Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2011-2012 Targeted Surveys

Targeted Survey Investigating Bacterial Pathogens and Generic *E. coli* in Fresh Leafy Herbs

RDIMS # 4199990

Canada

Table of Contents

Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and strengthen Canada's food safety system in order to better protect Canadians from unsafe food and ultimately reduce the occurrence of foodborne illness.

In recent years, leafy herbs have been reported to be responsible for numerous outbreaks of foodborne illness worldwide. The Food and Agriculture Organization of the United Nations/World Health Organization (FAO/WHO) has ranked leafy herbs as the highest priority of concern among fresh fruits and vegetables in terms of microbiological hazards. Leafy herbs can become contaminated with various foodborne pathogens in the field by animals, improperly composted manure, and contaminated irrigation water during primary production. Leafy herbs can also become contaminated during harvest, post-harvest handling, packaging and distribution by infected handlers and/or poor hygiene practices. As they are often eaten raw, the presence of pathogens in leafy herbs creates a potential risk for foodborne illness.

Considering the above factors and their relevance to Canadians, leafy herbs have been selected as one of the priority commodity groups of fresh fruits and vegetables for enhanced surveillance under the FSAP. Between 2009/10 and 2012/13, over 5,000 leafy herb samples were collected from Canadian retail locations and tested for the presence of pathogens of concern.

The main objectives of this targeted survey (2011/12) were to generate baseline surveillance data on bacterial pathogens of concern *Salmonella*, *Shigella*, *E. coli* O157, and *Campylobacter,* as well as generic *E. coli* (an indicator of fecal contamination) for leafy herbs available in the Canadian market. In total, 1540 fresh leafy herb samples were collected and analysed, including imported, domestic, conventionally and organically produced herb samples. The majority (99.3%) of the samples were assessed as satisfactory. Three samples (0.2%) were unsatisfactory; one sample was contaminated with *Salmonella* and two other samples had high levels of generic *E. coli* (> 1000 Most Probable Number (MPN)/g). Subsequent food safety investigations resulted in no product recalls. In addition, seven samples (0.5%) had elevated levels of generic *E. coli* (100 - 1000 MPN/g). These samples were assessed as investigative and further evaluation resulted in no immediate follow-up activities. These findings suggest that the majority of leafy herbs in the Canadian market sampled during this survey were produced under Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs).

The Canadian Food Inspection Agency (CFIA) regulates and provides oversight to the industry, works with provinces and territories, and promotes safe handling of foods

throughout the food production chain. However, it is important to note that the food industry and retail sectors in Canada are ultimately 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. Moreover, general advice for the consumer on the safe handling of foods is widely available. The CFIA will continue its surveillance activities and inform stakeholders of its findings.

1 Introduction

1.1 Food Safety Action Plan

In 2007, the Canadian government launched a five-year initiative in response to a growing number of product recalls and concerns about food safety. This initiative, called the Food and Consumer Safety Action Plan (FCSAP)[1], aims to modernize and strengthen Canada's safety system for food, health and consumer products. The FCSAP initiative unites multiple partners in ensuring safe food for Canadians.

The Canadian Food Inspection Agency (CFIA)'s Food Safety Action Plan (FSAP)[2] is one element of the government's broader FCSAP initiative. The goal of FSAP is to identify risks in the food supply, limit the possibility of occurrence of these risks, improve import and domestic food controls, and identify food importers and manufacturers.

Within the FSAP, there are 12 main areas of activity, one of which is risk mapping and baseline surveillance. The main objective of this area is to better identify, assess and prioritize potential food safety hazards through risk mapping, information gathering and analysis of foods in the Canadian marketplace. Targeted surveys are one tool used to test for the presence and level of particular hazards in specific foods.

1.2 Targeted Surveys

Targeted surveys are used to gather information regarding the potential occurrence of hazards in food commodities. The microbiological targeted surveys aim to establish baseline data on priority and/or emerging microbiological hazards in targeted commodities, primarily fresh fruits and vegetables and imported food ingredients. A statistically significant number of samples will be collected over five years to allow for seasonal and/or production variations. This work differs from regular CFIA microbiological monitoring activities which test samples of a broad range of commodities for multiple hazards and are aimed to determine the compliance of defined lots with established microbial standards or guidelines for regulatory purposes.

To identify food-hazard combinations of greatest potential health risk for the targeted surveys, the CFIA uses a combination of scientific literature, documented outbreaks of foodborne illness, and/or information gathered from the Food Safety Science Committee (FSSC), a group of Canadian federal, provincial and territorial subject matter experts in the area of food safety[3].

This microbiological targeted survey (2011/12) represents part of the collection of over 5,000 leafy herb samples over four years (2009/10 to 2012/13) and was designed to gather

baseline information on the occurrence of bacterial pathogens of concern in leafy herbs available to Canadians at retail.

1.3 Codes of Practice, Acts, and Regulations

International food safety standards, codes of practice, and guidelines relating to food, food production, and food safety are developed under the joint Food and Agriculture Organization of the United Nations/World Health Organization (FAO/WHO) Codex Alimentarius Commission. Producers of fresh fruits and vegetables are encouraged to follow the international codes of practice. Of relevance for this survey are the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RCP 53-2003)[4] and the *Recommended International Code of Practice - General Principles of Food Hygiene* (CAC/RCP 1-1969)[5]. These codes address Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) which, when applied, control and reduce the potential for contamination with microbial, chemical, and physical hazards at all stages of the production of fresh fruits and vegetables from primary production to packaging.

Fresh fruits and vegetables available in the Canadian market must comply with the *Food and Drugs Act* (FDA)[6] and the *Food and Drug Regulations* (FDR)[7], which prescribe certain restrictions on the production, importation, sale, composition and content of foods and food products. Section 4(1)a of the FDA prohibits the sale of food contaminated with foodborne pathogens, while sections 4(1)e and 7 prohibit the sale of unsafe food and food produced under unsanitary conditions.

Fresh fruits and vegetables that are imported in Canada or domestically produced and marketed inter-provincially must also comply with safety requirements of the *Fresh Fruit and Vegetable Regulations*[8] under the *Canada Agricultural Products Act*[9]. These regulations are intended to ensure that fresh fruits and vegetables sold to consumers are safe, wholesome and properly graded, packaged and labelled.

The *Fresh Fruit and Vegetable Regulations* and the food-related portions of the FDA and FDR are enforced by the CFIA.

The FSAP targeted surveys are primarily conducted for surveillance and not for regulatory compliance verification purposes. However, bacterial pathogens and/or high levels of generic *E. coli* detected in any samples tested under this survey would trigger food safety investigations, including activities such as follow-up sampling, inspections of facilities, and health risk assessments. Depending on the findings, a recall of the affected product may be warranted.

2 Survey on Fresh Leafy Herbs

2.1 Rationale

Leafy herbs have been reported to be responsible for numerous outbreaks of foodborne illness worldwide. From 1997 to March 2012, 22 foodborne disease outbreaks associated with leafy herbs contaminated with bacterial pathogens were documented worldwide (information based on data compiled by the Public Health Agency of Canada (PHAC), Appendix B). Of these outbreaks, pathogenic *E. coli, Shigella* and *Salmonella* were identified and accounted for approximately 95% of the outbreaks (Appendix C). Three outbreaks occurred in Canada that were linked to leafy herbs contaminated with *Shigella sonnei* (Appendix B).

Leafy herbs, like other leafy vegetables, can become contaminated with various foodborne pathogens in the field by domestic and wild animals, improperly composted manure, and contaminated irrigation water during primary production. Production practices can also affect the microbial load of leafy herbs. For example, the use of improperly composted animal manure has led to concerns about the potential contamination of produce with human pathogens. Since organic productions are more reliant on the use of manure to fertilize fields, it has been suggested, while not proven to this day, that organic produce may face higher levels of microbial contamination. Leafy herbs can also become contaminated with pathogens during harvest, post-harvest handling, processing, storage and distribution by poor hygiene practices and/or infected handlers. As leafy herbs are often consumed raw, contaminated leafy herbs can cause foodborne illnesses.

Contaminated leafy herbs can introduce pathogens from an herb producing country to herb-consuming countries resulting in outbreaks of foodborne illness. Recent outbreaks of foodborne illness that occurred in the United Kingdom[10, 11], Denmark[12], and Norway[13] were associated with imported leafy herbs harbouring bacterial pathogens (e.g., *Salmonella*, pathogenic *E. coli,* and *Shigella*).

Leafy herbs, along with leafy vegetables, were identified as a level one (highest) priority of concern among fresh fruits and vegetables in terms of microbiological hazards during a 2007 joint FAO/WHO Expert Meeting[14]. This was based on multiple factors, such as historical outbreaks, potential for contamination, and other evidence (e.g., exposure levels, outbreaks with high number of illnesses in a wide range of geographic locations).

Based on the above information and the Food Safety Science Committee's recommendations[3], fresh leafy herbs have been selected as one of the priority commodity groups of fresh fruits and vegetables for targeted surveillance under FSAP. The overall objective is to gather baseline information on the occurrence of various pathogens of

concern in leafy herbs available to Canadians at retail. This targeted survey (2011/12) is part of the information collection with a focus on investigating the presence and distribution of bacterial pathogens *E. coli* O157:H7/NM, *Salmonella*, *Shigella*, and *Campylobacter*, as well as the presence, distribution and levels of generic *E. coli* (as an indicator of fecal contamination) in imported and domestic, conventionally and/or organically produced leafy herb samples.

2.2 Targeted Microorganisms

2.2.1 Bacterial Pathogens of Concern

Bacterial pathogens *Salmonella* and *E. coli* O157 are found naturally in the intestines of animals, such as poultry and cattle, respectively[15]. Most outbreaks associated with these bacterial pathogens are linked to the consumption of the contaminated food of animal origin (e.g., chicken and beef, respectively). However, in the last decade, fresh fruits and vegetables have emerged as significant sources of these bacterial pathogen related illnesses[16]. Fruits and vegetables can become contaminated with these bacterial pathogens in the field by improperly composted manure, contaminated water, wildlife feces, and/or poor hygiene practices of the farm workers[17].

Humans are the only host of the bacterial pathogen *Shigella*. Food contaminated by infected food handlers and water contaminated with human feces are the most common causes of shigellosis. Shigellosis illnesses have been known to be associated with consumption of contaminated fruits, vegetables, shellfish and chicken[15].

Similarly to *Salmonella* and *E. coli* O157, bacterial pathogen *Campylobacter* is also found naturally in the intestines of most food-producing animals, such as chicken, swine, and cattle. *Campylobacter* is one of the leading bacterial causes of foodborne illnesses in the U.S.[18] and Canada[19]. Raw poultry and unpasteurized (raw) milk are major sources of contaminated food. However, vegetables were also found, sporadically, to be contaminated with *Campylobacter*[15].

2.2.2 Generic *E. coli* as an Indicator of Fecal Contamination

Typically, *E. coli* bacteria that inhabit the large intestines of humans and animals are harmless. Due to their regular presence in stools of humans and animals, the occurrence of *E. coli* in foods indicates direct or indirect contamination with fecal matter[20]. The presence of generic *E. coli* in foods can also indicate potential contamination with pathogenic enteric microorganisms, such as *Salmonella* or *E. coli* O157:H7, that also live in the intestines of infectious humans and animals. It is important to note that the presence of generic *E. coli* in food only implies an increased risk of contamination with pathogenic microorganisms but does not conclusively indicate that these pathogenic organisms are present. High levels

of generic *E. coli* in fresh produce sold at retail is an indication that contamination has occurred at some point between production and the time of sale.

2.3 Sample Collection

Leafy herb samples included pre-trimmed bunches, or pre-packaged, non-cut fresh leafy herbs. Dried herbs were excluded from this survey.

All samples were collected from national chain and local/regional grocery stores, other conventional retail, natural food stores and farmers' market located in various cities across Canada. The number of samples collected in the various regions was based on the relative proportion of the population in the respective regions. Samples were collected during 2011/12 fiscal year (April 1, 2011 to March 31, 2012). Domestic samples were collected during the summer months (June-September). Imported samples were collected primarily in the fall, winter, and spring months. Samples that were labelled as organic at retail were identified as "organic" in this survey. Other samples were identified as "conventional".

In this survey, a sample consisted of a single sample unit (e.g., individual consumer-size package(s) from a single lot) with a total weight of at least of 200 g. This sampling approach has been used for many retail food surveys[21, 22, 23] and by other federal partners such as the Public Health Agency of Canada (PHAC) under the retail component of their FoodNet surveys[24].

Collected samples were required to be shipped under conditions that limited the growth of microorganisms during transit. If issues or questions arose about the conditions in which the sample was shipped, the sample was declared unfit for analysis.

2.4 Sample Distribution

As per the survey design, four groups of fresh leafy herbs were collected and analysed for the specific combinations of targeted microorganisms (Table 1).

Table 1 Sample Distribution by Targeted Pathogen Group

Objective Group	Targeted Microorganisms	Products Origin	Number (Percentage) of Samples
Conventional	*E. coli* O157, *Salmonella*, *Shigella*, *Campylobacter*, and generic *E. coli*	Imported	716
		Domestic	323
		Subtotal	*1039 (67.5)*
Organic	*E. coli* O157, *Salmonella*, *Shigella*, and generic *E. coli*	Imported	348
		Domestic	153
		Subtotal	*501 (32.5)*

2.4.1 Sample Distribution by Country of Origin

Approximately one third of the herb samples were domestically produced and two thirds of the herb samples were imported (Table 2). The majority of imported herb samples were from the U.S. (79.7% of imported samples) and seven other countries (18.3% of imported samples) (Table 2). The country of origin could not be identified for 21 samples, which were collected in the winter and were assumed to be imported.

Table 2 Sample Distribution by Country of Origin

Country of Origin	Conventional	Organic	Total	
	Number of Samples	Number of Samples	Number of Samples	Percentage of Samples in Total
Canada	323	153	476	30.9
Subtotal – Domestic	*323*	*153*	*476*	*30.9*
Colombia	15	6	21	1.4
Costa Rica	2	0	2	0.1
Dominican Republic	33	0	33	2.1
Israel	16	2	18	1.2
Mexico	87	29	116	7.5
Morocco	3	0	3	0.2
Vietnam	2	0	2	0.1
USA	541	307	848	55.1
Unidentified	17	4	21	1.4
Subtotal - Imported	*716*	*348*	*1064*	*69.1*
Total	**1039**	**501**	**1540**	**100**

2.4.2 Sample Distribution by Product Type

More than 14 different types of fresh herbs were collected from the Canadian retail market. Five types of herbs, parsley, cilantro (coriander), dill, mint and basil, accounted for majority (92.3%) of the herb samples collected in this survey (Table 3).

Table 3 Types of Fresh Leafy Herb Samples

Type of Herb	Conventional	Organic	Total	
	Number of Samples (%)	Number of Samples (%)	Number of Samples	Percentage of Total Samples
Basil	45	28	73	4.7
Chives	16	4	20	1.3
Cilantro	239	103	342	22.2
Dill	103	50	153	9.9
Marjoram	6	2	8	0.5
Mint	73	20	93	6.0
Oregano	15	8	23	1.5
Parsley	501	261	762	49.5
Rosemary	14	6	20	1.3
Sage	4	3	7	0.5
Savoury	7	4	11	0.7
Tarragon	4	3	7	0.5
Thyme	8	4	12	0.8
Others *	4	5	9	0.6
Total	1039 (67.5)	501 (32.5)	1540	100

* Others refer to herb types with small number of samples (e.g., one or two samples in total) or herb types were not identified.

2.5 Method Details

Samples were analysed using the analytical methods as published in Health Canada's *Compendium of Analytical Methods* for the Microbiological Analysis of Foods[25] (Appendix D). These methods are used for regulatory testing by the CFIA and are fully validated for the analysis of fresh fruits and vegetables, including leafy herbs. Modified versions of the methods from Health Canada's Compendium were used for *Salmonella* and *Campylobacter* testing, as indicated in Appendix D.

For the detection of *E. coli* O157:H7/NM, *Salmonella, Shigella*, and *Campylobacter,* samples were analyzed by cultural presence/absence methods. The laboratories also had the option of using polymerase chain reaction (PCR)-based screening methods to first

screen enrichment broths for the presence of DNA from the pathogen of interest, followed by confirmation of presumptive positives.

Salmonella isolates from any positive samples were further characterised by pulsed field gel electrophoresis (PFGE) (i.e., DNA fingerprint) at the CFIA's PFGE Centre. Serotyping for *Salmonella* spp. was performed at the *Salmonella* Typing Laboratory, Laboratory for Foodborne Zoonoses, PHAC.

Enumeration of generic *E. coli* was obtained using the most probable number (MPN) or direct plating procedure.

2.6 Assessment Guidelines

The assessment criteria presented below (Table 4 and Table 5) are based on principles of the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods*[26] and associated methods published in Health Canada's *Compendium of Analytical Methods*[25].

Table 4 Assessment Guidelines for Bacterial Pathogens in Leafy Herbs

Bacterial Analysis*	**Assessment Criteria**	
(Method Identification Number)	**Satisfactory**	**Unsatisfactory**
***E. coli* O157:H7/NM** (MFLP-30 with Supplement 1 & 2 and MFLP-80 if required for confirmation)	Absent in 25 g	Present in 25 g
Salmonella* spp.* (MFLP-29 modified and MFHPB-20 if required for confirmation)	Absent in 25 g	Present in 25 g
Shigella* spp. * (MFLP-26 and MFLP-25 if required for confirmation)	Absent in 25 g	Present in 25 g
Campylobacter* spp. * (MFLP-46 modified)	Absent in 25 g	Present in 25 g

* *Compendium of Analytical Methods*[25].

**No criteria have been established by Health Canada at this time for these bacterial pathogens in fresh fruits and vegetables. However, in the absence of a specified criteria, presence in foods is considered to be a violation of FDA Section 4(1)a and is therefore assessed by the CFIA as unsatisfactory.

Table 5 Assessment Guidelines for Generic *E. coli* in Leafy Herbs

Bacterial Analysis* (Method Identification Number)	Assessment Criteria		
	Satisfactory	**Investigative**	**Unsatisfactory**
Generic *E. coli* (MFHPB-19 or 27)**	≤ 100	100 < x ≤ 1000	> 1000

* *Compendium of Analytical Methods*[25].

** Concentration unit depends on method used. For MFHPB-19 method: MPN/g, for MFHPB-27 method: CFU/g. MFHPB-19 method was used for the majority of the samples in this survey.

Samples assessed as investigative in this survey required some form of follow-up activity. For example, further sampling may be done to verify the levels of generic *E. coli* in the samples in question. Unsatisfactory sample assessments were subject to follow-up actions, such as directed follow-up sampling, inspection of establishment, health risk assessment, and/or product action (e.g., product recall).

2.7 Limitations

Samples tested during this survey were collected at retail locations across Canada, as opposed to monitoring samples that are picked up at distribution points and warehouses. As such, products sampled at retail could be mixed and originate from different shipments and/or suppliers. Though this represents what the Canadian consumer experiences, this imposes certain limitations with respect to the traceability of the products and the identification of the source of contamination in the case of positive results.

Results obtained for a targeted survey sample are from the analysis of a single sample unit. This sampling and testing strategy generally precludes the extrapolation of the laboratory result to the whole production lot as it is not statistically representative. This imposes certain limitations in the interpretation of the results to the specific lot in the absence of additional information.

Finally, given the seasonality, as well as the varying channels of commerce, the source of the products can change dramatically from one season to the next. As such, there is an insufficient number of samples in this survey to carry out a detailed analysis of the results based on country of origin. In cases of positive results, unsatisfactory rates between countries are not considered to be statistically comparable.

3 Results

A total of 1,540 herb samples were analysed for pathogenic bacteria *E. coli* O157:H7/NM, *Salmonella*, and *Shigella*, as well as generic *E. coli*, an indicator of fecal contamination. Of these samples, 933 conventional herb samples (610 imported and 323 domestic) were additionally tested for *Campylobacter*.

E. coli O157:H7, *E. coli* O157:NM, *Shigella* and *Campylobacter* were not detected in any of the herb samples tested. *Salmonella* and generic *E. coli* (> 100 MPN/g) were not found in the majority of the samples (99.3%) (Table 5).

Table 5 Summary of Assessment Results of Fresh Leafy Herb Samples

Production Practice	Product Origin	Number of Samples	Assessment		
			Unsatisfactory	Investigative	Satisfactory
			Number of Samples (Percentage)	Number of Samples (Percentage)	Number of Samples (Percentage)
Conventional	Imported	716	1	4	711 (99.3)
	Domestic	323	2	1	320 (99.1)
	Subtotal	***1039***	***3 (0.3)***	***5 (0.5)***	***1031 (99.2)***
Organic	Imported	348	0	0	348 (100)
	Domestic	153	0	2	153 (98.7)
	Subtotal	***501***	***0 (0)***	***2 (0.4)***	***499 (99.6)***
Total		**1540**	**3 (0.2%)**	**7 (0.5%)**	**1530 (99.3)**

Three samples (0.2%) were found to be unsatisfactory (Table 6). One sample was unsatisfactory due to the presence of *Salmonella* and the other two samples had high levels of generic *E. coli*. *Salmonella* Anatum was identified from the isolate of the *Salmonella* positive sample. The unsatisfactory samples originated from Canada and the U.S.

As a result of these findings, the CFIA conducted food safety investigations and appropriate follow-up activities for the unsatisfactory samples. The *Salmonella* contaminated sample was found to be an isolated incidence. No product recalls resulted from the unsatisfactory samples and subsequent food safety investigations. It is important to note that there were

no reported illnesses associated with consumption of any of the *Salmonella* contaminated product during this survey.

Table 6 Summary of Unsatisfactory Samples

Product Type/Production Practice/ Country of Origin	**Reason for Unsatisfactory Assessment**
Curly Parsley/Conventional/Canada	*Salmonella* Anatum
Cilantro/Conventional/Canada	Generic *E. coli*: >1600 MPN/g
Basil /Conventional /USA	Generic *E. coli*: >1600 MPN/g

Elevated levels of generic *E. coli* (> 100 and ≤ 1,000 MPN/g) were found in a total of seven samples (0.5%) (Table 7). These samples were assessed as investigative, as the *E. coli* counts were elevated but below the unsatisfactory threshold. Further evaluation of these samples resulted in no immediate follow-up sampling.

Table 7 Summary of Investigative Samples

Product Type /Production Practice /Country of Origin	**Generic *E. coli* Counts (MPN/g)**
Parsley/Organic/Canada	920
Mint/Conventional/USA	920
Rosemary/Conventional/Mexico	920
Mint/Conventional/Canada	240
Tarragon/Organic/Canada	130
Mint/Conventional/USA	130
Mint/Conventional/Vietnam	110

4 Discussion and Conclusion

In this survey (2011/12), *E. coli* O157 H7/NM and *Shigella* were not detected in any of the 1,540 leafy herb samples tested and *Campylobacter* was not detected in any of the 933 conventional leafy herb samples tested. The majority (99.3%) of the samples were assessed as satisfactory. However, *Salmonella* was detected in one sample (0.06%), high levels of generic *E. coli* (> 1,000 MPN/g) were found in two samples (0.13%) and elevated levels of generic *E. coli* (100 - 1,000 MPN/g) were found in seven samples (0.5%).

As a result of the unsatisfactory findings, the CFIA conducted appropriate food safety investigations including directed sampling, inspection of facilities or review of importation procedures, and health risk assessment (conducted by Health Canada). No product recalls resulted from the subsequent food safety investigations. It is important to note that there were no reported illnesses associated with the *Salmonella* contaminated product during this survey. After further evaluation of the investigative results, no further actions were deemed necessary.

Samples collected under this survey were obtained at retail. A positive result indicates that contamination had occurred at some point(s) along the whole food continuum from the primary production to the point of sale. The food safety investigation of the *Salmonella* positive sample found that the directed follow-up samples of the available product were negative for *Salmonella.* The *Salmonella* contaminated herb sample was considered as an isolated incident and the product was not recalled.

The overall findings of this survey suggest that fresh leafy herbs in the Canadian market are generally produced and handled under acceptable GAPs/GMPs. However, contamination of leafy herbs with *Salmonella* can occur at a very low rate, which represents a food safety risk. The presence of elevated or high levels of generic *E. coli* in leafy herbs can also occur. Although generic *E. coli* are not disease causing agents, their presence is used by the CFIA as an indicator to assess general sanitation and hygiene practices throughout the production chain to the point of sail.

While the food industry and retail sectors in Canada are ultimately responsible for the food they produce and sell, and individual consumers are responsible for the safe handling of the food they have in their possession, the CFIA regulates the industry, provides oversight and promotes safe handling of foods throughout the food production chain. The CFIA will continue its surveillance activities and inform stakeholders of its findings.

5 Acknowledgement

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Appendix A: List of Acronyms

CDC: Centres for Disease Control and Prevention

CFIA: Canadian Food Inspection Agency

CFU: colony forming unit

E. coli: *Escherichia coli*

FAO: Food and Agriculture Organization of the United Nations

FDA: *Food and Drugs Act*

FDR: *Food and Drug Regulations*

FCSAP: Food and Consumer Safety Action Plan

FSAP: Food Safety Action Plan

FSSC: Food Safety Science Committee

GAPs: Good Agricultural Practices

GMPs: Good Manufacturing Practices

HC: Health Canada

MPN: Most Probable Number

PCR: Polymerase Chain Reaction

PHAC: Public Health Agency of Canada

***Salmonella* spp.**: *Salmonella* species

USFDA: United States Food and Drug Administration

WHO: World Health Organization

°C: Degree Celsius

g: gram

Appendix B: Global Foodborne Disease Outbreaks Associated with Fresh Leafy Herbs Contaminated with Bacterial Pathogens (1997 – March 2012)

Case number	Year	Product	Micro-organism	Country	Number of Cases	Source
1	1998	Parsley	Multiple Organisms	Multiple Countries	1126	J Food Protection 2003;66(4):535-541
2	1998	Parsley	*Shigella boydii*	Massachusetts, USA	6	Journal of Food Protection 2003, 66(4):535-541 & JFP 68 (3):521-527
3	1998	Parsley	*Shigella boydii*	Florida, USA	37	Journal of Food Protection 2003, 66(4):535-541 & JFP 68 (3):521-527
4	1998	Parsley	*Shigella sonnei*	Alberta, Canada	4	Journal of Food Protection 2003, 66(4):535-541
5	1998	Parsley	*Shigella sonnei*	Ontario, Canada	35	Morbidity and Mortality Weekly Report (MMWR) 1998, 48(14) :285-9
6	1998	Parsley	*Shigella sonnei*	British Columbia, Canada	13	Canada Communicable Disease Report 1999, Vol 25
7	1998	Parsley	*Shigella sonnei*	California, USA	9	J Food Protection 2003; 66(4):535-541
8	1998	Parsley	*E. coli* O6:H16	Minnesota, USA	42	Emerging Infectious Diseases 2004, 10(3) & Journal of Food Protection 2003; 66(4):535-541
9	1998	Parsley	Enterotoxigenic *E. coli*	Minnesota, USA	35	J Food Protection 2003; 66(4):535-541
10	1999	Cilantro	*Salmonella* Thompson	California, USA	35	CDC
11	1999	Basil	*Shigella sonnei*	Multiple States, USA	10	CDC
12	2000	Basil	*E. coli* O169:H41	Washington, USA	100	Emerging Infectious Diseases Vol. 10; No. 3, 2004

Case number	Year	Product	Micro-organism	Country	Number of Cases	Source
13	2001	Cilantro	*Salmonella* Newport	California, USA	8	CDC
14	2002	Cilantro	*Salmonella* Newport	Colorado, USA	13	CDC
15	2005	Parsley	*E. coli* O157:H7	Oregon, USA	18	ProMed Oct. 25, 2005 & FSNet Oct. 31 2005
16	2005	Parsley	*E. coli* O157:H7	Washington, USA	4	CDC 2005
17	2005	Parsley	*E. coli* O157:H7	Washington, USA	2	CDC 2005
18	2006	Basil	Enterohemorrhagic *E. coli*	Denmark	250	European Food Safety Authority
19	2007	Basil	*Salmonella* Senftenberg	United Kingdom	32	Foodborne Pathogens and Disease, Vol 5, No 5
20	2007	Basil	*Salmonella* Senftenberg	Multiple states, USA	11	CDC 2007
21	2009	Parsley	*E. coli* O157	South Australia	31	OzFoodNet quarterly report, 2009: Oct-Dec
22	2011	Basil	*Shigella sonnei*	Norway	46	EID, 18:9 2012

- Information of the outbreaks was compiled by Judy D. Greig, Laboratory for Foodborne Zoonoses, PHAC (Public Health Agency of Canada). The data presented were collected from several sources of information, such as peer-reviewed journals, newspapers, press releases, health units, national laboratory and government websites

Appendix C: Summary of Global Foodborne Disease Outbreaks Associated with Leafy Herbs Contaminated with Bacterial Pathogens (1997 – March 2012)

Bacterial Pathogen	Outbreaks	
	Number of Outbreaks	Percentage of Outbreaks
Pathogenic *E. coli*	8	36.4
***Salmonella* spp.**	5	22.7
***Shigella* spp.**	8	36.4
Multiple pathogenic bacteria	1	4.5
Total	**22**	**100**

* Summarized according to Appendix B

Appendix D: Analytical Methods Used for Microbial Analysis

Bacterial Analysis	Method Identification Number (Date Issued)	Title of Method*
***E. coli* O157:H7/NM**	MFLP-30 (May 2003, Supplement 1 May 2005 & Supplement 2 November 2006)	The Dupont Qualicon Bax® System Method for the Detection of *E. coli* O157:H7 in Raw Beef and Fruit Juice
	MFLP-80 (March 2008)	Isolation of *E. coli* O157:H7 or NM in Foods
***Salmonella* spp.**	MFLP-29 (July 2007, modified**)	The Qualicon Bax® System Method for the Detection of *Salmonella* in a Variety of Food and Environmental Samples
	MFHPB-20 (March 2009)	Methods for the Isolation and Identification of *Salmonella* from Foods and Environmental Samples
***Shigella* spp.**	MFLP-26 (February 2006)	Detection of *Shigella* spp. In Foods by the Polymerase Chain Reaction (PCR)
	MFLP-25 (March 2006)	Isolation and Identification of *Shigell*a spp. from Foods
***Campylobacter* spp.**	(MFLP-46) (March 2002, modified***)	Isolation of Thermophilic *Campylobacter* from Food
Generic *E. coli*	MFHPB-19 (April 2002)	Enumeration of Coliforms, Faecal Coliforms and *E. coli* in Foods
	MFHPB-27 (September 1997)	Enumeration of *Escherichia coli* in Foods by the Direct Plating (DP) Method

**Compendium of Analytical Methods*[25].

** MFLP-29 was performed as written with the following modification: Secondary enrichment was performed as outlined for cantaloupes, i.e., transferred from buffered peptone broth as specified to RVS and TBG broths (Rappaport-Vassiliadis Soya Peptone broth and Tetrathionate Brilliant Green broth) and incubated for 24 ± 2 h at 42.5°C. After incubation 2 ml from each of RVS and TBG are combined to one sample and proceed with step 7.3.1.4 of the method.

*** MFLP-46 was performed as written with the following modifications. 25g from each sample were added to a filtered stomacher bag and stomached with 50 ml of peptone water for 2 min at 200 RPM. 25 mL of supernatant were removed and added to 100 mL of Park and Sanders Enrichment Broth, which is comprised of 100 mL of brucella broth, 0.5 mL supplement A per 100 mL of broth, 0.5 mL supplement B per 100 mL of broth, 5 mL blood per 100 mL of broth. The sample was then incubated under microaerophilic atmosphere in a Tri-Gas incubator (5% O2, 10% CO2, 85% N2) at 37°C for 3 to 4 hours and then transferred to a 42°C incubator and incubated under microaerophilic atmosphere (as specified above) for 24 and 48 hours. Following incubation, the enrichment broth was plated as described in section 6.3 of MFLP-46.