



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Food Microbiology – Targeted Surveys

FINAL REPORT

Bacterial Pathogens in Pre-Packaged, Fresh-Cut, Ready-to-Eat Vegetables

April 1, 2014 – March 31, 2016



Summary

In recent years, the availability of pre-packaged, fresh-cut, ready-to-eat (RTE) vegetables has increased to meet consumers' demand for convenient and healthy foods. Unfortunately, fresh vegetables, including fresh-cut vegetables and vegetable mixes, have been associated with numerous recalls and several outbreaks of foodborne illnesses worldwide. Vegetables can become contaminated with pathogens during production, harvest, post-harvest handling, processing, packaging and distribution. The additional processing steps that fresh-cut vegetables undergo such as cutting, slicing, peeling and shredding remove or damage their protective surfaces, providing a favourable environment (i.e. increased availability of nutrients, higher water activity, neutral pH) for any micro-organisms that may be present on the surface to multiply¹. Since pre-packaged, fresh-cut RTE vegetables are expected to be consumed raw without further preparation, the presence of bacterial pathogens creates a potential risk for foodborne illnesses.

Considering the factors mentioned above and their relevance to Canadians, pre-packaged, fresh-cut, RTE vegetables were selected for targeted surveys. The purpose of targeted surveys is to generate baseline information on the occurrence and distribution of pathogenic bacteria in food. Over the course of this study (April 1, 2014 to March 31, 2016), a total of 2675 samples were collected from retail locations in 11 cities across Canada and tested for bacterial pathogens of concern (*Listeria monocytogenes*, *Salmonella*, *Shigella*, and *Escherichia coli* O157:H7 (*E. coli* O157:H7)) as well as generic *E. coli*. Generic *E. coli* is an indicator of the overall sanitation conditions throughout the food production chain.

Salmonella, *Shigella*, *E. coli* O157:H7 and generic *E. coli* (>100 Most Probable Number (MPN)/g) were not found in any samples, while *Listeria monocytogenes* was found in six (0.22%) samples. The Canadian Food Inspection Agency (CFIA) conducted appropriate follow-up activities. In three cases, due to the perishable nature of the products and the time elapsed between sample pick up and the completion of analyses, the implicated products were no longer available on the market when the pathogen was detected. Consequently, no direct product action was possible, however corrective actions were implemented by the processing facilities in two out of the three cases. In the other three cases, follow-up activities resulted in product recalls and the implementation of corrective actions by the processing facilities. There were no reported illnesses linked to the *Listeria monocytogenes* contaminated products.

Overall, our survey results suggest that almost all pre-packaged, fresh-cut, RTE vegetables are safe for consumption. Regardless, pre-packaged, fresh-cut, RTE vegetables are a known potential source of foodborne illness and as such, safe handling practices are recommended for producers, retailers and consumers.

What Are Targeted Surveys?

Targeted surveys are used by the Canadian Food Inspection Agency (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 Canadian Food Inspection Agency 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?

In recent years, the availability of pre-packaged, fresh-cut, ready-to-eat (RTE) vegetables has increased to meet consumers' demand for convenient and healthy foods. Unfortunately, fresh vegetables, including fresh-cut vegetables and vegetable mixes, have been associated with numerous recalls and several outbreaks of foodborne illnesses worldwide.

Vegetables can become contaminated with pathogens during production, harvest, post-harvest handling, processing, packaging and distribution. The additional processing steps that fresh-cut vegetables undergo such as cutting, slicing, peeling and shredding remove or damage the protective surfaces of vegetables, providing a favourable environment (i.e. increased availability of nutrients, higher water activity, neutral pH) for any micro-organisms that may be present on the surface to multiply¹. Since pre-packaged, fresh-cut, RTE vegetables are expected to be consumed raw without further preparation, the presence of pathogens creates a potential risk for foodborne illnesses.

Given the above, pre-packaged, fresh-cut RTE vegetables available at retail in Canada were selected for targeted surveys over a four fiscal year period starting in 2012 to gather baseline

information on the occurrence and distribution of *Listeria monocytogenes*, *Salmonella*, *Shigella*, *Escherichia coli* O157:H7 (*E. coli* O157:H7) and generic *E. coli*. Generic *E. coli* is an indicator of the overall sanitation conditions throughout the food production chain. This report details results of the last two fiscal years of the survey period (April 1, 2014 to March 31, 2016). Results of the first two fiscal years of the survey (April 1, 2012 to March 31, 2014) are very similar to those reported here and are detailed in a separate report.

What Did We Sample?

For this survey, a sample consisted of a single unit (e.g., individual consumer-size package(s) from a single lot) with a total weight of at least 250 g. All samples were collected from national retail chains and local/regional grocery 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), and the 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. Samples were collected between April 1, 2014 and March 31, 2016. A variety of pre-packaged, pre-cut, RTE vegetables were sampled. Samples included conventional and organic produce of domestic or imported origin.

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*² (Table 1). The assessment criteria used in this survey (Table 1) are based on the principles of Health Canada's *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods*³.

No assessment guidelines had been established in Canada for the presence of *Salmonella* or *Shigella* in fresh vegetables at the time of writing this report. However, these microorganisms are considered pathogenic to humans and as such in the absence of assessment guidelines, their presence in pre-packaged RTE vegetables is considered to be a violation of the *Food and Drugs Act* (FDA) Section 4(1) and is therefore assessed by the CFIA as unsatisfactory.

The assessment guidelines for *Listeria monocytogenes* are based on Health Canada's Policy on *Listeria monocytogenes* in RTE foods and is dependent upon the sample type analysed (i.e., Category 1, 2A or 2B)⁴.

Unlike harmful bacterial pathogens (e.g. *Salmonella*, *E. coli* O157:H7), 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. Its presence at some levels is tolerated on agricultural products. An investigative assessment which may result in further follow-up actions is associated with elevated levels of generic *E. coli* ($100 < x \leq 1000$ MPN/g). An unsatisfactory assessment is associated with high levels of generic *E. coli* (> 1000 MPN/g) as it may indicate a breakdown in Good Agricultural Practices, or Good Manufacturing Practices (sanitation practices), and therefore possibly warranting the initiation of follow-up activities to, for example, improve sanitation conditions along the food chain. As the results are based on the analysis of one unit ($n=1$), further sampling is required to verify the levels of generic *E. coli* of the lot.

Table 1 Analytical Methods and Assessment Criteria for Bacteria in Fresh-cut Vegetables

Bacterial Analysis	Method Identification Number*	Assessment Criteria		
		Satisfactory	Investigative	Unsatisfactory
<i>Listeria monocytogenes</i>	MFLP-28 MFHPB-30 MFLP-74	Absent in 25g	Not Applicable (N/A) (Category 1)	Present in 25g (Category 1)
			≤ 100 CFU/g (Category 2)	> 100 CFU/g (Category 2)
<i>Salmonella</i>	MFHPB-20	Absent in 25g	N/A	Present in 25g
<i>Shigella</i>	MFLP-25	Absent in 25g	N/A	Present in 25g
<i>E. coli</i> O157:H7	MFLP-30, MFHPB-10	Absent in 25g	N/A	Present in 25g
Generic <i>E. coli</i>	MFHPB-19 MFHPB-27	≤ 100 MPN/g	$100 < x \leq 1000$ MPN/g	> 1000 MPN/g

* The methods used were the published versions at the time of analysis

What Were the Survey Results?

Over the course of this study (April 1, 2014 to March 31, 2016), a total of 2675 samples were tested for bacterial pathogens of concern (*Listeria monocytogenes*, *Salmonella*, *Shigella*, *E. coli* O157:H7) as well as generic *E. coli*. Generic *E. coli* is an indicator of the overall sanitation

conditions throughout the food production chain. Sample assessment results can be found in Table 2.

Table 2 Assessment Results of Fresh-cut Vegetable Samples

Organism under test	<i>Listeria monocytogenes</i>	<i>Salmonella</i>	<i>Shigella</i>	<i>E. coli</i> O157	Generic <i>E. coli</i> (>100 MPN/g)
Number of samples analysed	2675				
Satisfactory Assessment (%)	2669 (99.78%)				
Unsatisfactory Assessment (%)	6 (0.22%)	0	0	0	0

Salmonella, *Shigella*, *E. coli* O157 and generic *E. coli* (>100 MPN/g) were not found in any samples while *Listeria monocytogenes* was found in six (0.22%) samples. The six samples that were positive for *Listeria monocytogenes* (<100 CFU/g) were determined to be Category 1 product as per Health Canada’s Policy on *Listeria monocytogenes* in RTE foods⁴ and were therefore assessed as Unsatisfactory.

Of the 2675 samples tested, 63% (1680/2675) were imported, 25% (672/2675) were domestic and 12% (323/2675) were of unknown origin. Of the 2675 samples tested, 93% (2486/2675) were conventional and 7% (189/2675) were organic. All (6/6) *Listeria monocytogenes* positive samples were of domestic origin and 83% (5/6) were conventionally produced.

A variety of pre-packaged, fresh-cut, RTE vegetable product types were analysed and are detailed in Table 3. *Listeria monocytogenes* contamination was found in five samples of fresh-cut mushrooms and one sample of mixed vegetables.

Table 3 Sample Distribution by Product Type

Product Type	Number of Samples Analysed (% of total samples)	<i>Listeria monocytogenes</i> Positive Samples (% of samples of that category)
Mixed Vegetables	1848 (69%)	1 (<1%)
Mushrooms	514 (19%)	5 (1%)
Broccoli	210 (8%)	0
Carrot	50 (2%)	0
Cauliflower	18 (1%)	0
Bell Peppers	18 (<1%)	0
Cabbage	6 (<1%)	0
Cucumber	6 (<1%)	0
Celery	4 (<1%)	0
Hot Peppers	1 (<1%)	0
Total	2675	6

What Do the Survey Results Mean?

In this survey, 99.8% of the pre-washed, pre-packaged, RTE vegetable samples analyzed were free of pathogenic bacteria tested for. *Salmonella*, *Shigella*, *E. coli* O157:H7 and generic *E. coli* (>100 MPN/g) were not found in any samples. *Listeria monocytogenes* was found in six (0.22%) samples.

The prevalence of *Listeria monocytogenes* in our survey (0.22%) was lower when compared to both a 2000-2001 US study (0.74%)⁵ and a 2001 UK study (2.33%)⁶, both of which investigated the presence of *Listeria monocytogenes* in ready-to-eat salads. Our survey results also showed lower *Salmonella* (0.00%) and generic *E. coli* (>100 MPN/g) (0.00%) prevalence when compared to the UK study⁶ which showed a prevalence of 0.13% for *Salmonella*, 0.36% for generic *E. coli* (100-1000 CFU/g) and 0.13% for generic *E. coli* (>1000 CFU/g). Both our study and the UK study⁶ found no presence of *E. coli* O157. The lower rates of contamination in our study may be due to various reasons such as differences in product types tested (our study excluded leafy green vegetables), methodology, study design etc.

Trends in the occurrence of *Listeria monocytogenes* contamination were observed in our study when comparing the production practice and where the sample was produced. All (6/6) *Listeria monocytogenes* positive samples were of domestic origin and 83% (5/6) were conventionally produced. This observation may be due to the fact that mushrooms which accounted for 83%

(5/6) of contaminated samples were all of domestic origin and 85% were conventionally produced.

The CFIA conducted appropriate follow-up activities. In three cases, due to the perishable nature of the products and the time elapsed between sample pick up and the completion of analyses, the implicated products were no longer available on the market when the pathogen was detected. Consequently, no direct product action was possible, however corrective actions were implemented by the processing facilities in two out of the three cases. In the other three cases, follow-up activities resulted in product recalls and the implementation of corrective actions by the processing facilities. There were no reported illnesses linked to the *Listeria monocytogenes* contaminated products.

Overall, our survey results suggest that almost all pre-packaged, fresh-cut, RTE vegetables are safe for consumption. Regardless, pre-packaged, fresh-cut, RTE vegetables are a known potential source of foodborne illness and as such, safe handling practices are recommended for producers, retailers and consumers.

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