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

Aflatoxins in chocolate, cocoa powder, grain-based foods, nuts and nut products, spices and wine – April 1, 2014 to March 31, 2015

Food chemistry – Targeted surveys – Final report

Canada

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.

Aflatoxins are a family of mycotoxins (naturally-occurring and toxic secondary metabolites) produced by *Aspergillus* fungi. Hot, humid conditions and pest damage during plant growth or storage can favour the growth of aflatoxin-producing fungi, leading to the presence of aflatoxins in foods.. This survey targeted chocolate, cocoa powder, grain-based foods, nuts and nut products, spices and wine as these products are most likely to contain aflatoxins.

To look at the levels of aflatoxins present in foods in the Canadian market, the CFIA carried out a retail survey of foods likely to contain aflatoxins. In this report, 1300 products were sampled. Aflatoxins were found in 2% of samples tested and ranged from 1.0 parts per billion (ppb) to 24 ppb. The Canadian maximum level for total aflatoxin in nuts and nut products is 15 ppb and the compliance rate in this survey was 100%. There are currently no limits for aflatoxins in the other commodities examined. All aflatoxin results are reviewed by Health Canada's Bureau of Chemical Safety to determine if aflatoxin levels 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

Aflatoxins are naturally occurring mycotoxins produced by *Aspergillus* fungi[1]. The 4 main aflatoxins are AFB_1, AFG_1, AFB_2 and AFG_2. The B_1 form is the predominant and most toxic form of aflatoxin[2]. Short term exposure to high levels of aflatoxins can cause vomiting, abdominal pain and death[2]. Long term exposure to higher levels of aflatoxins, specifically AFB_1, has been linked to liver cancer and liver disease as well as preventing proper growth in children[2]. It is important to note that exposure to high levels of aflatoxins is very rare in developed countries.

Aflatoxins can be present in foods such as nuts and nut products, spices, rice, dried foods, grains and cocoa beans[1]. During growth and harvest phases of food, moulds can be produced as a result of hot and humid conditions and pest damage resulting in aflatoxin contamination[1]. The major route of human exposure to aflatoxins is through the consumption of contaminated foods directly or as ingredients[2]. This survey provided a snapshot of the levels found in food products that are available in Canada.

What did we sample

A variety of domestic and imported products from the following categories were sampled including: chocolate, cocoa powder, grain based products, nuts and nut products, spices, and wine. Products were sampled from April 1, 2014 to March 31, 2015. 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 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. Samples were imported from 36 countries.

Table 1. Distribution of survey samples based on product type and origin

Product type	Details	Number of domestic samples	Number of imported samples	Number of samples of unspecified origin[a]	Total number of samples
Chocolate	Milk/dark chocolate bars, milk/sweet/ semi-sweet/unsweetened/white chocolate chips and baking chocolate	16	66	68	150
Cocoa powder	Alkanilized, Dutch process, etc.	0	46	54	100
Grain-based foods	Bagels, bread, English muffins, breakfast cereals, infant cereals, oats, and oatmeal	77	77	195	349
Nuts and nut products	Almonds and almond butter, Brazil nuts, cashews and cashew butter, chestnuts, hazelnuts/filberts and hazelnut butter, macadamia nuts, mixed nut butters, peanuts and peanut butter, pecans, pine nuts, pistachios, walnuts	89	62	149	300
Spices	Allspice, anise, caraway seeds, cardamom, celery seeds, cinnamon, cloves, coriander, cumin, curry, fenugreek/methi, ginger, mace, mixed spices, mustard seeds, nutmeg, paprika, pepper (black, cayenne, chili), star anise, turmeric	8	53	140	201
Wine	Red, rosé, white, sparkling	1	197	2	300
Total		**191**	**501**	**608**	

[a] 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

All samples were analyzed by ISO/IEC 17025 accredited food testing laboratories The samples were tested for total aflatoxins (sum of AFB_1, AFG_1, AFB_2 and AFG_2). All samples are tested “as sold”, i.e., not prepared according to package instructions.

Currently, there are no Canadian regulatory limits for aflatoxins for the most of the categories of products included in the survey, but Health Canada has determined a maximum level (ML) of 15 ppb for total aflatoxins in nuts and nut products. All aflatoxin results are reviewed by Health Canada’s Bureau of Chemical Safety to determine if the levels are harmful to consumers. Levels in this survey were considered safe for consumption by Canadians and no product recalls were required.

What were the survey results

In total, 1300 samples were tested and 1274 or 98% did not contain detectable levels of aflatoxins. Aflatoxin levels in the remaining samples ranged from 1.0 ppb to 24 ppb as presented in Table 2. Aflatoxins were not detected in the samples of chocolate, cocoa products or wine. Average aflatoxin levels were highest in grain-based foods and lowest in spices.

Of the 1300 products tested, 1171 were conventionally grown and 129 were labelled as “organic”. The detection rates were 2.0% and 1.6%. respectively, for conventionally grown and organic products. For the conventionally grown products, the levels ranged from 1.0 ppb to 24 ppb, with an average level of 5.5 ppb. For the organic products, the levels ranged from 3.4 ppb to 9.0 ppb, with an average of 6.6 ppb. Please see Appendix A for a more detailed breakdown of the testing results.

Table 2. Summary of aflatoxin detection rates and levels per commodity

Product type	Number of samples	Number of samples (%) with detected levels	Minimum (ppb)	Maximum (ppb)	Average[b] (ppb)
Chocolate	150	0 (0)	n/a	n/a	n/a
Cocoa powder	100	0 (0)	n/a	n/a	n/a
Grain-based foods	349	2 (0.6)	3.4	5.1	4.2
Nuts and nut products	300	9 (3.0)	1.3	12	3.8
Spices	201	15 (7.5)	1.0	24	3.7
Wine	200	0 (0)	n/a	n/a	n/a
Total	**1300**	**26 (2.0)**	**1.0**	**24**	**3.6**

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

Chocolate, cocoa powder, and wine

None of the samples of chocolate, cocoa powder, or wine contained a detectable level of aflatoxins. Please consult Table 1 for a description of the different types of samples tested.

Grain-based foods

Nine different product types were tested. Aflatoxins were not detected in samples of bread/bread products (including bagels, English muffins, pita breads, naan, tortillas, buns/rolls, crumpets), breakfast cereals marketed to adults, infant cereals, oat grains or oatmeal. Only 2 samples of breakfast cereals marketed to children had detectable levels of aflatoxins; both cereals contained corn as a principal grain. This is consistent with previous surveys.

Nuts and nut products

This survey included 11 types of nuts and 5 different nut butters. Aflatoxins were not detected in 9 nut types (almonds, cashew nuts, chestnuts, hazelnuts/filberts, macadamia nuts, peanuts, pine nuts, pistachios, and walnuts), and 1 type of nut butter (cashew butters) did not contain detectable levels of aflatoxins.

A total of 10 nut and nut butter samples contained detectable levels of aflatoxins. This included:

- 3 samples of almond butter (2.2., 4.2 and 4.5 ppb)
- 2 samples of peanut butter (1.4 and 2.8 ppb)
- 1 sample of Brazil nuts (8.3 ppb)
- 1 sample of pecans (12 ppb)
- 1 sample of almond/hazelnut mix (1.3 ppb)
- 1 sample of hazelnut butter (2.0 ppb)

All nuts and nut butters tested in this survey were compliant (100% compliance) with Health Canada's ML of 15 ppb. There is no health risk to consumers from consumption of these products.

Spices

This survey included 23 types of spices. Aflatoxins were not detected in 17 types of spices (allspice, anise, caraway seed, celery seeds, cinnamon, cloves, coriander, cumin, fennel, fenugreek/methi, ginger, mace, mustard seeds, black pepper, mixed spices, spice – other, or star anise). Aflatoxins were detected in:

- 5 samples of nutmeg (4.1, 10, 10.5, 13.1 and 24 ppb)
- 4 samples of paprika (1.2, 2.3, 2.6 and 8.4 ppb)
- 2 samples of hot/cayenne peppers (1.4 and 2.4 ppb)
- 2 samples of turmeric (2.7 and 5.5 ppb)
- 1 sample of cardamom (9.9 ppb)
- 1 sample of curry powder (1.0 ppb).

What do the survey results mean

Aflatoxins can contaminate foods in the field or in storage; as the samples were obtained at the retail level, no information is available on levels of aflatoxins in newly harvested raw materials nor on the storage conditions. Fungicides can be employed to prevent mold formation; no information is available on whether the samples were treated with synthetic or natural fungicides.

The current survey results were compared to those published in earlier CFIA targeted surveys[3,4,5,6] and[i] the scientific literature[7,8,9]. When comparing the results reported in the current survey to other surveys or scientific literature, the detection rates, maximum observed levels and average concentration are lower than or similar to those reported for all product types, except for average concentration of aflatoxins in grain-based foods. This is likely related to a ten-fold difference in the limit of detection for the 2012 and 2013 surveys relative to the 2010-2012 surveys.

Table 3. Minimum, maximum and average concentration levels of total aflatoxins for each product category across CFIA survey years and in the scientific literature

Product type	Survey author	Number of samples	Number of samples (%) with detected levels	Minimum (ppb)	Maximum (ppb)	Average[c] (ppb)
Chocolate	**CFIA, 2014**	**150**	**0 (0)**	**n/a**	**n/a**	**n/a**
Chocolate	Turcotte et al., 2013	39	30 (77)	n/a	0.97	0.22
Chocolate	Copetti, 2012	100	73 (73)	<LOD	1.65	0.39
Cocoa powder	**CFIA, 2014**	**100**	**0 (0)**	**n/a**	**n/a**	**n/a**
Cocoa powder	CFIA, 2013	49	1 (2)	n/a	1.4	n/a
Cocoa powder	CFIA, 2012	25	0 (0)	n/a	n/a	n/a
Grain-based foods	**CFIA, 2014**	**349**	**2 (0.6)**	**3.4**	**5.1**	**4.2**
Grain-based foods	CFIA, 2013	491	21 (4.3)	1.0	17	3.6
Grain-based foods	CFIA, 2012	295	40 (13)	0.10	2.0	0.49
Grain-based foods	CFIA, 2011	304	20(6.6)	0.10	1.5	0.45
Grain-based foods	CFIA, 2010	285	23 (8.1)	0.10	1.7	0.5
Nuts and nut products	**CFIA, 2014**	**300**	**9 (3.0)**	**1.3**	**12**	**3.8**
Nuts and nut products	CFIA, 2013	238	13 (5.5)	1.0	24	4.1
Nuts and nut products	CFIA, 2012	437	79 (18)	0.10	28	1.8
Nuts and nut products	CFIA, 2011	399	55 (14)	0.10	12	1.4
Nuts and nut products	CFIA, 2010	253	21 (8.3)	0.1	21	4.1
Spices	**CFIA, 2014**	201	15 (7.5)	1.0	24	3.7
Spices	CFIA, 2013	94	15 (16)	1.5	72	14
Spices	CFIA, 2012	49	34 (69)	0.10	44	4.0
Wine	CFIA, 2014	**200**	**0 (0)**	**n/a**	**n/a**	**n/a**
Wine	Sugita-Konishi et al., 2006	10	6 (60)	0.07	0.72	0.34

[c]Only positive results were used to calculate average aflatoxins levels

The CFIA survey results support that chocolate, cocoa powder, grain-based foods, nuts and nut products, spices and wine are safe for human consumption. There were no recalls resulting from this survey.

References

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Appendix A

Table A1.Summary of testing results for conventionally grown products

Product	No of samples	Detection Rate (%)	Minimum (ppb)	Maximum (ppb)	Average[d] (ppb)
Chocolate	131	0	n/a	n/a	n/a
Cocoa powder	89	0	n/a	n/a	n/a
Grain-based foods	311	0.32	n/a	5.1	n/a
Nuts and nut products	269	3.3	1.3	12	4.3
Spices	177	7.9	1	24	6.4
Wine	194	0	n/a	n/a	n/a

Table A2. Summary of testing results for organic products

Product	No of samples	Detection Rate (%)	Minimum (ppb)	Maximum (ppb)	Average[e] (ppb)
Chocolate	19	0	n/a	n/a	n/a
Cocoa powder	11	0	n/a	n/a	n/a
Grain-based foods	38	2.6	n/a	3.4	n/a
Nuts and nut products	31	0	n/a	n/a	n/a
Spices	24	4.2	n/a	9.9	n/a
Wine	6	0	n/a	n/a	n/a

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