Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Coumarin in Selected Foods - April 1, 2016 to March 31, 2018

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.

Coumarin is a naturally occurring sweet-smelling compound found in many plants, including cinnamon and tonka beans. Its derivatives can be found in plants commonly used as licorice flavour, such as fennel, aniseed and licorice root[1,2,3]. Coumarin was used as a flavouring agent in the food and cosmetic industries for many years, and although its use in the cosmetic industry continues, it has been discontinued in the food industry due to evidence of potential toxic and adverse effects on the liver[4,5]. Low exposure to this compound from natural sources is expected and not anticipated to represent a health risk. The CFIA considered it important to examine coumarin levels in commonly available ground cinnamon, cinnamon-containing products and licorice flavoured products to ensure that these are safe for consumption.

This targeted survey generated further baseline surveillance data on the levels of coumarin in domestic and imported products on the Canadian retail market. The CFIA sampled and analyzed 1497 products, including 498 baked goods, 199 breakfast cereal samples, 300 cinnamon samples, 450 spice mixes, and 50 flavoured oatmeal samples. Coumarin was detected in 96% of the samples, with levels ranging from 0.2 parts per million (ppm) to 11,700 ppm. The highest levels were detected in cinnamon and in spice mixes. The average and maximum level in all categories were comparable to previous targeted surveys and scientific studies.

Health Canada determined that the levels of coumarin observed in this survey are not expected to pose a concern to human health, therefore there were no follow-up actions resulting from these surveys.

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 coumarin in cinnamon, spice mixes, and cinnamon-containing products (baked products, breakfast cereal samples, flavoured oatmeal samples) on the Canadian retail market, and to compare the presence of coumarin in foods targeted in this survey to previous targeted surveys and scientific literature.

Coumarin is a naturally occurring sweet-smelling compound found in many plants, including cinnamon and tonka beans. High coumarin concentrations can be found in Cassia cinnamon (also known as true cinnamon) and Saigon cinnamon, whereas the Ceylon variety typically contains only traces. Ceylon cinnamon is typically more expensive than Cassia cinnamon, and has a milder flavour/spice profile. Due to economics and a preference of the public for a "spicier flavour profile", most of the cinnamon sold today is Cassia cinnamon.

In order to achieve a consistent flavour profile in processed foods, the use of flavouring extracts has been a common practice in the food industry. Coumarin, either naturally derived or synthetically produced, was used as a flavouring agent in the past; however, its use in food has been discontinued based on reports of adverse health effects in animal studies[4,5]. The deliberate addition of coumarin to foods is not permitted in Canada; however, plants or herbs that are added to foods as flavours may contain this compound naturally. The main source of naturally occurring coumarin in the human diet is cinnamon[5,6]. The majority of people can consume these foods daily without adverse effects; however, there is a small number of individuals who are sensitive to coumarin. For this group, consuming higher levels than would normally be found in food can lead to elevation of liver enzymes, and in severe cases to inflammation of the liver[1].

Limited data is available on the occurrence of coumarin in foods containing cinnamon and licorice flavouring. Cinnamon is frequently used in baked goods, spice mixes and tea for its unique flavour[9] and licorice flavours are commonly incorporated into teas and spice mixes. It was considered important to examine the coumarin levels in commonly available cinnamon-containing products to ensure that the populations consuming these foods are not at risk. All of the survey data was shared with HC.

What did we sample

A variety of domestic and imported baked products, cinnamon, spice mixes, breakfast cereals, and flavoured oatmeal were sampled between April 1, 2016 and March 31, 2018. All samples, other than pure cinnamon, had cinnamon listed as an ingredient. 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. 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 of unspecified origin[a]	Total number of samples
Baked products	62	49	387	498
Breakfast cereal	19	134	46	199
Flavoured oatmeal	1	16	33	50
Cinnamon	11	54	235	300
Mixed spices	44	117	289	450
Total	**137**	**370**	**990**	**1497**

[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/IEC 17025 accredited food testing laboratory under contract with the Government of Canada. 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 coumarin in foods, elevated levels of coumarin 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

The samples tested in this survey included cinnamon, spice mixes, as well as baked products, breakfast cereals, and flavoured oatmeal. Of the 1497 samples tested, 96% had detected levels of coumarin. Coumarin is a natural compound found in cinnamon. Its concentration varies among the different types of cinnamon. Cassia cinnamon, the most common type, also contains high levels of coumarin which may account for the high detection rate in all tested products[16]. All observed results are noted in table 2 below.

Table 2. Summary of targeted survey results on coumarin in cinnamon, spice mixes, and cinnamon-containing foods

Product type	Number of samples	Number of samples (%) with detected levels	Minimum (ppm)	Maximum (ppm)	Average[b] (ppm)
Baked products	498	482 (97)	0.2	80.5	16.2
Baked goods	126	124 (99%)	0.3	75.4	19.2
Bakery products	372	358 (96%)	0.2	80.5	14.5
Breakfast cereal	199	173 (85)	0.2	45.6	9.75
Adult cereals	100	83 (83)	0.3	35.4	5.73
Children cereals	99	90 (90)	0.2	45.6	11.2
Flavoured oatmeal	50	48 (96)	1.9	34.9	13.4
Cinnamon	300	300 (100)	5.8	11700	3339
Mixed spices	450	431 (96)	0.2	3380	361
Total	**1497**	**1434 (96)**	**0.2**	**11700**	**814**

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

Coumarin levels in the survey samples ranged from 0.2 ppm to 11,700 ppm. The highest coumarin level of all products was found in pure cinnamon at 11,700 ppm. All sampled foods and spices, other than pure cinnamon, had cinnamon amongst other ingredients. Since the cinnamon content is lower in the tested products than in pure cinnamon, lower coumarin levels in these products was expected.

Coumarin was detected in 97% of baked products with levels ranging from 0.2 ppm to 80.5 ppm. Baked products sampled were comprised of baked goods (cakes, pies, rolls, donuts, pastries, etc.) and bakery products (bread, English muffins, bagels, etc.). Baked goods had a higher detection rate and average than bakery products.

Breakfast cereals included single or multi-grain cereals targeted at adults and at children. Children cereals had a higher detection rate and significantly higher average coumarin levels than that of adult cereals.

The detection rate in flavoured oatmeal samples was higher than in breakfast cereals at 96%, as was the average of 13.4 ppm, with levels ranging from 1.9 to 34.9 ppm.

Of the spice mixes, the top 4 samples with the highest levels of coumarin were blends of 4 spices (cinnamon, Jamaican pepper, clove, and nutmeg), ranging from 2560 to 3380 ppm. The next highest samples were cinnamon with chia and apple pie spice, both with 2490 ppm.

What do the survey results mean

The average and maximum coumarin levels found in baked products, cinnamon, spice mixes, breakfast cereals, and flavoured oatmeal were comparable to previous targeted survey years[10,11,12,13] and scientific studies[9,14,15,16,17,18,19,20]. The wide range of coumarin levels found in these commodities may be due to natural variation, degree of processing, the amount and the type of cinnamon used in these commodities[16]. The Government of Canada has restrictions on coumarin as an additive to foods, but not on maximum concentrations from natural sources[21]. The highest coumarin level reported in this survey was 11,700 ppm in pure cinnamon. The reported level was within the range observed in literature[12,14,15,22].

The percentages of baked products, cinnamon, and spice mix samples with detected levels of coumarin in this survey were 97%, 100% and 96%, respectively. These numbers are comparable to detection rates in the most recent CFIA 2015 survey for comparable product types (94%, 100% and 95%, respectively). The average and maximum levels in these commodities are also in agreement with the literature values and previous surveys shown in Table 3.

Coumarin levels in flavoured oatmeal were comparable to breakfast cereals results. No studies on coumarin levels in flavoured oatmeal have been found, and only limited information could be found on breakfast cereals. However, literature values for breakfast cereals are small and limited to small sample sizes, and therefore can't be representative of the market. Average levels are also low for this commodity type compared to other types.

The average and maximum coumarin levels of baked products in this survey are in close agreement with the results of the 2013 and 2015 surveys for baked goods. The range of coumarin levels observed in baked goods was within 130 ppm reported in literature and previous surveys. The average level of coumarin in baked products in this survey (16 ppm) closely matched that of previous surveys (18 and 16 ppm).

Results for cinnamon samples were comparable to data from previous surveys and literature. There is a natural variation in the different types of cinnamon, which could account for the range of sample levels of 5.8 to 11,700 ppm.

Data regarding spice mixes was similar across all surveys (2011-2018) for minimum, maximum, and average coumarin levels.

Health Canada's Bureau of Chemical Safety determined the levels of coumarin in food observed in this survey are not expected to pose a concern to human health; therefore no follow-up actions were required. Different agencies, such as the European Food Safety Authority (EFSA), Germany's Federal Institute of Risk Assessment (BfR), and the Norwegian Scientific Committee for Food Safety have emitted warnings or established limits regarding cinnamon consumption and elevated intake of coumarin[6,7,8].

Table 3. Minimum, maximum and average level of coumarin in cinnamon-containing foods across various studies

Product type	Study	Number of samples	Minimum (ppm)	Maximum (ppm)	Average (ppm)
Cinnamon	CFIA survey, 2016 to 2018	300	5.8	11700	3340[e]
Ground cinnamon	CFIA survey, 2015	28	6.8	5040	2939[e]
Ground cinnamon	CFIA survey, 2011	87	16.2	7816	3594[e]
Saigon cinnamon	Wang et al., 2013	2	1060	6970	4015
Ceylon cinnamon	Wang et al., 2013	17	5	90	18.8
Ground cinnamon	Blahová et al., 2012	60	2571	7057	3856
Cinnamon powder and sticks	Krüger et al., 2018	28	8	5017	1449
Cassia cinnamon powder and sticks	Woehrlin et al., 2010	69	<LOD[d]	9900	3697
Cinnamon powder	Lungarini et al., 2008	20	5	3094	1456
Tea	CFIA survey, 2015	297	0.2	2230	442[e]
Tea	CFIA survey, 2014	508	0.2	1920	302[e]
Tea	CFIA survey, 2013	115	0.3	2430	500[e]
Tea	CFIA survey, 2011	11	<0.29	1040	380[e]
Tea	Krüger et al., 2018	8	20	137	62
Tea	Lungarini et al., 2008	5	30	192	81
Spice mix	CFIA survey, 2016 to 2018	450	0.2	3380	361[e]
Spice mix	CFIA survey, 2015	222	0.2	3040	327[e]
Spice mix	CFIA survey, 2014	324	0.2	2170	329[e]
Spice mix	CFIA survey, 2013	103	0.2	2510	390[e]
Spice mix	CFIA survey, 2012	53	30	3078	568[e]
Spice mix	CFIA survey, 2011	24	<0.29	2014	352[e]
Spice mix	Raters et al., 2008	172	<0.03	4309	174
Baked products	CFIA survey, 2016 to 2018	498	0.2	80	16[e]
Baked goods	CFIA survey, 2015	200	0.2	130	18[e]
Baked goods	CFIA survey, 2013	139	0.1	83	16[e]
Baked goods	Raters et al., 2008	307	<0.03	103	7.87
Breakfast cereals	CFIA survey, 2016 to 2018	199	0.2	45.6	9.75[e]
Breakfast cereals	Krüger et al., 2018	3	0.7	1.3	0.9

Other bakery products and breakfast cereals	Ballin, 2014	13	N/A[f]	32	9
Breakfast cereals	Sproll et al., 2008	4	0.9	10	3.3
Flavoured oatmeal	CFIA survey, 2016 to 2018	50	1.9	39.4	13.4[e]

[d] Limit of detection
[e] Only positive results were used to calculate the average coumarin levels
[f] Not available

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