03
	2,3,3',4,4',5,5'-HpCB (PCB 189)	1	0.00003

<sup>d</sup>LOD: Method limit of detection

<sup>e</sup>TEF: Toxic Equivalency Factor (2005 WHO TEF values)<sup>9</sup>