Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2010-2011 Targeted Surveys

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

RDIMS # 3393654

Canada

Table of Contents

Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and enhance 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 in fruits and vegetables in terms of microbiological hazards. Leafy herbs can become contaminated with various foodborne pathogens in production, harvest, post-harvest handling, packaging and distribution. The presence of pathogens in leafy herbs creates a potential risk for foodborne illness as leafy herbs are often consumed raw. *Salmonella*, *Shigella*, and *Escherichia coli* (*E. coli*) O157 have been identified as the primary bacterial pathogens of concern in leafy herbs.

Considering these factors and their relevance to Canadians, leafy herbs have been selected as one of the priority commodity groups of fruits and vegetables for enhanced surveillance under the FSAP. Over the course of this four-year baseline study (2010/10 to 2012/13) approximately 5,000 leafy herb samples were collected from retail locations and tested for the presence of various pathogens of concern. The main objectives of the 2010/11 survey were to generate baseline surveillance data on bacterial pathogens *Salmonella*, *Shigella*, *Campylobacter* and *E. coli* O157, and on generic *E. coli* (an indicator of fecal contamination) for leafy herbs available in the Canadian market. In total, 1646 samples were collected and analysed, including imported, domestic, conventional and organically grown leafy herbs.

The results of the 2010-11 survey indicate that bacterial pathogens and generic *E. coli* were not detected in the majority (98.8%) of the herb samples. Two samples (0.1%) were found to be contaminated with *Salmonella* and four samples (0.2%) had unsatisfactory levels (>1000 CFU/g) of generic *E. coli*. Investigations of these findings resulted in two product recalls. Furthermore, thirteen samples (0.8%) had elevated levels (100-1000 CFU/g) of generic *E. coli*, though no immediate action was required. These results suggest that the vast majority of fresh herbs in the Canadian market sampled during this survey were produced under Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs).

The 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's (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 fruits and vegetables and imported food ingredients. A statistically significant number of samples will be collected over several 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 targeted survey (2010/11) represents part of the collection of over 5,000 leafy herb samples over four years (2009/10 – 2012/13), which was designed to gather baseline information on the occurrence of microbial pathogens of concern as well as the presence and levels of generic *E. coli* 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 FAO/WHO Codex Alimentarius Commission. Producers of fresh fruits and vegetables are encouraged to follow these international codes of practice. Of relevance for this survey are the *Code of Hygienic Practices 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 GAPs and GMPs which, when applied, control and reduce the potential for contamination with microbial, chemical, and physical hazards at all stages of 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 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.

Fresh fruits and vegetables that are represented as organic in international and inter-provincial trade, or that bear the federal organic agricultural product legend (or federal logo) must also comply with the *Organic Products Regulations, 2009* (10) under the *Canada Agricultural Products Act.* These products must be certified by a certification body recognized by the CFIA.

The *Fresh Fruit and Vegetable Regulations*, the *Organic Products Regulations,* and the food-related sections of the FDA and FDR are enforced by the CFIA.

FSAP targeted surveys are primarily conducted for surveillance and not for regulatory compliance purposes. However, results indicating a potential risk to public health for any samples tested under this survey will trigger food safety investigations; including activities such as follow-up sampling, inspections of facilities, and consultations with Health Canada for health risk assessments. Depending on the findings, a recall of the affected product may be warranted.

2 Survey on Leafy Herbs

2.1 Rationale

Leafy herbs have been reported to be responsible for numerous outbreaks of foodborne illness worldwide. From 1997 to 2010, there were 21 foodborne disease outbreaks associated with contaminated leafy herbs (Appendix B). Of these outbreaks, pathogenic *E. coli*, *Shigella* spp. and *Salmonella* spp., were identified and accounted for approximately 95% of the outbreaks (Appendix C). Three outbreaks occurred in Canada and were linked to leafy herbs contaminated with *Shigella sonnei* (Appendix B).

Leafy herbs, like other leafy vegetables, can become contaminated with various foodborne pathogens during production, harvest, post-harvest handling, processing and distribution. Contaminated leafy herbs can introduce pathogens from a herb producing country to herb-consuming countries resulting in outbreaks of foodborne illness. Recent outbreaks of foodborne illness that occurred in the United Kingdom (11,12) and Denmark (13) were associated with imported leafy herbs harbouring bacterial pathogens (e.g., *Salmonella*, pathogenic *E. coli*). 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 and leafy green vegetables were identified as a level one (highest) priority in 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., outbreaks with high numbers of illnesses in a wide variety of geographic locations).

Based on the above information and the Food Safety Science Committee's recommendations(3), leafy herbs have been selected as one of the priority commodity groups of fresh fruits and vegetables for targeted surveillance under FSAP, for four years (2009/10 - 2012/13). The overall objective of this four year study (2009/10- 2012/13) is to gather baseline information on the occurrence of bacterial pathogens of concern in leafy herbs available to Canadians at retail.

This targeted survey (2010/11) is part of the information collection, with a focus on determining the presence and distribution of bacterial pathogens *E. coli* O157:H7/NM, *Salmonella* and *Shigella*, and the presence, distribution and levels of generic *E. coli* (as an indicator of fecal contamination) in imported and domestic, conventional and organically grown leafy herbs. Furthermore, the presence and distribution of the bacterial pathogen

Campylobacter in imported and domestically produced conventionally grown leafy herbs was also surveyed.

2.2 Targeted Micro-Organisms

2.2.1 Bacterial Pathogens- *Salmonella, E. coli O157, Shigella,* and *Campylobacter*

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 contaminated food of animal origin (e.g., chicken, beef). However, in the last decade, fresh fruits and vegetables have emerged as significant sources of these bacterial pathogens related illnesses (16). Fruits and vegetables can typically become contaminated with *Salmonella* and *E. coli* O157 in the field, by improperly composted manure, contaminated water, wildlife feces, or poor hygienic practices of the farm workers (17).

Humans are the only host of *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, *Campylobacter* is also found naturally in the intestines of most food-producing animals, such as chickens, swine, and cattle. *Campylobacter* is one of the leading bacterial causes of foodborne illnesses in the U.S. and Canada. Raw poultry and unpasteurized (raw) milk are major sources of contaminated food. However, vegetables can also become contaminated with *Campylobacter* (15).

2.2.2 Generic *E. coli*- 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 the stools of humans and animals, the occurrence of *E. coli* in foods indicates direct or indirect contamination with fecal matter (18). The presence of generic *E. coli* in foods can also indicate potential contamination with pathogenic enteric micro-organisms, such as *Salmonella* or *E. coli* O157 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 the increased risk of contamination with pathogenic micro-organisms but does not conclusively indicate that these bacterial pathogens are present. High levels of generic *E. coli* in fresh produce sold at retail are an indication that contamination has occurred at some point between production and the time of sale.

2.3 Sample Collection

Leafy herb samples collected for this survey included pre-trimmed bunches, or pre-packaged, non-cut fresh leafy herbs. Dried herbs were excluded from the survey. All samples were collected from national retail chains and local/regional grocery stores as well as other conventional retail and natural food stores located in various cities across Canada. The number of samples collected in the various regions across Canada was based on the relative proportion of the population in the respective regions. 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".

For 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 200g. Collected samples were required to be shipped under conditions that limited the growth of micro-organisms during transit. Samples were declared "unfit" for analysis if there were issues regarding the conditions in which the sample was handled or shipped.

2.4 Sample Distribution

As per the survey design, a total of 1,646 samples were collected; 67.3% (1107 samples) of the samples were imported and 32.7% (539 samples) of the samples were domestically produced herbs. Conventionally grown herb samples accounted for about 70% of the total number of samples; the remainder consisting of organically grown samples.

Most of the imported herb samples originated from the U.S. (62%) and three other countries (31.7%): Colombia, the Dominican Republic, and Mexico (Table 1). The country of origin could not be identified for 17 samples (1.5%).

More than 14 different types of herbs were collected from the Canadian retail market. Three types of herbs, parsley, cilantro (coriander), and basil, accounted for 63.2% of the total number of the samples (Table 2).

Table 1 Imported Sample Distribution by Country of Origin

Country of Origin	Conventional	Organic	Total	
	Number of Samples	Number of Samples	Number of Samples	Percentage of Samples
China	1	0	1	0.1
Colombia	75	39	114	10.3
Costa Rica	2	0	2	0.2
Dominican Republic	125	0	125	11.3
Israel	34	5	39	3.5
Italy	0	1	1	0.1
Mexico	96	16	112	10.1
U.S.A.	417	269	686	62.0
Vietnam	9	0	9	0.8
Thailand	1	0	1	0.1
Unidentified	17	0	17	1.5
Total	**777**	**330**	**1107**	**100**

Table 2 Types of Leafy Herb Samples

Type of Herb	Imported		Domestic		Total	
	Conventional	Organic	Conventional	Organic	Number of Samples	Percentage of Samples
	Number of Samples	Number of Samples	Number of Samples	Number of Samples		
Basil	64	32	58	24	178	10.8
Chives	32	7	53	13	105	6.4
Cilantro	160	99	59	11	329	20.0
Dill	8	17	4	9	38	2.3
Marjoram	3	1	0	2	6	0.4
Mint	58	13	44	16	131	8.0
Oregano	45	5	20	10	80	4.9
Parsley	283	130	72	49	534	32.4
Rosemary	53	11	18	6	88	5.4
Sage	11	3	1	10	25	1.5
Savoury	0	1	1	8	10	0.6
Sorrel	0	0	0	4	4	0.2
Tarragon	3	3	0	6	12	0.7
Thyme	45	6	25	7	83	5.0
Others *	12	2	7	2	23	1.4
Total	777	330	362	177	1646	100

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

2.5 Method Details

Samples were analysed using the analytical methods published in Health Canada's *Compendium of Analytical Methods* for the Microbiological Analysis of Foods (19) (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.

For the detection of *E. coli* O157:H7/NM, *Salmonella* spp. and *Shigella* spp., a two-step procedure was employed. Samples were first screened by PCR-based methods. Presumptive positive results were confirmed by isolation, purification and identification procedures. For the detection of *Campylobacter* spp., a cultural method was used, without the use of a PCR screening method. Enumeration of generic *E. coli* was obtained using the most probable number (MPN) or direct plating procedure.

If pathogens were detected, the isolates were further characterised by pulsed field gel electrophoresis (PFGE), i.e., DNA typing, at the CFIA's PFGE Centre. Serotyping for *Salmonella* spp. was performed at the *Salmonella* Typing Laboratory, Laboratory for Foodborne Zoonoses, Public Health Agency of Canada (PHAC) in Guelph, Ontario.

2.6 Assessment Guidelines

The assessment criteria used in this survey (Tables 3 and 4) are based on the principles of the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods* (20) and associated methods published in Health Canada's *Compendium of Analytical Methods* (19).

Unsatisfactory sample assessments were subject to follow-up actions, such as directed follow-up sampling, establishment inspection, health risk assessment, and/or product action (e.g., product recall).

Samples assessed as investigative in this survey required some follow-up activity. This could include, for example, further sampling (to verify the levels of generic *E. coli* in the samples in question) or data gathering for program design purposes.

Table 3. Assessment Guidelines for Bacterial Pathogens in Leafy Herbs

Bacterial Analysis* (Method Identification Number)	Assessment Criteria	
	Satisfactory	**Unsatisfactory**
***E. coli* O157:H7/NM** (MFLP-30 with Supplements 1 & 2, and MFLP-80)	Absent in 25 g	Present in 25 g
Salmonella* spp.* (MFLP-29 modified and MFHPB-20)	Absent in 25 g	Present in 25 g
Shigella* spp. * (MFLP-26 and MFLP-25)	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* (19).

**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 4. Assessment Guidelines for Generic *E. coli* in Leafy Herbs

Bacterial Analysis* (Method Identification Number)	Assessment Criteria		
	Satisfactory	**Investigative**	**Unsatisfactory**
Generic *E. coli* (MFHPB-19 and MFHPB-27)**	≤ 100	$100 < x \leq 1{,}000$	$> 1{,}000$

* *Compendium of Analytical Methods* (19).

** Concentration unit depends on method used. For MFHPB-19 method: MPN/g, for MFHPB-27 method: CFU/g.

2.7 Survey 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 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 in the absence of additional information.

Potential reasons for contamination cannot be elucidated based on a single sampling point (e.g., sampling at retail only). Therefore, it is not possible to determine if a breakdown of GAPs has occurred (e.g., contamination while the crop was on the field or during harvest), if a breakdown of GMPs has occurred (when the food is washed, packaged and sent to market) or if cross-contamination occurred during transportation, storage, or at the store where the sample was picked up.

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

Of the 1,646 herb samples analysed, a total of 98.8% of the samples were assessed as satisfactory (Table 5). *E. coli* O157 (H7 & NM) and *Shigella* spp. were not detected in any of the leafy herbs sampled in this survey. Furthermore, *Campylobacter* spp. was not detected in any of the 1,139 conventional samples that were additionally tested for this pathogen. Six samples (0.4%) were assessed as unsatisfactory; five of which were imported. Thirteen samples were assessed as investigative; nine of these were domestic samples.

Table 5 Summary of the Results for the Leafy Herb Samples

Product Origin	Production Practice	Number of Samples	Assessment					
			Investigative		Unsatisfactory		Satisfactory	
			Number of Samples	Percentage of Samples	Number of Samples	Percentage of Samples	Number of Samples	Percentage of Samples
Imported	Conventional	777	2	0.3	5	0.6	770	99.1
	Organic	330	2	0.6	0	0	328	99.4
	Subtotal	***1107***	***4***	***0.4***	***5***	***0.5***	***1098***	***99.2***
Domestic	Conventional	362	4	1.1	0	0	358	98.9
	Organic	177	5	2.8	1	0.6	171	96.6
	Subtotal	***539***	***9***	***1.7***	***1***	***0.2***	***529***	***98.1***
Total		**1646**	**13**	**0.8**	**6**	**0.4**	**1627**	**98.8**

The six unsatisfactory samples (Table 6) consisted of two samples that were positive for *Salmonella* spp., and four samples with unsatisfactory levels of generic *E coli* (>1000 CFU/g). *Salmonella* Weltevreden var.15+(15:r:z6) and *Salmonella* IIIb:60:r:z53 were identified from the isolates of the *Salmonella* positive samples.

The unsatisfactory samples originated from the U.S. (two samples), the Dominican Republic (two samples), Mexico (one sample), and Canada (one sample). Furthermore, the unsatisfactory findings were found across four herb varieties: basil (two samples), parsley (two samples), rosemary (one sample) and sage (one sample).

Elevated levels (100-1000 CFU/g) of generic *E. coli* were found in a total of 13 samples (0.8%). These samples were assessed as investigative since the counts were below the threshold of 1000 CFU/g (Table 7). These samples were from domestic and imported sources.

Table 6 Summary of Unsatisfactory Samples

Product Origin	Product Type/Production Practice/ Country of Origin	Reason for Unsatisfactory Assessment
Imported	Thai Basil /Conventional /USA	*Salmonella* Weltevreden var.15+(15:r:z6)
	Parsley /Conventional /USA	*Salmonella* IIIb:60:r:z53;
	Sage /Conventional /Dominican Republic	Generic *E. coli*: 1300 CFU/g
	Rosemary /Conventional /Dominican Republic	Generic *E. coli*: 1800 CFU/g
	Basil /Conventional /Mexico	Generic *E. coli*: > 1000 CFU/g
Domestic	Parsley /Organic /Canada	Generic *E. coli*: 1400 CFU/g

Table 7 Summary of Investigative Samples

Product Origin	Product Type /Production Practice /Country of Origin	Generic *E. coli* Counts (CFU/g)
Imported	Rosemary /Conventional /USA	690
	Parsley /Conventional /USA	340
	Mint /Organic /Mexico	180
	Basil /Organic /USA	130
Domestic	Mint /Conventional /Canada	830
	Mint /Conventional /Canada	710
	Cilantro /Conventional /Canada	170
	Chives /Conventional /Canada	110
	Mint /Organic /Canada	200
	Mint /Organic /Canada	110
	Basil /Organic /Canada	200
	Cilantro /Organic /Canada	180
	Cilantro /Organic /Canada	170

4 Discussion and Conclusion

From this survey (2010/11) it was determined that 98.8% of the samples were negative for the bacterial pathogens tested and had acceptable levels of generic *E. coli*. Bacterial pathogens *E. coli* O157: H7/NM and *Shigella* were not detected in any of the 1,646 leafy herb samples tested. Furthermore, *Campylobacter* was not detected in any of the 1,139 conventional herb samples. However, *Salmonella* was detected in two samples and high levels of generic *E. coli* were found in four samples, resulting in unsatisfactory assessments. In addition, elevated levels of generic *E. coli* (>100 and ≤1,000 CFU/g) were detected in 13 samples, resulting in investigative assessments.

As a result of the unsatisfactory findings, the CFIA conducted appropriate follow-up food safety investigations including health risk assessments, directed sampling, review of importation procedures, etc. Two product recalls resulted from the subsequent investigations. It is important to note that there were no reported illnesses associated with consumption of any of the *Salmonella* contaminated products during this survey. Finally, after further evaluation of the investigative results, no further actions were deemed necessary.

Samples used in this survey were obtained at retail and contamination may have occurred at a number of points along the food chain. These include a failure with Good Agricultural Practices (GAPs), whereby the contamination could have occurred while the crop was on the field or during harvest. As well, there may have been a failure in Good Manufacturing Practices (GMPs) whereby the produce was improperly handled, packaged transported, or delivered to market. It is possible that contamination occurred at the store where the samples were obtained.

The overall findings of this survey suggest that the vast majority of leafy herbs in the Canadian market are produced and handled under acceptable GAPs/GMPs. However, contamination of leafy herbs with *Salmonella* can occur with imported and with domestic product, which represents a food safety risk. Furthermore, generic *E. coli* contamination of leafy herbs can also occur. While generic *E. coli* do not lead to illness, their presence is used by the CFIA as an indicator that pathogenic micro-organisms may potentially be introduced during the production, processing, and marketing of these commodities.

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. Surveillance activities will continue and the CFIA will inform stakeholders of its findings.

5 References

1. Government of Canada. *Food and Consumer Product Safety Action Plan* [online]. 2012 September, Accessed 2012 Oct, http://www.tbs-sct.gc.ca/hidb-bdih/initiative-eng.aspx?Hi=85

2. Canadian Food Inspection Agency. *Food Safety Action Plan* [online]. 2012 June, Accessed 2012 Oct, http://www.inspection.gc.ca/food/consumer-centre/industry-s-role/food-safety-action-plan/eng/1335455338583/1335455420137

3. Canadian Food Inspection Agency. *Food Safety Science Committee Summary Report 2008* [online]. 2008, Accessed 2012 Oct, http://merlin.cfia-acia.inspection.gc.ca/english/fssa/invenq/guidoce.asp#refman5

4. CODEX Alimentarius committee in Food Hygiene. *The Code of Hygienic Practices for Fresh Fruits and Vegetables (CAC/RCP 53-2003)* [online]. 2011, Accessed 2011, http://www.codexalimentarius.net/download/standards/10200/CXP_053e.pdf

5. CODEX Alimentarius committee in Food Hygiene. *Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969)* [online]. 2011, Accessed 2011, http://www.codexalimentarius.net/download/standards/23/cxp_001e.pdf

6. Department of Justice Canada. *Food and Drugs Act* [online]. 2008 June, Accessed 2012 Oct, http://laws-lois.justice.gc.ca/eng/acts/F-27/

7. Department of Justice Canada. *Food and Drug Regulations* [online]. 2012 August, Accessed 2012 Oct, http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._870/index.html

8. Department of Justice Canada. *Fresh Fruit and Vegetable Regulations* [online]. 2011 September, Accessed 2012 Oct, http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._285/index.html

9. Department of Justice Canada. *Canada Agricultural Products Act* [online]. 2005 December, Accessed 2012 Oct, http://laws-lois.justice.gc.ca/eng/acts/C-0.4/

10. Department of Justice Canada. *Organic Products Regulations, 2009* [online]. 2013 March, Accessed 2013 Mar, http://laws-lois.justice.gc.ca/eng/regulations/SOR-2009-176/

11. Elviss NC, Little CL, Hucklesby L, et al. Microbiological study of fresh herbs from retail premises uncovers an international outbreak of salmonellosis. *Int J Food Microbiol* 2009;**134**(1-2):83-8.

12. Pezzoli L, Elson R, Little CL, et al. Packed with Salmonella--investigation of an international outbreak of Salmonella Senftenberg infection linked to contamination of prepacked basil in 2007. *Foodborne Pathog Dis* 2008;**5**(5):661-8.

13. Pakalniskiene J, Falkenhorst G, Lisby M, et al. A foodborne outbreak of enterotoxigenic E. coli and Salmonella Anatum infection after a high-school dinner in Denmark, November 2006. *Epidemiol Infect* 2009;**137**(3):396-401.

14. WHO/FAO. *Microbiological Risk Assessment Series 14: Microbiological Hazards in Fresh Leafy Vegetables and Herbs* [online]. 2011, Accessed 2011, http://www.fao.org/ag/agn/agns/jemra/Jemra_Report%20on%20fresh%20leafy%20vegetables%20and%20herbs.pdf

15 Food and Drug Administration (FDA). *Bad Bug Book: Foodborne Pathogenic Microorganisms and Natural Toxins Handbook*. 2nd Edition. 2012. Available at URL: http://www.fda.gov/Food/FoodSafety/FoodborneIllness/default.htm

16 Kozak G.K., MacDonald D., Landry L., Farber J.M. Foodborne Outbreaks in Canada Linked to Produce: 2001 through 2009. *J Food Protection*, 2013; 76(1):173-183.

17 Centers for Disease Control and Prevention (CDC). Ongoing multistate outbreak of Escherichia coli serotype O157:H7 infections associated with consumption of fresh spinach--United States, September 2006. *MMWR Morb Mortal Wkly Rep* 2006;**55**(38):1045-6.

18 Forsythe, S.J. *The Microbiology of Safe Food*. 2nd Edition. Blackwell Publishing Ltd., 2011.

19. Health Canada. *Compendium of Analytical Methods* [online]. 2011 April, Accessed 2012 Oct, http://www.hc-sc.gc.ca/fn-an/res-rech/analy-meth/microbio/index-eng.php

20. Health Canada. *Health Products and Food Branch Standards and Guidelines for the Microbiological Safety of Food - an Interpretive Summary [online]*. 2008. Accessed October 2012, http://www.hc-sc.gc.ca/fn-an/res-rech/analy-meth/microbio/volume1/intsum-somexp-eng.php

Appendix A: List of Acronyms

CDC: Centres for Disease Control and Prevention

CFIA: Canadian Food Inspection Agency

CFU/g: colony forming units per gram

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

HPB/MFHPB: Health Protection Branch/ Microbiology Food Health Protection Branch

MFLP: Microbiology Food Laboratory Procedures

HC: Health Canada

MPN: Most Probable Number

NM: non-motile

PCR: Polymerase Chain Reaction

PFGE: Pulsed Field Gel Electrophoresis

PHAC: Public Health Agency of Canada

spp.: species

WHO: World Health Organization

g: gram

Appendix B: Global Foodborne Disease Outbreaks Associated with Leafy Herbs Contaminated with Bacterial Pathogens (1997-2010)*

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

* The author wishes to thank by Judy D. Greig, Laboratory for Foodborne Zoonoses, PHAC (Public Health Agency of Canada) for providing this information. 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 (1997-2010)

Bacterial Pathogen	Outbreaks	
	Number of Outbreaks	Percentage of Outbreaks
Pathogenic *E. coli*	8	38.1
***Salmonella* spp.**	5	23.8
***Shigella* spp.**	7	33.3
Multiple pathogenic bacteria	1	4.8
Total	**21**	**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 of *E. coli* in Foods
	MFHPB-27 (September 1997)	Enumeration of *Escherichia coli* in Foods by the Direct Plating (DP) Method

* *The Compendium of Analytical Methods* [19].

** 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.