



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Furan, 2-methylfuran and 3-methylfuran in selected foods – April 1, 2021, to March 31, 2023

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 frying and canning¹. Precursors to furan are often present in food, these include ascorbic acid, polyunsaturated fatty acids, amino acids and sugars¹⁻²³. 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 furan⁵. 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 748 samples were collected from retail stores in 6 cities across Canada. The samples collected were foods that were likely to contain these compounds, including baked goods, infant and toddler food, and noodles. Furans were detected in 86% of the survey samples and levels ranged from 0.32 parts per billion (ppb) to 459 ppb. The highest average concentrations of furans were found in baked goods. The majority of the samples (58%) 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 targeted surveys are

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 we conducted 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 furan⁵. 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. The objective of this survey was to establish further baseline surveillance data and to expand upon the data collected by other agencies.

What we sampled

A variety of domestic and imported baked goods (crispbread, crackers and croutons), infant and toddler food (purees and meals) and noodles (instant soup and instant pasta) were sampled from April 1 to March 31 over the 2021 and 2022 survey years. 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
Baked goods	31	150	22	203
Infant/toddler food	54	289	27	370
Noodles	4	165	6	175
Total	89	604	55	748

Table notes

^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 samples were analyzed and assessed

Samples were analyzed by an ISO 17025 accredited CFIA food testing laboratory. The furans level reported per sample is the sum of the levels of furan, 2-methylfuran and 3-methylfuran, where detected. 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 in specific foods may be assessed by Health Canada on a case-by-case basis using the most current scientific data available.

Results of the survey

Of the 748 samples tested, 644 (86%) had detected levels of furans. Table 1 shows that the detection rate of furans varied between product types. Among all product types included in this survey, the average concentration was highest in baked goods and lowest in noodles.

Most (58%) of the positive samples contained all 3 furan analogues. In 200 products furan and 2-methylfuran were both detected, 4 samples contained furan and 3-methylfuran, and 11 samples contained only 1 analogue (furan or 2-methylfuran). Furan had the highest average concentrations in all product types.

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)
Baked goods (crispbread, crackers and croutons)	203	202 (99)	2.2	459	55.5
Infant/toddler food	370	364 (98)	0.32	146	30.9
Noodles	175	78 (45)	1.1	93	11.0
Total	748	644 (86)	0.32	459	36.2

Table notes

^b Only positive results were used to calculate the average levels.

Baked goods had highest detection rate and the highest levels of furans reported in this survey. The highest level of furans (459 ppb) was reported in a sample of grain-free crispbread. Although most infant/toddler food samples tested were positive for furans, the levels observed were relatively low compared to other foods tested to date⁸. Within the infant/toddler food samples, fruit-based purees contained the lowest average levels of furans, whereas products containing meat or fish had the highest. Noodles also contained relatively low levels of furans.

What 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}.

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^{14,15}. 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)
Crispbread, crackers and croutons	CFIA survey, 2021	203	5.8	260	36.8
Crispbread and crackers	Hamlet et al., 2018	9	60	470	316
Crispbread and crackers	FDA, 2017	4	4.2	18.6	12.2
Infant/toddler food	CFIA survey, 2021	370	0.69	130	26.8
Infant/toddler food (Meat/fish-based)	CFIA survey, 2021	193	0.69	130	41.3
Infant food (Other)	CFIA survey, 2021	177	1.1	67	11.2
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
Noodles	CFIA survey, 2021	175	1.7	74	13.8
Noodles	Lee et al., 2021	30	4.24	13.3 ^d	N/A
Noodles	Sijja et al., 2014	3	3.02	11.4	7.32

Table notes

^c Only positive results were used to calculate the average (hazard) levels.

^d Concentration range of furan was much larger (up to 218 ppb) for soup base (reported separately).

N/A: not available.

Although there was limited data available for comparison of the survey results on furan in crispbread, crackers and croutons, the levels observed in this survey were within the range reported in literature^{7,10}. Large variability of furan levels within each brand of products and between different lots of the same product suggested, that in some cases the processing practices have larger effect on the furan levels than the ingredients.

The furan levels found in infant/toddler foods were within the range reported in the scientific literature and previous targeted surveys^{8,9,11}. 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 previously; which shows lowest amounts of furan in fruit and/or vegetable only recipes^{8,9,11}.

There was limited data available for comparison of the survey results on furan in noodles, specifically in instant noodle-based soup. In this survey the results represent the entire product, including soup-base. When furan levels reported were compared to those from a study that reported levels for both noodles and soup-base and both values were considered, the results were comparable¹². The results for plain instant noodles were also comparable to the levels reported in the scientific literature¹³.

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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