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

Furan, 2-methylfuran and 3-methylfuran in Selected Foods - 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.

Furan is a chemical that can unintentionally form in foods that undergo thermal treatment such as canning[1]. Precursors to furan that are often present in food include ascorbic acid, polyunsaturated fatty acids, amino acids and sugars[1,2,3]. This compound occasionally coexists with 2-methylfuran and 3-methylfuran. In this report, the term 'furans' refers to the sum of furan, 2-methylfuran and 3-methylfuran, whereas 'furan' refers only to the furan compound. The term "analogue" 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 are not related 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. Therefore, the goal of this survey was to generate further baseline surveillance data on the presence and levels of furan, 2-methylfuran and 3-methylfuran in selected heat treated foods available on the Canadian retail market.

A total of 250 samples were collected from retail stores in 6 cities across Canada. The samples collected included canned fish, canned meat, canned milk, dried dairy products, dried beverage mix and soy sauce. Furans were detected in 70% of the survey samples and levels ranged from 1.23 ppb (parts per billion) to 179 ppb. The highest average concentrations of furans were found in soy sauce. None of the dried dairy products had detected levels of furans. In 52% of the samples, only 1 of the 3 furans was present. It was also common for products to contain both furan and 2-methylfuran. The results from this survey were comparable to those found in international surveys and a variety of scientific studies.

The levels of furans 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 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 its precursors such as 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.

Maximum Residue Limits (MRLs) for furans levels 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 HC 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 canned fish, canned meats, canned milks, dried beverage mixes, dried dairy products and soy 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
Canned fish	4	45	1	50
Canned meat	14	35	1	50
Canned milk	14	0	2	16
Dried beverage mix	10	7	25	42
Dried dairy products	20	5	17	42
Soy sauce	13	33	4	50
Grand total	**75**	**125**	**50**	**250**

[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 HC on a case-by-case basis using the most current scientific data available.

What were the survey results

Of the 250 samples tested, 176 (70%) 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 soy sauce and lowest in dried dairy products. Average concentrations of the analogues were comparable, with furan having the

highest average concentration and 3-methylfuran having the lowest. In 38% of products included in this survey, furan and 2-methylfuran were both detected, and more than half of the samples contained only a single furan analogue.

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)
Canned fish	50	50 (100)	16.3	146	46.6
Canned meat	50	50 (100)	10.8	64	31.1
Canned milk	16	10 (63)	13.9	33.2	19.8
Dried beverage mix	42	15 (36)	5.1	22.5	9.7
Dried dairy products	42	0 (0)	0	0	0
Soy sauce	50	50 (100)	1.2	179	73.8
Grand total	**250**	**176 (70)**	**1.2**	**179**	**45.5**

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

Canned fish

All canned fish samples had detected levels of furans. As the chart in Figure 1 shows, most canned fish samples contained between 16 ppb and 84 ppb furans, with a few samples containing above 110 ppb.

Canned meat

All canned meat samples had detected levels of furans. Of the 12 samples included in this survey that contained all 3 furan analogues, 11 were canned meat samples.

Canned milk

A majority (63%) of canned milk samples had detected levels of furans. In canned milk products, the average 2-methylfuran level was nearly twice that of furan, whereas for all other product types, average furan and 2-methylfuran levels were comparable.

Dried beverages

A majority (64%) of sampled dried beverage mixes did not have detected levels of furans and dried beverages contained the lowest positive concentration of all product types included in this survey. Dried beverages included tea-based drink mixes as well as hot and cold chocolate-based drink mixes.

Dried dairy products

None of the 42 dried dairy products sampled in this survey contained detected levels of furans. This category included skim milk powder and coffee whitener.

Soy sauce

All of the 50 soy sauces sampled contained detected levels of furans. The average concentration of furans in soy sauces was higher than that of other product types included in this survey.

Figure 1 shows that the levels of furans varied considerably between individual soy sauce samples. For some brands, the entire range of observed levels was above or below the average concentration, although some brands had only a few samples. Furans levels of different lots within the same brand were generally comparable.

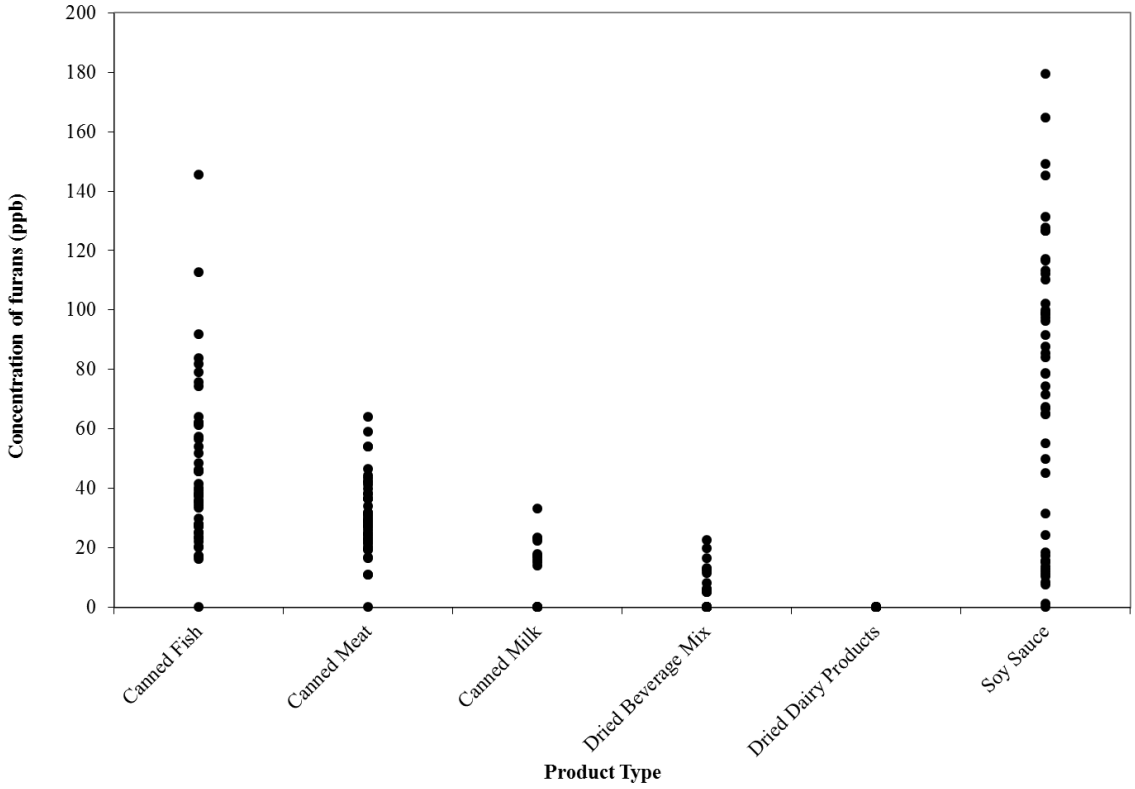

Figure 1. Distribution of furans concentrations for each product type in 2018 to 2019

What do the survey results mean

For all product types, furan levels found in this survey were comparable to the data in the scientific literature and previous targeted surveys[6,7, 8,9,10,11]. Table 3 only compares levels for furan, as limited data is available concerning 2- and 3-methylfuran levels in foods and therefore no comparison on the presence of 2- and 3-methylfuran could be made.

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[12,13]. 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 (ppb)
Canned fish	CFIA survey, 2018 to 2019	50	1.62	64.4	16.9[c]
Canned fish	Crews et al., 2012[g]	37	<0.3	70	26
Canned fish	Kim et al., 2009[h]	29	0.4	212	39.1[c]
Heat treated fish	EFSA survey, 2004 to 2010[i]	47	<5	172	17
Canned fish	FDA survey, 2004[j]	6	3.25[d]	7.1	4.93
Canned meat	CFIA survey, 2018 to 2019	50	1.19	40	14[c]
Canned meat	Kim et al., 2009[h]	19	2.8	194	24.3[c]
Meat products	EFSA survey, 2004 to 2010[i]	147	<8	160	13-17[e]
Meat products	FDA survey, 2004[j]	9	3.25[d]	39.2	15.4[c]
Canned milk	CFIA survey, 2018 to 2019	16	1.27	20.8	6.87[c]
Canned milk	FDA survey, 2004[j]	3	10.9	15.3	12.5
Milk products	EFSA survey, 2004 to 2010[i]	64	<0.5	80	5-5.6[e]
Dried beverage	CFIA survey, 2018 to 2019	43	2.7	8.22	5.43[c]
Dried chocolate beverage[f]	FDA survey, 2004[j]	7	0.5[f]	0.8[d,f]	0.76[f]
Dried dairy products	CFIA survey, 2018 to 2019	42	0	0	0
Baby formula powdered milk	Liu et al., 2018[k]	10	2.4	26.1	8.93
Soy sauce	CFIA survey, 2018 to 2019	50	1.09	159	38.5[c]
Soy sauce	Arisseto et al., 2009 to 2011[l]	46	6	138	28.2
Soy sauce	EFSA survey, 2004 to 2010[i]	94	<0.07	78	27
Soy sauce	FDA survey, 2004[j]	5	17.2	75.6	52.1

[c] Only positive results were used to calculate the average (hazard) levels
[d] Recorded value was between LOD and LOQ, so an average of LOD and LOQ is used
[e] A range indicates different results for the lower and upper bounds
[f] Commodity tested as it is consumed
[g] Crews, C., Pye, C. (2013). Furan in canned sardines and other fish. Food Additives & Contaminants: Part B, 7(1), pp. 43-45.

[h] Kim, Y. M., Her, J.-Y., Kim, M.K., Lee, K.-G. (2015). Formation and reduction of furan in a soy sauce model system. Food Chemistry, 189, pp. 114-119.
[i] Update on furan levels in food from monitoring years 2004-2010 and exposure assessment. (2011) Italy. European Food Safety Authority.
[j] Exploratory Data on furan in Food. (2005). United States of America. U.S. Food and Drug Administration.
[k] Liu, Y.-T., Tsai, S.-W. (2010). Assessment of dietary furan exposures from heat processed foods in Taiwan. Chemosphere, 79(1), pp. 54-59.
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The differences in canned fish 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 differing levels of polyunsaturated fatty acids (a precursor to furan) in fish, which has been shown to change depending on type and diet of fish[14]. Among canned meats sampled in this and other surveys, differences in ingredients and degree of thermal processing may have contributed to the variety of observed furan, 2-methylfuran and 3-methylfuran concentrations.

Dried beverage products sampled in other surveys were tested as-consumed whereas the CFIA tested dried beverages as-purchased. When a dilution factor is considered, furan levels in dried beverages from this survey are comparable to dried beverages included in other surveys.

Canned milk and soy sauce samples tested in this survey reported comparable furan levels to those reported in literature. Additionally, in this survey and in the literature, soy sauce samples generally contained more furan than other product types tested. This could be due to a process called “Maillard browning” which is often used in soy sauce manufacturing to enhance flavour and extend shelf-life[15,16]. Maillard browning involves the Maillard reaction, which has been shown to be a formation pathway for furan[17].

HC’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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