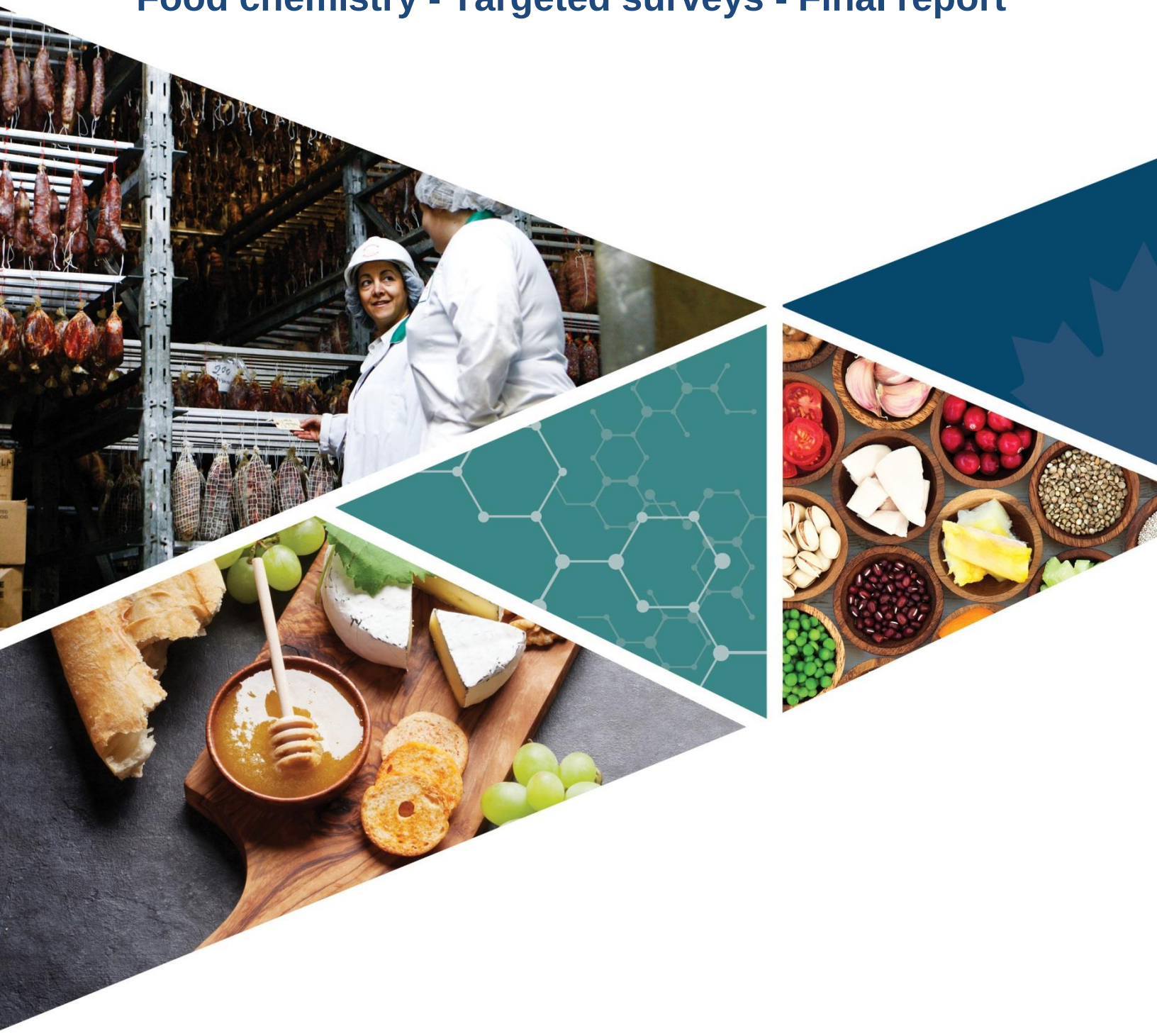
Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Furan, 2-methylfuran and 3-methylfuran in Selected Foods - April 1, 2020 to March 31, 2021

Food chemistry - Targeted surveys - Final report



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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.

Furan is a chemical that can unintentionally form in foods that undergo thermal treatment such as frying and canning[1]. Precursors to furan are often present in food, these include ascorbic acid, polyunsaturated fatty acids, amino acids and sugars[1,2,3]. Furan occasionally coexists with 2-methylfuran and 3-methylfuran. In this report, the plural term 'furans' refers to the sum of furan, 2-methylfuran and 3-methylfuran, whereas 'furan' refers only to the furan compound. The term "analogue" also used, refers to compounds which have similar but slightly different structures; it is sometimes used in this report to refer to the 3 forms of furan. It should be noted that the furans in this survey do not refer to chlorinated dibenzofurans, the environmental contaminants which are often also referred to as "furans".

Furan may pose a health risk to the consumer, as the International Agency for Research on Cancer (IARC) has classified it as 'possibly carcinogenic to humans'[4]. Additionally, 2-methylfuran and 3-methylfuran have been shown to have a similar toxicity to furan[5]. Although preliminary estimates for consumer exposure are well below what would cause harmful effects, limited information is available concerning furan levels in food. This survey was initiated in consultation with Health Canada to expand upon the data collected by other agencies and to generate further baseline surveillance data on the presence and levels of furan analogues in selected foods available on the Canadian retail market.

A total of 399 samples were collected from retail stores in 6 cities across Canada. The samples collected were foods that were expected to contain these compounds, including chocolate, coffee/coffee beverages and infant foods. Furans were detected in 97% of the survey samples and levels ranged from 0.2 parts per billion (ppb) to approximately 39000 ppb. The highest average concentrations of furans were found in coffee. The majority of the samples (78%) contained all 3 analogues. The results from this survey were comparable to those found in international surveys and a variety of scientific studies.

Maximum Levels (MLs) for furans have not yet been established, as the toxicity of furans in humans is not well known, so levels were assessed by Health Canada on a case-by-case basis using the most current scientific data. Health Canada determined the levels of furans in food

observed in this survey are not expected to pose a concern to human health, therefore there were no follow-up actions 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 further baseline surveillance data on the level of furan, 2-methylfuran and 3-methylfuran in domestic and imported products on the Canadian retail market, and to compare the prevalence of furans in foods targeted in this survey with that of similar products in international surveys and to the scientific literature.

Furan may pose a health risk to consumers since the IARC has classified it as 'possibly carcinogenic to humans'[4]. Furan can sometimes form in foods that undergo heat treatments, particularly in foods that contain ascorbic acid, polyunsaturated fatty acids, amino acids and sugars[1,2,3]. In some foods, 2-methylfuran and 3-methylfuran can also form, which have a similar toxicity to furan[5]. Because thermal treatments are widely used for manufacturing shelf-stable food, it is important to establish data on the prevalence of furan, 2-methylfuran and 3-methylfuran in food available on the Canadian retail market.

MLs for furans have not yet been established, as the toxicity of furans in humans is not well known. The U.S. Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA) have studied furan levels in a variety of commodities[6,7], but limited data is available concerning 2- and 3-methylfuran levels. This survey was initiated in consultation with Health Canada to establish further baseline surveillance data to compliment and expand upon the data collected by other agencies[1].

What did we sample

A variety of domestic and imported chocolate, coffee/coffee beverages and infant food samples were sampled between April 1, 2020 and March 31, 2021. Samples of products were collected from local/regional retail locations in 6 major cities across Canada. These cities encompassed 4 Canadian geographical areas:

- Atlantic (Halifax)
- Quebec (Montreal)
- Ontario (Toronto and Ottawa)
- 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
Chocolate	6	38	5	49
Coffee/coffee beverages	66	91	43	200
Infant food	24	116	10	150
Grand total	**96**	**245**	**58**	**399**

[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 17025 accredited CFIA food testing laboratory. The results presented represent finished food products as sold and not as they would be consumed, whether the product sampled is considered an ingredient or requires preparation prior to consumption.

In the absence of established tolerances or standards for furans in foods, elevated levels of in specific foods may be assessed by Health Canada on a case-by-case basis using the most current scientific data available.

What were the survey results

Of the 399 samples tested, 385 (97%) had detected levels of furans. Table 1 shows that the detection rate of furans varied greatly between product types. Among all product types included in this survey, the average concentration was highest in coffee and lowest in chocolate.

Most of the samples (78%) included in this survey contained all 3 furan analogues. In 17% of products furan and 2-methylfuran were both detected, 2 samples contained furan and 3-methylfuran, and 6 samples contained only 1 analogue. Average concentrations of the 3 furan analogues were comparable, with furan having the highest average concentration in chocolate and infant food and 2-methylfuran in coffee.

Table 2. Summary of targeted survey results on furans in selected foods

Product type	Number of samples	Number of samples (%) with detected levels	Minimum (ppb)	Maximum (ppb)	Average[b] (ppb)
Chocolate	49	49 (100)	6.7	31.6	16.4
Coffee/coffee beverages	200	188 (94)	2.4	38670	8109
Infant food	150	150 (100)	1.77	102.5	22.6
Grand total	**399**	**387 (97)**	**1.77**	**38670**	**3950**

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

Although all chocolate samples tested were positive for furans, the average levels found were the lowest of all product types included in this survey. Infant foods also contained relatively low levels of furans. Within the infant food samples, fruit-based purees contained the lowest average levels of furans whereas infant products containing meat or fish had the highest. As previously observed, coffee had high levels of furans. The highest level of furans in this survey (38,670 ppb) was reported in a sample of dark roast coffee beans. Samples identified as dark roast products had on average 46% higher levels of furans than other whole bean and ground coffee products. Instant coffee (488 ppb) and coffee beverages (94.2 ppb) had relatively low levels of furans compared to other coffee products.

What do the survey results mean

For all product types, furan levels found in this survey were comparable to the levels reported in the scientific literature and previous targeted surveys[6,7,8,9,10, 11,12,13,14].

Table **3** only compares levels for furan for product on the Canadian market, as limited data is available concerning 2- and 3-methylfuran levels in foods.

The literature shows that 2-methylfuran and 3-methylfuran can form alongside furan from precursors found in foods, although limited data is available concerning specific precursors or reaction pathways[15,16]. The variety of 2- and 3-methylfuran levels in foods sampled in this

survey is possibly due to differences in ingredients and processing, which may favour the formation of different furan analogues.

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

Product type	Study	Number of samples	Minimum (ppb)	Maximum (ppb)	Average[c] (ppb)
Chocolate	CFIA survey, 2020	49	4.5	18	9.7
Chocolate beverages	CFIA survey, 2018	105	5.05	13.8	7.0
Coffee/coffee beverages	CFIA survey, 2020	200	3	8800	2111
Ground/whole	CFIA survey, 2020	105	890	8800	4705
Decaf	CFIA survey, 2020	2	2200	6400	4300
Instant	CFIA survey, 2020	18	39	810	193
Coffee	CFIA survey, 2017	25	9.39	11520	2690
Ground	CFIA survey, 2017	14	9978	57697	21150
Decaf	CFIA survey, 2017	3	11156	16418	13876
Instant	CFIA survey, 2017	2	182	1174	678
Coffee (ground)	Becalski et al., 2016	15	715	2800	2200
Coffee (decaf)	Becalski et al., 2016	7	1640	3450	2450
Coffee (instant)	Becalski et al., 2016	14	32	896	264
Infant food	CFIA survey, 2020	150	1	94	19.5
Meat/fish-based	CFIA survey, 2020	43	9.4	94	48.4
Fruit/vegetable puree	CFIA survey, 2020	107	1	91	7.9
Infant food	CFIA survey, 2017	22	8.26	204	92.9
Infant food (Meat/fish-based)	Becalski et al., 2010	3	121	331	193.3
Infant food (fruit/vegetable puree)	Becalski et al., 2010	12	8.5	239	69.3

[c] Only positive results were used to calculate the average (hazard) levels

The differences in furan levels between this survey and the other studies in

Table **3** as well as the variety of reported levels within this survey might be caused by the differences in ingredients and degree of thermal processing. Some differences observed may also be due to the specific type of product tested or sample size.

There was limited data available for comparison of the survey results on furan in chocolate. The levels of furan observed in this survey were within the range reported in a previous survey for

chocolate beverages[13]. This survey confirms that the occurrence of furan in chocolate products available on the Canadian market is low.

The range of the furan levels observed in coffee was comparable to previous survey years and closely matched the average level of furan in coffee reported in the literature[11,14]. Furan levels in different coffee types were examined. As previously reported, no significant differences were observed between regular and decaffeinated coffee, whereas instant coffee contained much lower average level of furan. Heat processing is the main parameter that impacts furan formation, therefore higher amounts of furan were also found in coffees with a higher degree of roast.

The furan levels found in infant foods were within the range reported in the scientific literature and a previous targeted survey[12,14]. The classification of infant foods into savory products containing meat or fish and fruit and/or vegetable-based purees allowed to confirm the trend reported in the literature; which shows lower amounts of furan in fruit and/or vegetable only recipes[10].

Health Canada's Bureau of Chemical Safety determined the levels of furan, 2-methylfuran and 3-methylfuran in food observed in this survey are not expected to pose a concern to human health; therefore no follow-up actions were required.

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