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

Ochratoxin A in Selected Foods - April 1, 2012 to March 31, 2018 and April 1, 2019 to March 31, 2022

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 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.

A wide variety of products consumed by Canadians can be naturally contaminated with fungi (includes mould) which can produce toxins known as mycotoxins. Ochratoxin A (OTA) is a mycotoxin released by mould that can grow on agricultural products as a result of warm, wet climate conditions during storage. OTA may cause kidney cancer, and has negative effects on the liver, the developing fetus, and the immune system.

Cocoa, coffee, dried fruits, grain-based foods, infant formula, licorice products, nuts and nut butters, pulse products, seeds, soy products, and spices are susceptible to contamination by OTA. These products are consumed in varying degrees by some or all populations in Canada. Unfortunately, these products can be naturally contaminated with mycotoxins, which are toxic secondary metabolites of fungi

Considering the factors mentioned above and their relevance to Canadians, cocoa, coffee, dried fruits, grain-based foods, infant formula, licorice products, nuts and nut butters, pulse products, seeds, soy products, and spices were selected for these targeted surveys. The purpose of targeted surveys is to generate a snapshot of the occurrence and levels of chemical hazards in food.

Over the course of these studies, a total of 8384 samples were collected from retail locations in 6 cities across Canada and tested for OTA. OTA was found in 4056 (48%) samples tested. Health Canada has proposed several maximum levels for OTA: 3 parts per billion (ppb) for grain-based foods 0.5 ppb for infant foods, 7 ppb for wheat bran, and 10 ppb for dried vine fruits (raisins, currants, sultanas). The compliance rate for these products was 96.95%. There are currently no limits for OTA in: other grains, cocoa, coffee, licorice, other dried fruits, nuts and nut butters, pulses, seeds, soy products and spices. All results associated with these products are reviewed by Health Canada's Bureau of Chemical Safety (BCS) to determine if the OTA levels observed are harmful to consumers. Levels in these samples did not pose a health risk to Canadian consumers and there were no product recalls resulting from this survey.

CFIA will continue to monitor OTA levels in a variety of foods to ensure the safety of the Canadian food supply.

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

Cocoa, coffee, dried fruits, grain-based foods, infant formula, licorice products, nuts and nut butters, pulse products, seeds, soy products, and spices are consumed to varying degrees by some or all populations in Canada. Various strains of Aspergillus and Penicillium moulds can infect foods in storage, resulting in the production of a toxin (ochratoxin A or OTA). This report provides the results of a chemistry survey that was carried out to detect a toxin (ochratoxin A) produced by moulds. Wet, warm weather conditions in storage will favour the development of OTA[1]. OTA only forms after harvest and is most commonly found in in cereal grains (wheat, corn, oat, and barley), green coffee, grape juice, beer, wines, cocoa, dried fruits, and nuts[2]. OTA is not easily destroyed by heating so it survives under normal cooking or processing conditions[3,4].

The International Agency for Research on Cancer (IARC) has classified OTA as a possible human carcinogen[5], especially in the kidneys. In animal studies, OTA has also been shown to have negative effects on the kidneys, the developing fetus, and the immune system[5]. Health Canada completed a risk assessment for OTA[6], and as a result, has proposed maximum levels for OTA in various food commodities[5] as well as an industry guidance value for OTA in unprocessed cereal grains[5].

The main objectives of this targeted survey were to generate additional baseline surveillance data on the levels of OTA in foods not routinely monitored under other CFIA programs, to assess compliance with proposed Canadian regulations, and to compare the prevalence of OTA in foods in this survey with that of previous targeted surveys.

What did we sample

A variety of domestic and imported cocoa, coffee, dried fruits, grain-based foods, infant formula, licorice products, nuts and nut butters, pulse products, seeds, soy products, and spices were sampled between April 1, 2012 and March 31, 2018 and between April 1, 2019 and March 31, 2022. 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)
- 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	Sample types	Number of domestic samples	Number of imported samples	Number of samples of unspecified[a] origin	Total number of samples
Grain-based foods	Bran/flour/meal/milled grains/ starch/flakes/groat/grits, baked goods, baking mixes, bread, cookies, infant/ breakfast cereals, crackers, pasta (wheat, corn, oat, rice), amaranth, arrowroot, barley, buckwheat, kamut, millet, quinoa, rye, sorghum, spelt, teff, triticale (alone or in combination)	1025	1477	1610	4112
Cocoa	Powders	3	207	32	242
Coffee	Beans, beverages, instant/ground coffee, dried mixes	263	381	146	790
Dried fruits	Apple, apricot, banana, Goji berry, blueberry, cherry, cranberry, currant, date, dragon fruit, fig, , kiwi, mango, cantaloupe, mixed fruits, papaya, pineapple, plantain, prune, raisin, other	31	530	134	695
Infant formula	Milk or soy-based, all ages	0	188	4	192
Licorice products	Candy	4	134	2	140
Nuts and nut butters	Almonds, brazil nuts, cashews, chestnuts, hazelnuts/filberts, macadamia, peanuts, pecans, pine nuts, pistachio, walnuts, almond butter, nut butters containing cocoa/ chocolate/coconut, cashew butter, hazelnut butter, peanut butter, rainforest nut butter	45	81	22	148
Pulses	Fresh/frozen/canned beans, chickpeas, lentils, peas + flours + derived products	252	243	152	647
Seeds	Chia, flax, hemp, poppy, pumpkin, sesame, sunflower, other	97	111	71	279
Soy products	Soybean, soy beverage, soy flour, meat/fish alternative, soynuts, soybean paste/miso, tempeh, tofu	127	147	87	361
Spices	Coriander, chili powder, cinnamon, cumin, curry powder, curry leaves, fennel, fenugreek/methi, dry garlic, garlic powder, ginger, dry mustard, mustard seeds, nutmeg, paprika, pepper (black, white), turmeric, other, mixed	41	533	204	778
Total	N/A	**1888**	**4032**	**2464**	**8384**

[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 food testing laboratory under contract with the Government of Canada. The results are based on the food products as sold and not necessarily as they would be consumed.

In 2009, Health Canada proposed maximum levels (MLs) for OTA in a variety of foods. These MLs as well as an industry guidance value for OTA in unprocessed cereal grains are still under consideration and remain in "proposed" status[7]. The proposed Canadian standards and guidance value for OTA, and the established international maximum levels for OTA in foods are presented in Appendix A[7,8,9,10].

In the absence of established tolerances or standards for OTA in foods, elevated levels of OTA 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 8384 samples that were tested, 52% were free from contamination by OTA. Of the 48% of samples where OTA was detected, there were various ranges of contamination as seen in Table 2. Average levels of OTA were highest in spices, and lowest in nuts and nut butters.

Of the 8384 samples tested, 7071 samples were conventionally grown and 1313 samples were labelled as "organic". The detection rate for OTA was 51% for conventionally grown products and 35% in organic products. For conventionally grown products, OTA levels ranged from 0.040 ppb to 1770 ppb, with an average concentration of 3.8 ppb. For organic products, OTA levels ranged from 0.040 ppb to 65 ppb, with an average concentration of 1.1 ppb. All commodities examined included both conventional and organic products. For most commodities, the number of samples and the diversity of product types was greater for conventional products than for organic products. The exception are the less commonly consumed grains (labelled as other grains) where organic products were 150% higher than conventional products, In addition, kamut was exclusively organic and triticale was exclusively conventional. For a detailed breakdown of the results, please see Appendix B. As mentioned earlier, OTA is naturally occurring – expected to be seen in both conventionally grown or organic products. As samples were collected at retail, no information on storage conditions of the raw commodities or whether the samples were treated with fungicides (may reduce mold formation and release of OTA) is available.

Table 2. Levels of OTA in selected foods

Product	Total number of samples	Number (%) of positive samples	Number of samples with non-compliant levels	Min (ppb)[b]	Max (ppb)[b]	Average level (ppb)[b]
Cocoa	242	219 (90)	N/A	0.070	6.6	1.3
Coffee	790	190 (24)	N/A	0.043	11	0.96
Dried Fruits	695	224 (32)	6	0.041	116	1.4
Grain-Based Foods	4112	2358 (57)	119	0.040	65	0.51
Infant Formula	192	13 (7)	0	0.049	11	1.1
Licorice Products	140	111 (79)	N/A	0.042	36	2.1
Nuts and Nut Butters	148	31 (21)	N/A	0.048	1.2	0.20
Pulse	647	208 (32)	N/A	0.040	26	1.2
Seeds	279	87 (31)	N/A	0.050	65	1.1
Soy	361	51 (14)	N/A	0.040	3.0	0.36
Spices	778	517 (66)	N/A	0.044	1770	22

[b] Only detectable values of OTA were included in the calculation

Of the products tested, 119 grain-based foods and 6 raisin samples (3.05%) had non-compliant levels of OTA.

The results for the entire dataset, were forwarded to Health Canada's BCS for a safety assessment. Health Canada is of the opinion that the levels of OTA in the products analyzed in this survey were unlikely to pose a health risk. No product recalls were warranted given the lack of a risk to human health.

What do the survey results mean

In this survey, 52% of samples of selected foods analyzed were free of detectable levels of OTA. Tables 3-13 present a comparison of the maximum, minimum and average OTA levels in specific food categories observed in this study which were comparable to previous targeted surveys[11,12,13,14] and scientific papers[15,16,17,18,19,20].

Table 3. Summary of targeted survey data on OTA concentrations in cocoa products

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2015	100	82	0.07	4.8	0.91
2014	93	95	0.5	6.6	1.4
2013	49	100	0.39	5.3	2.0

Table 4. Summary of targeted survey data on OTA concentrations in coffee products

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2019	150	20	0.05	1.2	0.20
2015	300	17	0.05	9.1	0.97
2014	141	18	0.43	6.7	1.8
2013	199	42	0.043	11	0.96

Coffee products included coffee beans, pre-packaged beverages, ground coffee, instant coffee, and dried mixes. The detection rate decreased in the order: dried mixes (100%) < instant coffee (64%) < ground coffee (27%) < coffee beans (23%) < pre-packaged beverages (2%). The average concentration decreased in the order: instant coffee (2.5 ppb) > ground coffee (0.66 ppb) > coffee beans (0.56 ppb) > dried mixes (0.13 ppb) > beverages (0.063 ppb). The highest OTA level (9.1 ppb) was observed in a ground coffee sample.

Table 5. Summary of targeted survey data on OTA concentrations in dried fruits

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2020	175	27	0.042	116	3.8
2015	321	31	0.046	14.4	0.76
2013	100	33	0.041	17.8	0.90
2012	99	44	0.041	14.5	0.88
2011	105	24	0.042	8.8	1.0
2010	97	22	0.049	3.8	0.49

There were 21 different types of dried fruits analysed, 11 different types did not contain detectable levels of OTA. The detection rate decreased in the order: currants (73%), raisins (70%) > figs (28%) > apricots (26%) > papayas (14%) > dates (9%) > prunes & pineapples (8%) > mixed fruits & cranberry (6%) > mango (3%). The average OTA concentrations decreased in the order: raisin (2.0 ppb) > currant (0.84 ppb) > pineapple (0.34 ppb) > apricot (0.27 ppb) > prune (0.19 ppb) > fig (0.14 ppb) > mango (0.13 ppb) > papaya (.12 ppb) > cranberry (0.10 ppb)

> date (0.072 ppb) > mixed fruits (0.067 ppb). The highest OTA level observed (116 ppb) was observed in a raisin sample.

Table 6. Summary of targeted survey data on OTA concentrations in grain-based foods

Grain Type or Product Type	Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
Corn (bran, chips, cornmeal/polenta/grits, flour, pasta, starch, taco, tostada)	2013	129	12	0.045	0.44	0.14
	2012	149	15	0.043	6.2	0.69
	2011	71	11	0.062	1.4	0.47
	2010	73	10	0.047	1.3	0.34
Less commonly consumed grains (amaranth, arrowroot, barley, buckwheat, kamut, millet, quinoa, rye, sorghum, spelt, teff, triticale)	2018	100	44	0.05	7.6	1.0
	2017	88	34	0.043	3.3	0.47
	2013	133	22	0.057	13	2.2
	2012	133	33	0.045	6.7	0.94
	2011	112	35	0.041	28	1.5
Oat (bran, flour, grains, meal)	2018	97	54	0.05	1.6	0.26
	2013	157	37	0.04	21	1.3
	2012	163	52	0.04	7	0.64
	2011	29	20	0.047	1.2	0.37
	2010	17	76	0.085	0.74	0.26
Rice (flour, grains, pasta)	2018	99	14	0.049	11	1.1
	2013	7	4	0.053	0.26	0.16
	2012	7	0	N/A	N/A	N/A
Wheat (bran, bulgur, couscous, flour, freekeh, germ, kernels, soft wheat, wheatlets)	2018	29	62	0.06	1.5	0.4
	20178	1	0	N/A	N/A	N/A
	2013	149	71	0.041	13	0.62
	2012	145	79	0.043	7.6	0.85
	2011	104	84	0.042	14	0.96
	2010	94	92	0.044	6.8	0.90
Grain-based Foods (baked goods, baking mixes, bread, breakfast cereals, cookies, crackers, infant cereals, pasta)	2020	14	78	0.046	1.5	0.53
	2018	171	54	0.042	2.2	0.24
	2016	860	66	0.04	65	0.42
	2014	5	0	N/A	N/A	N/A
	2013	845	66	0.04	7	0.31
	2012	1127	64	0.041	5.6	0.47
	2011	413	72	0.041	3.34	0.57
	2010	288	51	0.04	3.1	0.45
	2009-10	225	22	0.30	7.2	1.2

OTA was detected in 7 of 8 types of corn products tested; OTA was not detected in any tostada samples. The detection rate decreased in the order: bran (100%) > flour (31%) > taco (23%) > pasta (18%) > chips (9%) > starch & meal (5%). The average OTA concentration decreased in the order: flour (0.85 ppb) > taco (0.32 ppb) > chips (0.25 ppb) > meal (0.15 ppb) > bran & pasta (0.11 ppb) > starch (0.081 ppb). The highest OTA level observed (6.2 ppb) was observed in a sample of corn flour.

OTA was detected in 11 out of 13 types of less commonly consumed grains; OTA was not detected in arrowroot or teff. The detection rate decreased in the order: mixed grains (100%) > buckwheat (49%) > rye (43%) > quinoa (42%) > triticale (33%) > spelt (26%) > kamut (24%) > millet (23%) > sorghum (20%) > barley (17%) > amaranth (15%). The average OTA concentration decreased in the order: kamut (13 ppb) > triticale (2.5 ppb) > quinoa (1.7 ppb) > rye (1.5 ppb) > buckwheat (0.80 ppb) > millet (0.41 ppb) > barley (0.38 ppb) > mixed grains (0.27 ppb) > spelt (0.26 ppb) > amaranth (0.24 ppb) > sorghum (0.045 ppb). The highest OTA level observed (13 ppb) was observed in a sample of kamut kernels.

OTA was detected in all oat product types. The detection rate decreased in the order: bran (73%) > flour (53%) > oatmeal (41%) > oat grains (38%). The average OTA concentration decreased in the order: flour (2.0 ppb) > oatmeal (0.93 ppb) > bran (0.57 ppb) > grains (0.54 ppb). The highest OTA level observed (21 ppb) was observed in a sample of oat flour.

OTA was not detected in rice flour or rice grains; 4 out of 7 (57%) rice pasta samples contained OTA, with levels ranging from 0.053 ppb to 0.26 ppb, with an average OTA concentration of 0.16 ppb.

OTA was detected in 7 of 9 types of wheat products; OTA was not detected in wheat kernels or soft wheat. The detection rate decreased in the order: freekeh (100%) > wheat germ (90%) > bran (89%) > couscous (78%) > flour (77%) > wheatlets (50%) > bulgur (8%). The average OTA concentration decreased in the order: bulgur (2.2 ppb) > germ (0.86 ppb) > bran (0.78 ppb) > freekeh (0.72 ppb) > couscous (0.68 ppb) > flour (0.67 ppb) > wheatlets (0.20 ppb). The highest OTA level observed (13 ppb) was in a sample of wheat flour.

OTA was detected in all grain-based product types. The detection rate decreased in the order: bread (82%) > crackers (79%) > cookies (74%) > baking mixes (67%) > baked goods (63%) > breakfast cereals (59%) > pasta (56%) > infant cereals (47%). The average OTA concentration decreased in the order: baked goods (0.95 ppb) > infant cereals (0.62 ppb) > breakfast cereals (0.50 ppb) > bread (0.35 ppb) > crackers (0.32 ppb) > pasta (0.29 ppb) > baking mixes (0.28 ppb) > cookies (0.24 ppb). The highest OTA level observed (65 ppb) was observed in a sample of frozen waffles.

Table 7. Summary of targeted survey data on OTA concentrations in infant formula

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2014	44	18	0.050	0.46	0.14
2012	148	35	0.040	0.89	0.14
2011	96	20	0.13	0.19	0.16
2010	102	3	0.063	0.37	0.19
2009	75	1	N/A	0.40	N/A

Infant formula included milk-based and soy-based formulas. None of the milk-based formula samples contained detectable levels of OTA. The OTA in soy-based infant formula resulted from use of corn as carbohydrate source, not from soybeans[8].

Table 8. Summary of targeted survey data on OTA concentrations in licorice products

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2014	91	78	0.042	36	2.8
2013	49	82	0.042	3.7	0.85

Table 9. Summary of targeted survey data and scientific literature on OTA concentrations in nuts and nut butters

Author	Year	Product type	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
CFIA	2020	Nut Butters	49	37	0.048	1.2	0.28
		Nuts	99	13	0.060	0.13	0.095
Demirhan et al.	2022	Hazelnut butter	20	25	0.01	0.94	0.27
		Peanut butter	40	95	0.09	37.26	3.80
Boli et al.	2014	Peanut butter	45	98	0.53	2.23	1.66
Abdulkadar et al.	2004	Nuts	18	0	N/A	N/A	N/A
		Peanut butter	7	0	N/A	N/A	N/A

OTA was not detected in Brazil nuts, cashews, macadamia nut, peanuts, pecans, pine nuts, or walnuts. The detection rate decreased in the order: nut butters containing cocoa/chocolate or coconut (78%) > cashew butter (50%) > almond butter (38%) > rainforest nut butter & almonds

& chestnuts (33%) > hazelnut butters & hazelnuts/filberts (25%) > pistachio (17%) > peanut butter (11%).

The average OTA concentration decreased in the following order: nut butters containing cocoa/chocolate or coconut (0.54 ppb) > almond butter (0.13 ppb) > hazelnuts/filberts (0.12 ppb) > rainforest nut butter (0.10 ppb) > pistachio (0.092 ppb) > almonds (0.084 ppb) > chestnuts (0.080 ppb) > peanut butter (0.058 ppb) > cashew butter (0.055 ppb) > hazelnut butter (0.055 ppb). The highest OTA level observed was in a sample of hazelnut butter containing cocoa at 1.2 ppb.

Table 10. Summary of targeted survey data on OTA concentrations in pulse products

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2020	157	35	0.041	19	1.6
2017	350	35	0.040	26	1.0
2016	140	21	0.041	7.4	1.0

The detection rate of OTA in pulses decreased in the order**:** chickpea (41%) > pea (38%) > bean (29%) > lentil (21%). The average OTA concentration decreased in the order: bean (1.7 ppb) > pea (1.1 ppb) > lentil (0.99 ppb) > chickpea (0.7 ppb). The highest OTA level observed was in a romano bean sample at 26 ppb.

Table 11. Summary of targeted survey data and scientific literature on OTA concentrations in seeds

Author	Year	Product type	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
CFIA	2020	Seeds	279	31	0.050	65	1.1
Esau et al.	2020	Melon seeds	53	2	<LOD	112	112
		Sesame seeds	59	0			
Makun et al.	2013	Sesame seeds	19	100	1.90	15.66	8.14

OTA was detected in all 8 types of seeds tested. The detection rate of OTA in seeds decreased in the order**:** chia seeds (41%) > other seeds including mixed seeds and melon seeds (40%) > pumpkin seeds (38%) > flax (34%) > sunflower seeds (30%) > sesame seeds (26%) > poppy seeds (19%) > hemp seeds (16%). The average OTA concentration decreased in the order: hemp (13 ppb) > sunflower (1.6 ppb) > sesame (0.27 ppb) > chia & flax (0.19 ppb) > pumpkin (0.16 ppb) > other (0.11 ppb) > poppy (0.059 ppb). The highest OTA level observed was in a sample of hemp seeds at 65 ppb.

Table 12. Summary of targeted survey data on OTA concentrations in soy products

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2020	1	100	N/A	0.71	N/A
2014	66	17	0.047	2.0	0.43
2013	96	11	0.052	0.49	0.20
2012	198	14	0.040	3.0	0.38
2011	198	17	0.041	5.9	0.48

OTA was not detected in soy nuts or tempeh. The detection rate in soy products decreased in the order: meat/fish alternatives (67%) > soy flour (40%) > soybean paste/miso (7%) > soy beverages (4%) > soybeans & tofu (2%). The average OTA concentration decreased in the order: soy flour (0.41 ppb) > soybean paste/miso & meat/fish alternatives (0.16 ppb) > soy beverages (0.13 ppb > tofu (0.099 ppb) > soybeans (0.061 ppb). The highest OTA level observed was in a soy flour sample at 3.0 ppb.

Table 13. Summary of targeted survey data on OTA concentrations in spices

Year	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
2019	144	74	0.05	124	8.4
2015	273	63	0.05	152	15
2014	262	57	0.11	1770	35
2013	99	89	0.044	631	33

OTA was detected in 18 of 29 types of spices tested. OTA was not detected in anise, cinnamon, cumin, fennel, fenugreek/methi Kaffir lime leaves, marjoram, dried onion, onion powder, savory or vanilla beans. The highest OTA level observed (1770 ppb) was observed in a sample of paprika.

The detection rate in spices decreased in the order: paprika (92%) > chili powder (88%) > hot/cayenne pepper & mixed spices (83%) > nutmeg (82%) > curry powder (79%) > turmeric (71%) > black pepper (67%) > garlic powder (66%) > ginger & onion powder (50%) > garlic (44%) > coriander (42%) > white pepper (33%) > mustard seeds (32%) > celery seeds (27%) > curry leaves (18%) > mustard (17%).

The average OTA concentration decreased in the order: paprika (62 ppb) > nutmeg (38 ppb) > chili powder (18 ppb) > hot/cayenne pepper (6.4 ppb) > ginger (6.0 ppb) > mixed spices (3.0 ppb) > turmeric (2.2 ppb) > garlic powder (1.9 ppb) > curry powder (1.5 ppb) > coriander (1.2 ppb) > black pepper (0.93 ppb) > celery seeds (0.90 ppb) > curry leaves (0.84 ppb) > garlic

(0.70 ppb) > mustard seeds (0.46 ppb) > mustard (0.31 ppb) > onion powder (0.070) > white pepper (0.052 ppb).

The OTA levels in all samples were assessed by Health Canada’s BCS. Health Canada concluded that the levels of OTA found in the products analyzed in this survey did not pose a health concern. No product recalls were warranted given the lack of a health concern.

Appendix A

Proposed Canadian and established international OTA maximum levels/levels/guidelines (µg/kg or ppb) in foods

Commodity	Canada (proposed)[c]	United States	European Union	Codex
Raw/unprocessed cereal grains	5	Not specified to date	5.0	5
Grains for direct consumption	3	Not specified to date	3.0	Not specified to date
Derived cereal products (e.g. flour, bread, breakfast cereal)	3	Not specified to date	3.0	Not specified to date
Wheat bran	7	Not specified to date	3.0	Not specified to date
Cereal-based foods for infants and young children	0.5	Not specified to date	0.5	Not specified to date
Wheat gluten not sold directly to the consumer	Not specified to date	Not specified to date	8.0	Not specified to date
Dried vine fruit (currants, raisins and sultanas)	10	Not specified to date	10.0	Not specified to date
Roasted coffee beans and ground roasted coffee, excluding soluble coffee	Not specified to date	Not specified to date	5.0	Not specified to date
Soluble coffee (instant coffee)	Not specified to date	Not specified to date	10.0	Not specified to date
Liquorice extract (42), for use in food in particular beverages and confectionary	Not specified to date	Not specified to date	80	Not specified to date
Piper spp. (fruits thereof, including white and black pepper), Myristica fragrans (nutmeg), Zingiber officinale (ginger), Curcuma longa (turmeric)	Not specified to date	Not specified to date	15	Under discussion
Capsicum spp. (dried fruits thereof, whole or ground, including chillies, chilli powder, cayenne and paprika)	Not specified to date	Not specified to date	20	Under discussion
Mixtures of spices containing one of the abovementioned spices	Not specified to date	Not specified to date	15	Under discussion

[c] Proposed maximum level by Health Canada

Appendix B

Table. B1. Summary of targeted survey data on OTA concentrations in conventionally grown products

Commodity	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
Cocoa	224	94	0.11	6.6	1.1
Coffee	683	27	0.043	11	0.98
Corn	211	16	0.043	6.2	0.48
Dried Fruits	597	31	0.041	116	1.4
Grain-Based Foods	2620	64	0.040	7.0	0.36
Infant Formula - Dairy	50	0	n/a	n/a	n/a
Infant Formula - Soy	116	48	0.040	0.89	0.12
Licorice Products	135	81	0.042	36	2.0
Nuts and Nut Butters	128	21	0.048	1.2	0.22
Oat	220	44	0.040	6.0	0.64
Other Grains	144	28	0.043	5.3	0.80
Pulse	581	32	0.040	26	1.3
Rice	7	0	n/a	n/a	n/a
Seeds	173	33	0.060	65	1.6
Soy Products	200	17	0.042	3.0	0.40
Spices	741	67	0.044	1770	23
Wheat	241	76	0.041	5.4	0.65

Table. B2. Summary of targeted survey data on OTA concentrations in organic products

Commodity	Number of samples	% of positive samples	Minimum OTA levels (ppb)	Maximum OTA levels (ppb)	Average OTA levels (ppb)
Cocoa	18	44	0.070	1.0	0.54
Coffee	107	8	0.050	1.4	0.42
Corn	67	6	0.051	0.59	0.34
Dried Fruits	98	38	0.041	14	1.5
Grain-Based Foods	234	70	0.041	65	0.86
Infant Formula - Dairy	2	0	n/a	n/a	n/a
Infant Formula - Soy	24	17	0.074	0.61	0.3
Licorice Products	5	40	0.88	17	9.1
Nuts and Nut Butters	20	20	0.061	0.14	0.093
Oat	100	45	0.040	21	1.6
Other Grains	210	30	0.050	13	1.4
Pulse	66	29	0.041	0.34	0.15
Rice	4	25	n/a	0.22	n/a
Seeds	106	28	0.050	1.1	0.18
Soy Products	161	10	0.040	1.2	0.26
Spices	37	51	0.230	15	4.3
Wheat	54	67	0.042	13	1.2

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