



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Bacterial Pathogens and Indicators in Imported Romaine Lettuce - April 1, 2019, to March 31, 2024

Food microbiology - Targeted surveys - Final report



Summary

A targeted survey¹ analyzed 4450 samples of imported fresh romaine lettuce (whole [n=1258], hearts [n=1822], fresh-cut or salads [n=1370]) over a 5-year period from April 1, 2019, to March 31, 2024. Samples were tested for the presence of the pathogens *E. coli* O157:H7/Non-Motile (NM), and *Salmonella* species (spp.). All samples were tested for generic *E. coli* which is an indicator of the overall hygienic and sanitary conditions throughout the food supply chain from production to the point of sale.

Almost all (99.98%) of the samples tested were found to be satisfactory. *E. coli* O157:H7/NM and *Salmonella* spp. were not found in any of the samples (0/4432 and 0/2795 samples, respectively). Generic *E. coli* at elevated levels was found in 1 of the 4450 (0.02%) samples. The Canadian Food Inspection Agency (CFIA) conducted appropriate follow-up activities, as necessary.

Overall, our survey results indicate that imported fresh romaine lettuce sold in Canada is generally safe for consumption. However, as with all foods, and especially those that are ready-to-eat (RTE), good hygienic practices are recommended for producers, retailers, and consumers.

Why the survey was conducted

The survey was conducted to provide enhanced oversight of imported romaine lettuce sold at retail in Canada. Romaine lettuce is popular among Canadians² as part of a healthy diet including plenty of fruits and vegetables. Unfortunately, leafy green vegetables (including romaine lettuce) have been associated with foodborne illness outbreaks of bacterial pathogens such as *E. coli* O157:H7, and *Salmonella* spp.^{3,4}. Between 2017 and 2020, romaine lettuce imported from the United States (US) were associated with several foodborne illness outbreaks of *E. coli* O157:H7 in the US^{5,6,7,8}, and Canada^{9,10,11}. This survey was initiated in response to these reoccurring outbreaks. Additionally, the CFIA implemented import requirements for products containing romaine lettuce harvested from the affected US growing regions^{12,13}.

Food safety investigations, and traceback studies into the outbreaks revealed that the contamination was associated with the close proximity of the lettuce growing fields to concentrated animal feeding operations^{14,15}. Lettuce in growing fields could have been contaminated with *E. coli* O157:H7 from cattle feces via irrigation water, wind and other means^{14,15}. Food safety action plans and control measures were implemented in the implicated US growing regions in 2020¹⁶.

When the survey was conducted

The survey was conducted over a 5-year period from April 1, 2019, to March 31, 2024.

Where the samples were collected from

Samples were collected from national retail chains and local/regional grocery stores located in the following 11 major cities across Canada:

- Halifax
- Moncton
- Quebec City
- Montreal
- Toronto
- Ottawa
- Vancouver
- Victoria
- Calgary
- Saskatoon
- Winnipeg

The planned number of samples to be collected from each city was based on the population of the province in which the city was located relative to the total population of Canada.

Total number and description of samples collected

A total of 4450 imported fresh romaine lettuce samples including whole (1258), hearts (1822), and fresh-cut romaine or romaine lettuce-based salads (1370) were collected over the 5-year survey period. A sample consisted of a single or multiple consumer sized packages of the same lot weighing at least 250 g.

What the samples were tested for

The imported fresh romaine lettuce samples (whole, hearts, and fresh-cut or salads) were tested for the presence of *E. coli* O157:H7/NM, *Salmonella* spp., and generic *E. coli* (table 1). *E. coli* O157:H7/NM, and *Salmonella* spp. are pathogenic bacteria while generic *E. coli* is an indicator of the overall hygienic and sanitary conditions under which the samples have been produced, processed, stored, and transported.

Table 1 - Bacterial analyses by romaine lettuce type

Fiscal year	Bacteria	Whole romaine lettuce	Whole romaine lettuce hearts	Fresh-cut romaine lettuce or romaine lettuce-based salads	Total number of samples tested
2019-2020 2020-2021	<i>E. coli</i> O157:H7/NM generic <i>E. coli</i>	457	682	516	1655
2021-2022 2022-2023 2023-2024	<i>E. coli</i> O157:H7/NM <i>Salmonella</i> spp. generic <i>E. coli</i>	801 (5 ^a)	1140 (9 ^a)	854 (4 ^a)	2795 (18 ^a)

Methods used to test the samples

Samples were analyzed using analytical methods published in Health Canada's *Compendium of Analytical Methods for the Microbiological Analysis of Foods*¹⁷ that were suitable for the testing of romaine lettuce.

How the samples were assessed

The samples were assessed using criteria based on the principles of the following Health Canada documents: *Health Products and Food Branch (HPFB) Standards and Guidelines for Microbiological Safety of Foods – An Interpretive Summary*¹⁸, and the *Food and Drugs Act* (Section 4(1)a)¹⁹. See table 2.

Table 2 - Assessment criteria

Bacteria	Satisfactory	Investigative	Unsatisfactory
<i>E. coli</i> O157:H7/NM	Not detected/25 g	Not applicable	Detected/25 g
<i>Salmonella</i> spp.	Not detected/25 g	Not applicable	Detected/25 g
Generic <i>E. coli</i>	≤ 10 ² Colony Forming Unit (CFU)/g	10 ² < x < 10 ³ CFU/g	> 10 ³ CFU/g

At the time of writing this report, no assessment guidelines had been established in Canada for the presence of *Salmonella* spp. in fresh vegetables. As *Salmonella* spp. is considered pathogenic to humans, its presence was assessed as unsatisfactory and might be considered a violation of the *Food and Drugs Act* Section 4(1)a¹⁹.

^a *E. coli* O157:H7 results not available

Survey results

Almost all (99.98%) of the samples tested were found to be satisfactory. *E. coli* O157:H7/NM and *Salmonella* spp. were not found in any of the (0/4432) and (0/2795) samples, respectively. Generic *E. coli* at elevated levels was found in one of the 4450 samples (table 3).

Table 3 - Analysis assessment results

Bacterial analysis	Number of samples tested	Satisfactory	Investigative	Unsatisfactory
<i>E. coli</i> O157:H7/NM	4432	4432	0	0
<i>Salmonella</i> spp.	2795	2795	0	0
Generic <i>E. coli</i>	4450	4449	1 ^b	0
Total (%)	4450 (100.00)	4449 (99.98)	1 (0.02)	0 (0.00)

Survey samples are also presented by product type (table 4), by fresh-cut romaine lettuce or romaine lettuce-based salad product sub-types (table 5), origin (table 6), and production practice (table 7).

Table 4 - Assessment results by product type

Product type	Number of samples tested (%)	Satisfactory	Investigative	Unsatisfactory
Whole romaine lettuce	1258 (28.3)	1258	0	0
Whole romaine lettuce hearts	1822 (40.9)	1821	1 ^b	0
Fresh-cut romaine lettuce or romaine lettuce-based salads	1370 (30.8)	1370	0	0
Total (%)	4450 (100.00)	4449 (99.98)	1 (0.02)	0 (0.00)

Table 5 - Product sub-types of fresh-cut romaine lettuce and romaine lettuce-based salads

Product sub-types of fresh-cut romaine lettuce and romaine lettuce-based salads	Number of samples tested
Fresh-cut romaine lettuce	283
Salad blend	75
Caesar salad	888
Romaine lettuce salad	74
Romaine lettuce heart salad	50
Total (%)	1370 (100.0)

The majority of the romaine lettuce samples were imported from the US (92.1%) with the remainder from Mexico (6.9%), and other countries (1%) (table 6).

^b Generic *E. coli* (290 CFU/g) found in one conventionally produced romaine heart sample imported from the US.

Table 6 - Country of origin of imported romaine lettuce samples

Country of origin	Number of samples tested (%)	Whole romaine lettuce	Whole romaine lettuce hearts	Fresh-cut romaine lettuce or romaine lettuce-based salads
Mexico	305 (6.9)	26	166	113
Spain	1 (0.02)	0	1	0
US	4102 (92.2)	1225	1655 (1 ^b)	1222
US and Mexico	41 (0.9)	6	0	35
Unknown ^c	1 (0.02)	1	0	0
Total	4450 (100.0)	1258	1822	1370

Most of the romaine lettuce samples tested in this survey were conventionally produced (81.9%) (table 7).

Table 7 - Production practice of imported romaine lettuce samples

Production practice	Number of samples tested (%)	Whole romaine lettuce	Whole romaine lettuce hearts	Fresh-cut romaine lettuce or romaine lettuce-based salads
Conventional	3645 (81.9)	1140	1178 (1 ^b)	1327
Organic	805 (18.1)	118	644	43
Total	4450 (100.0)	1258	1822	1370

What the survey results mean

The result of the current study has shown results approximating those from a previous Canadian study²⁰ on the microbial quality, and safety of leafy vegetables including imported romaine lettuce (whole and fresh-cut).

This 5-year survey was one of several collaborative actions of Canadian food safety authorities in response to the reoccurring *E. coli* O157:H7 outbreaks in the period 2017 to 2020^{12,13} to verify the safety of produce available to Canadians.

Overall, our survey results indicate that imported romaine lettuce products (whole, hearts and fresh-cut or salads) sold in Canada are generally safe for consumption. However, as with all foods, and especially those that are RTE, good hygienic practices are recommended for producers, retailers, and consumers.

^c Country of origin could not be assigned from the product label, or available sample information.

What is done with the survey results

All results are used to:

- inform risk management decisions
- support program design and re-design

The investigative sample triggered appropriate follow-up activities, as necessary.

Where to access the survey data

The data will be accessible on the [Open Government Portal](#).

References

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