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

Bacterial Pathogens in Dried Herbs and Dried Teas - April 1, 2014 to March 31, 2018

Food microbiology - Targeted Surveys - Final report

Canada

Summary

Dried aromatic herbs are widely used flavoring ingredients in food preparations. Dried teas including teas and herbal teas are used for brewing teas. Both dried herbs and teas are consumed globally and traded internationally. Dried herbs have been associated with numerous salmonellosis outbreaks worldwide, and dried teas have recently been associated with several recalls due to *Salmonella* contamination and a salmonellosis outbreak. Both dried herbs and teas are derived from agricultural products and can be contaminated with bacterial pathogens during primary production, processing, storage and packaging. Once contaminated, bacterial pathogens, such as *Salmonella* can survive for extended periods of time in these low-moisture products. Depending on the end use, for example if dried herbs are added to ready-to-eat (RTE) foods that undergo no further heat treatment, or dried teas are cold-brewed, the presence of bacterial pathogens creates a potential risk for foodborne illnesses.

Considering the factors mentioned above and their relevance to Canadians, dried herbs and dried teas were selected for targeted surveys. The purpose of this survey was to generate baseline information on the occurrence of pathogenic bacteria of concern in dried herb and tea products on the Canadian market.

Over the course of this study (April 1, 2014 to March 31, 2018), a total of 2680 dried herb samples and 1178 dried tea samples were collected from retail locations in 11 cities across Canada. All herb (2680) and tea (1178) samples were tested for generic *Escherichia coli* (*E. coli*) and the following bacterial pathogens: *Salmonella* species (spp.), *Bacillus cereus* (*B. cereus*) and *Clostridium perfringens* (*C. perfringens*). A portion of the dried herb samples (1773) and all of the dried tea samples (1178) were also tested for the bacterial pathogen *Staphylococcus aureus* (*S. aureus*). Generic *E. coli* is an indicator of the overall sanitation conditions throughout the food chain from production to the point of sale.

In this study, over 99.8% of the dried herb samples and over 99.5% of the dried tea samples were assessed as satisfactory. Presumptive *B. cereus* was found at elevated levels ($10^4 < x \leq 10^6$ colony-forming units (CFU)/gram (g)) in two herb samples (0.07%, 2/2680) and five tea samples (0.4%, 5/1178). *S. aureus* was found at elevated levels ($10^2 < x \leq 10^4$ CFU/g) in one herb sample (0.06% 1/1773). *Salmonella* spp. was identified in one herb sample (0.04%, 1/2680) and one tea sample (0.08%, 1/1178). High levels ($> 10^3$ most probable number (MPN)/g) of generic *E. coli* were found in two herb samples (0.07%, 2/2680).

In dried herb and tea products, the presence of elevated levels *B. cereus* ($10^4 < x \leq 10^6$ CFU/g) or *S. aureus* ($10^2 < x \leq 10^4$ CFU/g) could indicate that the food may have been produced under unsanitary conditions. The presence of high levels ($>10^3$ MPN/g) of generic *E. coli* could indicate inadequate sanitation controls during processing and/or at the processing facility.

The Canadian Food Inspection Agency (CFIA) conducted appropriate follow-up activities such as facility inspections and additional sampling. The *Salmonella* contaminated herb and tea samples resulted in product recalls. The two herb samples where high levels of generic *E. coli* were found resulted in the implementation of corrective actions by the processing facilities and one product recall as the product was considered to be RTE. There were no known reported illnesses associated with any of the contaminated herb or tea products.

Overall, our survey results indicate that most of the dried herbs and dried teas sampled appear to have been produced under sanitary conditions. However, contamination by bacterial pathogens such as *Salmonella* can occur occasionally, and a loss of sanitation controls along the food production chain can occur as well. Consequently, as with all foods, safe handling practices are recommended for producers, retailers and consumers.

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?

Dried herbs are widely used flavoring ingredients in food preparations. Dried teas including teas (green, white, black and oolong) and herbal teas (blended herbs, spices and other plant material) are used for brewing teas. Dried herbs have been associated with numerous foodborne illness outbreaks worldwide[1,2], and dried teas have recently[3,4] been associated with several recalls due to *Salmonella* contamination and a salmonellosis outbreak[5]. Both dried herbs and teas are derived from agricultural products and can be contaminated with bacterial pathogens during primary production, processing, storage and packaging. In addition, dried

herbs and teas are consumed all over the world and are traded internationally[6]. Contaminated products can be distributed internationally and potentially cause foodborne illnesses in multiple countries. Depending on the end use of the product, for example, if dried herbs are added to RTE foods that undergo no further heat treatment, or dried teas are cold-brewed, the presence of bacterial pathogens creates a potential risk for foodborne illnesses.

Considering the factors mentioned above and their relevance to Canadians, dried herbs and dried teas were selected for targeted surveys. The purpose of this survey was to generate baseline information on the occurrence of generic *E. coli* and the following pathogenic bacteria: *Salmonella* spp., *B. cereus*, *C. perfringens* and *S. aureus* in dried herb and tea products on the Canadian market. Generic *E. coli* is an indicator of the overall sanitation conditions throughout the food chain from production to the point of sale.

What did we sample?

A sample consisted of a single or multiple unit(s) (individual consumer-size package(s) from a single lot) with a total weight of at least 100 g. All samples were collected from national and local/regional retail stores located in 11 major cities across Canada. These cities encompassed four geographical areas:

- Atlantic (Halifax and Saint John)
- Quebec (Quebec City, Montreal)
- Ontario (Toronto, Ottawa)
- West (Vancouver, Kelowna, Calgary, Saskatoon and Winnipeg).

The number of samples collected from these cities was in proportion to the relative population of the respective areas.

Dried herb samples were collected between April 1, 2014 to March 31, 2015 and April 1, 2016 to March 31, 2018. Dried tea samples including dried teas and dried herbal teas (blended herbs, spices or other plant material) were collected between April 1, 2016 and March 31, 2018. Sample collection and testing information can be found in table 1.

Table 1- Sample collection and testing of dried herbs and dried teas

Product group	Survey year(s)	Analyses	Number of samples analyzed
Dried herbs (group i)	2014-2015	*B. cereus* *C. perfringens* *Salmonella* spp. Generic *E. coli*	907
Dried herbs (group ii)	2016-2017 2017-2018	*B. cereus* *C. perfringens* *S. aureus* *Salmonella* spp. Generic *E. coli*	1773
Subtotal (dried herbs)			**2680**
Dried teas	2016-2017 2017-2018	*B. cereus* *C. perfringens* *S. aureus* *Salmonella* spp. Generic *E. coli*	1178
Total			**3858**

What analytical methods were used and how were samples assessed?

Samples were analyzed using analytical methods published in Health Canada's *Compendium of Analytical Methods for the Microbiological Analysis of Foods*[7]. The assessment criteria used in this survey are based on the principles of the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods*[8]. At the time of writing this report, no assessment guidelines had been established in Canada for the presence of pathogenic bacteria in dried herbs and dried teas. Health Canada's guidelines for indicator organisms and bacterial pathogens in spices (ready-to-eat)[8] were applied in the assessment of dried herb and tea results (table 2).

Table 2 - Analytical methods and assessment criteria for bacteria in dried herbs and dried teas

Bacterial analysis	Method identification number [a]	Satisfactory assessment	Investigative assessment	Unsatisfactory assessment
Bacillus cereus	MFLP-42	≤ 10^4 CFU/g	$10^4 < x \leq 10^6$ CFU/g	> 10^6 CFU/g
Clostridium perfringens	MFHHPB-23	≤ 10^4 CFU/g	$10^4 < x \leq 10^6$ CFU/g	> 10^6 CFU/g
Staphylococcus aureus	MFHPB-21	≤ 10^2 CFU/g	$10^2 < x \leq 10^4$ CFU/g	> 10^4 CFU/g
Salmonella spp.	MFHPB-20	Absent in 25 g	Not Applicable (N/A)	Present in 25 g
Generic *E. coli*	MFHPB-19	≤ 10^2 MPN/g	$10^2 < x \leq 10^3$ MPN/g	> 10^3 MPN/g

[a] The methods used were the published versions at the time of analysis

B. cereus, C. perfringens and S. aureus are commonly found in the environment and are bacteria that can produce protein toxins in contaminated food or in the intestines of infected humans, which can cause foodborne illness. Elevated levels of these bacteria (table 2) indicate that the food may have been produced under unsanitary conditions. Therefore, an investigative assessment which may result in further follow-up actions is associated with elevated levels of the bacteria. As the results are based on the analysis of one unit (n=1), further sampling may be required to verify the levels of the bacteria of the lot. The presence of high levels of these bacteria (table 2) is indicative of high enough levels of the bacterial toxins to cause foodborne illnesses. Therefore, samples with high levels of the bacteria are assessed as unsatisfactory indicating that follow-up activities are warranted. The *B. cereus* method used in this survey is unable to discriminate *B. cereus* from other closely related organisms and therefore results are considered presumptive for *B. cereus*.

Unlike harmful bacterial pathogens such as *Salmonella* spp., generic *E. coli* is commonly found in the intestines of humans and most strains are harmless. It is considered to be an indicator organism and levels of generic *E. coli* found in a food product are used to assess the overall sanitation conditions throughout the food chain from production to the point of sale. An investigative assessment is associated with elevated levels of generic *E. coli* ($100 < x \leq 1000$ most probable number (MPN)/g), which may result in further follow-up actions. As the results are based on the analysis of one unit (n=1), further sampling may be required to verify the levels of generic *E. coli* of the lot. An unsatisfactory assessment is associated with high levels of generic *E. coli* (> 1000 MPN/g) as it may indicate a breakdown in good manufacturing practices (sanitation practices), and therefore possibly warranting the initiation of follow-up activities.

What were the survey results?

Group i dried herb samples (907) were tested for generic *E. coli* and the bacterial pathogens *B. cereus*, *C. perfringens* and *Salmonella* spp. (table 3). Group ii dried herb samples (1773) were tested for generic *E. coli* and the bacterial pathogens *B. cereus*, *C. perfringens, S. aureus* and *Salmonella* spp. *C. perfringens* (>10^4 CFU/g) was not found in any of the herb samples (2680). Presumptive *B. cereus* was found at elevated levels ($10^4 < x \leq 10^6$ CFU/g) in two herb samples (0.07%, 2/2680). *S. aureus* was found at elevated levels ($10^2 < x \leq 10^4$ CFU/g) in one herb sample (0.06% 1/1773). *Salmonella* spp. was identified in one herb sample (0.04%, 1/2680), which also contained an elevated level ($10^2 < x \leq 10^3$ MPN/g) of generic *E. coli*. High levels (>10^3 MPN/g) of generic *E. coli* were found in two herb samples (0.07%, 2/2680).

All of the dried tea samples (1178) were tested for generic *E. coli* and the bacterial pathogens *B. cereus*, *C. perfringens, S. aureus* and *Salmonella* spp. (table 3). *C. perfringens* (>10^4 CFU/g), *S. aureus* (>10^2 CFU/g) and generic *E. coli* (>10^2 MPN/g) were not found in any of the tea samples. Presumptive *B. cereus* were found at elevated levels ($10^4 < x \leq 10^6$ CFU/g) in five tea samples (0.4%, 5/1178). *Salmonella* spp. was identified in one tea sample (0.08%, 1/1178).

Table 3 - Results of bacterial analysis in dried herb and dried tea samples

Analysis group	Analysis	Unsatisfactory (% of total samples)	Investigative (% of total samples)	Satisfactory (% of total samples)	Number of samples tested
Dried herbs (group i)	*B. cereus*	0	2	903	907
	C. perfringens	0	0		
	Salmonella spp.	1 [a]	N/A		
	Generic *E. coli*	1	0		
Dried herbs (group ii)	*B. cereus*	0	0	1771	1773
	C. perfringens	0	0		
	S. aureus	0	1		
	Salmonella spp.	0	N/A		
	Generic *E. coli*	1	0		
Subtotal (dried herbs)		3 (0.1%)	3 (0.1%)	2674 (99.8%)	2680 (100%)
Dried teas	*B. cereus*	0	5	1172	1178
	C. perfringens	0	0		
	S. aureus	0	0		
	Salmonella spp.	1	N/A		
	Generic *E. coli*	0	0		
Subtotal (dried teas)		1 (0.1%)	5 (0.4%)	1172 (99.5%)	1178 (100%)
Total		**4 (0.1%)**	**8 (0.2%)**	**3846 (99.7%)**	**3858 (100%)**

[a] Elevated level (10^2-10^3 MPN/g) of generic *E. coli* also present.

Of the 2680 dried herb samples 6.7% were domestic and 67.7% were imported from more than 25 countries. The country where the product was processed could not be determined for 25.7% of the samples (table 4). Of the 1178 dried tea samples 19.0% were domestic and 59.2% were imported from more than 15 countries. The country where the product was processed could not be determined for 21.8% of the samples (table 5). In terms of production practice, 64.1% of dried herb samples and 68.2% of dried tea samples were conventional (tables 4 and 5).

Table 4 - Product origin and production practice of dried herb samples

Product origin	Total number of samples (%)	Conventional	Organic
Domestic	179 (6.7)	158	21
Imported	1812 (67.6)	921	891
Argentina	5	0	5
Croatia	2	0	2
Egypt	147	5	142
France	3	0	3
Germany	2	2	0
Greece	13	12	1
India	37	28	9
Iran	4	4	0
Israel	13	2	11
Italy	7	0	7
Lebanon	9	9	0
Morocco	28	14	14
Netherland	2	0	2
Norway	6	0	6
Peru	4	0	4
Poland	12	9	3
Romania	5	0	5
Sri Lanka	2	0	2
Tunisia	3	0	3
Turkey	64	26	38
United States	120	6	114
Other [a]	5	2	3
Imported unknown	1319	801	518
Unknown	689 (25.7)	639 (1 [b])	50
Total	**2680 (100)**	**1718 (64.1)**	**962 (35.9)**

[a] Number of countries which represented only one sample [b] *Salmonella* contaminated sample

Table 5 - Product origin and production practice of dried tea samples

Product origin	Total number of samples (%)	Conventional	Organic
Domestic	224 (19.0)	192 (1 [b])	32
Imported	697 (59.2)	468	229
Argentina	4	2	2
China	57	31	26
Egypt	22	7	15
France	10	5	5
Germany	80	61	19
Greece	2	1	1
India	76	25	51
Japan	6	6	0
Kenya	55	55	0
Lebanon	15	15	0
European Union	10	10	0
South Africa	5	1	4
Poland	18	18	0
Sri Lanka	133	131	2
Vietnam	2	0	2
United Kingdom	20	20	0
United States	80	21	59
Multiple	2	1	1
Other [a]	6	5	2
Imported unknown	94	53	41
Unknown	257 (21.8)	143	114
Total	**1178 (100)**	**803 (68.2)**	**375 (31.8)**

[a] Number of countries which represented only one sample [b] *Salmonella* contaminated sample

Dried herb and dried tea product types are detailed in table 6. A variety of dried herbs were collected representing 14 single and three mixed types (table 6). Dried tea samples were categorized into five tea types (black, green, oolong, white, and herbal) (table 7). Herbal teas (blended herbs, spices and other plant material) accounted for 51.4% of the dried tea samples.

Table 6 - Product types of dried herb samples

Product type	Number of samples	% of total
Basil	375	14
Bay leaves	1	0.03
Chive	1	0.03
Cilantro	236	8.8
Dill	110	4.1
Marjoram	37	1.4
Mint	12	0.4
Oregano	436	16.3
Parsley	157	5.9
Rosemary	381	14.2
Sage	231	8.6
Savoury	72	2.7
Tarragon	37	1.4
Thyme	478	17.8
Herbs of provence	10	0.4
Mixed italian herbs	31	1.3
Mixed herbs	75	2.8
Total	**2680**	**100**

Table 7 - Product types of dried tea samples

Product type	Tea types	Number of samples	% of total
Teas	Black tea	298	25.3
	Green tea	227	19.3
	Oolong tea	21	1.8
	White tea	27	2.3
Herbal tea	n/a	605	51.4
Total		**1178**	**100**

Further details of each unsatisfactory and investigative sample are provided in table 8.

Table 8 - Product types of unsatisfactory and investigative samples

Product type	**Unsatisfactory** *Salmonella*	**Unsatisfactory** Generic *E. coli* >10^3 CFU/g	**Investigative** *B. cereus* $10^4 < x \leq 10^6$ CFU/g	**Investigative** *S. aureus* $10^2 < x \leq 10^4$ CFU/g	**Number of samples tested per product type**
Dried oregano (RTE)	0	1	1	0	436
Dried rosemary	1	1	0	0	381
Dried savory	0	0	1	0	72
Dried tarragon	0	0	0	1	37
Dried herbal tea	1 [a]	0	2	0	605
Dried green tea	0	0	1	0	227
Dried black tea	0	0	1	0	297
Dried white tea	0	0	1	0	27
Total	**2**	**2**	**7**	**1**	**N/A**

[a] Elevated level ($10^2 < x \leq 10^3$ CFU/g) of generic *E. coli* also present

What do the survey results mean?

In this study, over 99.8% of the dried herb samples and over 99.5% of the dried tea samples were assessed as satisfactory. *C. perfringens* (>10^4 CFU/g) was not found in any of the herb samples (2680). *C. perfringens* (>10^4 CFU/g), *S. aureus* (>10^2 CFU/g), and generic *E. coli* (>10^2 CFU/g) were not found in any of the tea samples (1178).

Salmonella spp., a common bacterial pathogen associated with foodborne illnesses, was identified in 0.04% (1/2680) of the herb samples and 0.08% (1/1178) of the tea samples. All *Salmonella* contaminated samples resulted in product recalls. *B. cereus*, a common bacterial pathogen in low-moisture foods, was found at elevated levels ($10^4 < x \leq 10^6$ CFU/g) in 0.07% (2/2680) of the herb samples and 0.4% (5/1178) of the tea samples. *S. aureus* was found at an elevated level ($10^2 < x \leq 10^4$ CFU/g) in 0.06% (1/1173) of the herb samples. Samples where elevated levels of *S. aureus* and presumptive *B. cereus* were found could indicate that the food may have been produced under unsanitary conditions. High levels of generic *E. coli* (> 10^3 CFU/g) were found in 0.07% (2/2680) of the herb samples resulting in the implementation of corrective actions by the processing facilities and one product recall. There were no known reported illnesses associated with the any of the contaminated dried herb and dried tea products.

The prevalence of S*almonella* spp. (0.04%, 95% CI: 0.01-0.21%) in dried herb samples identified in this survey appears slightly lower than the prevalence reported in a study conducted in the US. The US study[9] investigated the prevalence of *Salmonella* in dried herbs collected from retail locations in the US between 2013 and 2014 and found *Salmonella* in 0.23% (4/1741, 95% CI: 0.09-0.59%) of the dried herb samples (basil, coriander, and oregano). A similar study conducted in the UK in 2004 reported the prevalence of *Salmonella* as being 1.21% (9/743, 95% CI: 0.64-2.29%) in retail dried herb samples (coriander, fenugreek, mint and sage). The UK study also reported the prevalence of *B. cereus* (and other *Bacillus* spp.) at levels >10^4 CFU/g as being 0.27% (2/743, 95% CI: 0.07-0.98%) in retail dried herbs. In comparison, the prevalence of presumptive *B. cereus* at levels >10^4 CFU/g (and below ≤ 10^6 CFU/g) was found to be 0.07% (2/2680, 95% CI: 0.02-0.27%) in retail dried herb samples (14 single and three mixed types) analysed in this study.

The prevalence of S*almonella* spp. (0.08%, 95% CI: 0.01-0.48%) and presumptive *B. cereus* (0.4%, 95% CI: 0.18-0.99%) at elevated levels ($10^4 < x \leq 10^6$ CFU/g) in dried tea samples were identified in the current study. To date, very few published studies investigating the microbiological safety and quality of dried teas have been conducted as dried teas have traditionally been brewed using boiling or hot water, serving as an effective microbial risk mitigation step. More recently, brewing teas in low temperature or ice water has become a common practice. A study[10] revealed that using boiling water or hot water (>80 °C) to brew teas from one to several minutes resulted in the complete inactivation of bacterial pathogens such as *Salmonella* from brewed teas[10]. The study did discover that the use of low temperature water (below 55°C) to brew teas did not inactivate all of the bacterial pathogens[10]. The study results[10] suggest that the practice of using low temperature water to brew teas contaminated with pathogens may result in foodborne illnesses in high risk population (such as infants[5], elderly and people with a weak immune system).

Overall, our survey results indicate that most dried herb and dried tea products sampled appear to have been produced under sanitary conditions. However, our results do indicate that contamination by bacterial pathogens such as *Salmonella* can occur occasionally, and a loss of sanitation controls along the food production chain can occur as well. Consequently, as with all foods, safe handling practices are recommended for producers, retailers and consumers.

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