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

Alternaria in Beer, Juices, Oils and Seeds - 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.

This targeted survey generated baseline surveillance data regarding *Alternaria* toxin levels in selected foods on the Canadian retail market. The most important *Alternaria* toxins are alternariol (AOH), alternariol monomethyl ether (AME), altuene (ALT) and L-tenuazonic acid (TeA). TeA is the most acutely toxic while AOH and AME have a lower toxicity[1]. However, there are several reports on the mutagenic and genotoxic effects of AME and AOH[2] as well as a tendency to kill fetuses of rats[3].

A total of 399 samples of beer, juices, oils and seeds were collected from retail locations in six cities across Canada and tested for AOH and AME. ALT and TeA were not included in the analytical method because of a lack of commercially available standards. AOH and/or AME were detected in 232 (58%) of the samples. The levels of AOH and AME were added so that the total *Alternaria* toxin levels are reported in this survey. The levels detected ranged from 0.050 parts-per-billion (ppb) to 573 ppb.

Currently in Canada as in the rest of the world, there are no regulated levels for *Alternaria* toxins in foods. Health Canada (HC) determined the levels of AOH and AME observed in the current survey are not expected to pose a concern to human health, therefore there were no recalls resulting from this survey. CFIA is conducting appropriate follow up activities which include further testing of similar products in previous and subsequent years.

Other regulatory agencies such as the US Food and Drug Administration, Australia/New Zealand and the European Union are not monitoring their foods for *Alternaria* toxins or are not currently publishing the results. A comparison of the exposure of Canadian consumers to *Alternaria* toxins with persons in other countries is not possible. All data was shared with Health Canada. This data may be used in future risk assessments and to set standards in Canada and/or internationally.

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 variety of beer, juices, oils and seeds is continuously increasing to meet consumers' demands. Moulds may develop in the field, during transport and/or during storage on the raw ingredients of these foods and beverages. *Alternaria* is a type of mould widely distributed in the soil and occurs in the air. *Alternaria* species are known as plant pathogens and as common allergens in humans.

Alternaria species also produce multiple toxins called mycotoxins. The most important ones are AOH, AME, ALT and TeA. Due to of the common presence of *Alternaria*, these toxins are frequently found in a wide variety of commodities. *Alternaria* mycotoxins have been recorded in fruits, such as apples, dark grapes, and citrus fruits, in vegetables like tomatoes, peppers and olives, and in fruit juices and beverages. They have also been found in grains such as wheat and barley, in sunflower seeds, and in wine. *Alternaria* has been reported to be the most frequent fungi invading tomatoes[4].

Among the mycotoxins produced by *Alternaria* species, TeA has the highest acute toxicity. In a study on mice, the oral administration of TeA salts to mice and rats resulted in cardiovascular collapse[1]. While the acute toxicity of AOH and AME is low, these toxins have shown genotoxic and mutagenic properties in cell cultures and laboratory animals[2]. These toxins have been observed to kill rat fetuses[3]. Exposure to *Alternaria* by inhalation can lead to asthma, infections and allergies. Dietary exposure has been linked to a variety of adverse health effects. TeA has been associated with human hematological disorders[4].

The primary source of *Alternaria* toxins in the human diet is fruit[6]. There are no Canadian or international regulations for *Alternaria* mycotoxins in foods[6]. The use of fungicide is the most common approach to manage the contamination of foods by *Alternaria*.

The main objectives of this targeted survey were to generate baseline surveillance data on the levels of *Alternaria* toxins in juices, beer, oils and seeds and to compare the prevalence of *Alternaria* mycotoxins in foods in this survey with that of other studies. *Alternaria* mycotoxins are not routinely monitored under other CFIA programs.

What did we sample

A variety of domestic and imported beer, juices, oils and seeds were sampled and tested 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[a]	Number of samples of unspecified[b] origin	Total number of samples
Beer	33	28	19	80
Juice	81	16	82	179
Oils	10	52	28	90
Seeds	16	5	29	50
Grand total	**140**	**101**	**158**	**399**

[a] Samples originated in at least 32 countries

[b] 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 are based on the food products as sold and not necessarily as they would be consumed.

There are no regulations in Canada or elsewhere in the world for *Alternaria* toxins in foods[5]. In the absence of a specific maximum level, the levels of *Alternaria* toxins are assessed by HC on a case-by-case basis using the most current scientific data available.

What were the survey results

A total of 399 samples of domestic and imported juices, beer, oils and seeds were tested for the *Alternaria* toxins AOH and AME. ALT and TeA were not included in the analytical method because of a lack of commercially available standards. AOH and/or AME were detected in 232 (58%) of the samples. The level of AOH and AME were added so that the total *Alternaria* toxin levels are reported in this survey. The levels ranged from 0.050 to 573 ppb. A summary of the *Alternaria* results by each product type can be seen in Table 2.

The percentage of samples with *Alternaria* toxin levels detected ranged from 28% in beer to 72% in juices and seeds. The highest average level of *Alternaria* toxins ranged from 0.26 ppb in beer to 17 ppb in juice. See Appendix A for a more detailed breakdown of the results by type of commodity (for example, by type of juice).

Table 2. Levels of *Alternaria* toxins in beer, juices, oils and seeds

Product type	Total number of samples	Number of positive samples	Min (ppb)	Max (ppb)	Average level (ppb) of positive results
Beer	80	24	0.091	1.2	0.26
Juices	174	125	0.050	573	17
Oils	90	50	0.10	57	7.1
Seeds	50	36	0.054	55	6.0

What do the survey results mean

The detection rates for *Alternaria* toxins in beer, juices, oils and seeds in this survey were comparable or lower than those reported in previous survey years and/or other cited scientific literature[7,8,9,10,11,12,13,14,15,16]. The average and highest observed levels of *Alternaria* toxins in this survey were comparable to or lower than those reported in previous years. Also consistent with other surveys, the level of *Alternaria* toxins is low in commonly consumed juices (such as apple, orange and grape juices) but is high in juices containing pomegranate as a main ingredient.

Table 3. Levels of *Alternaria* toxins in beer, juices, oils and seeds from various survey years and scientific literature

Product type	Jurisdiction/ author	Survey year	Number of samples	Number (percentage) of samples with detected *Alternaria* toxins	Min (ppb)	Max (ppb)	Ave. (ppb)
Beer	CFIA	2018 to 2019	80	22 (27)	0.091	1.2	0.26
Beer	Germany - Bauer et al.	2014	44	44 (100)	0.23	1.6	0.56
Beer	Italy - Prelle et al.	2012	30	9 (30)	6.04	23.2	Not specified
Juice	CFIA	2018 to 2019	174	125 (72)	0.050	573	17
Juice	CFIA	2014 to 2016	273	138 (50)	0.050	619	69
Juice	EU - Patriarca et al.	2016	95	41 (43)	0.13	20.19	Not specified
Juice	China - Chen Fan et al.	2016	15	9 (60)	0.13	8.68	2.56
Juice	Italy – Prelle et al.	2012	10	0 (0)	N/A	N/A	N/A
Juice	Canada - Lau et al.	2003	19	15 (79)	0.62	40.6	6.16
Juice	Canada - Scott et al.	1997	8	3 (38)	0.8	5.0	2.7
Juice	Spain - Delgado et al.	1993 to 1994	32	16 (50)	1.35	5.42	Not specified
Oils	CFIA	2018 to 2019	90	50 (56)	0.10	57	7.1
	EU - Patriarca et al.	2016	19	16 (84)	2.8	14	Not specified
Seeds	CFIA	2018 to 2019	50	36 (72)	0.054	55	6.0
Seeds	EU - Patriarca et al.	2016	11	7 (64)	16.64	60	Not specified
Seeds	Argentina - Chulze et al.	1991 to 1992	150	134 (89)	30	1512	286
Seeds	Argentina - Torres et al.	1993	50	38 (76)	90	1026	415

Other regulatory agencies such as the US Food and Drug Administration, Australia/New Zealand and the European Union are not monitoring their foods for *Alternaria* toxins or at least, are not currently publishing the results. A comparison of the exposure of Canadian consumers to *Alternaria* toxins with persons in other countries is not possible.

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Appendix A

Table 4. More detailed distribution of levels of *Alternaria* toxins in beer, juices, oils and seeds

Product type	Product type/principal ingredient	Total number of samples	Number of samples with detected levels	Min (ppb)	Max (ppb)	Average level (ppb) of positive results
Beer	Barley	76	18	0.091	1.2	0.25
Beer	Other	1	1	N/A	0.39	N/A
Beer	Wheat	3	2	0.20	0.33	0.27
Juices	Apple (cider and juice)	27	12	0.12	1.8	0.44
Juices	Blend	78	55	0.050	15	1.6
Juices	Blend (with pomegranate)	3	3	5.8	573	253
Juices	Cranberry	2	2	0.1	0.57	0.34
Juices	Grape	4	2	0.12	0.29	0.21
Juices	Grapefruit	3	0	N/A	N/A	N/A
Juices	Orange	34	27	0.070	2.1	0.5
Juices	Other[c]	11	8	0.26	12	3.3
Juices	Pineapple	12	10	0.10	0.84	0.4
Juices	Pomegranate	5	5	13	485	249
Oils	Canola	8	3	0.36	2.2	1.0
Oils	Corn	9	9	0.13	4.7	1.0
Oils	Olive	10	8	1.3	7.7	4.4
Oils	Other[d]	7	1	N/A	0.1	N/A
Oils	Palm	10	8	0.35	57	22
Oils	Peanut	9	6	0.10	0.52	0.3
Oils	Sesame	9	8	2.7	47	15
Oils	Soybean	11	1	N/A	0.1	N/A
Oils	Sunflower	10	6	0.12	4.8	1.4
Oils	Vegetable	7	7	N/A	N/A	N/A
Seeds	Chia	8	6	0.4	13	5.5
Seeds	Flax	10	8	0.11	8.2	2.6
Seeds	Pumpkin	12	5	0.12	0.77	0.32
Seeds	Sesame	3	3	4.2	55	37
Seeds	Sunflower	17	14	0.17	9.2	3.5

[c] Includes blueberry juice, cherry juice, mango juice/mango nectar, peach nectar, pear juices
[d] Includes coconut oil and grapeseed oil