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

Food Microbiology – Targeted Surveys

FINAL REPORT

Bacterial Pathogens in Cucumbers

April 1, 2014 – March 31, 2017

Canada

Summary

Cucumbers are frequently consumed by Canadians in all age groups. Unfortunately, cucumbers have been associated with several outbreaks of foodborne illnesses in recent years. Cucumbers can become contaminated by bacterial pathogens during production, harvest, post-harvest handling, processing, packaging and distribution. As cucumbers are often consumed raw, the presence of bacterial pathogens creates a potential risk for foodborne illnesses.

Considering the factors mentioned above and their relevance to Canadians whole cucumbers were selected for targeted surveys. The purpose of targeted surveys is to generate baseline information on the occurrence of pathogenic bacteria in food. Over the course of this study (April 1, 2014 – March 31, 2017), a total of 3071 samples were collected from retail locations in 11 cities across Canada and tested for bacterial pathogens of concern *(Salmonella* species (spp.)*, 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.

In this survey all (100%) of the cucumber samples analyzed were free of pathogenic bacteria tested for as *Salmonella* spp.*, Shigella and E.coli* O157:H7 were not found in any samples. Elevated levels of generic *E.coli* (100<x≤1000 Colony Forming Units (CFU)/g or Most Probable Number (MPN)/g) were found in 19 samples (0.6%) and high levels of generic *E.coli* (>1000 CFU/g or MPN/g) were found in 3 samples (<0.1%).

The Canadian Food Inspection Agency (CFIA) conducted appropriate follow-up activities such as additional sampling and facility inspections. Given the perishable nature of the products, the implicated products were no longer available on the market when the samples were declared as unsatisfactory and consequently, no product recalls were issued. In addition, it was not possible to determine the source of the generic *E. coli*, however corrective actions were implemented by the processing facilities.

Overall, our survey results suggest that almost all cucumbers are safe for consumption. They can however be found to have elevated and high levels of generic *E. coli*. Consequently, as with all foods, safe handling practices are recommended for producers, retailers and consumers.

What Are Targeted Surveys?

Targeted surveys are used by the 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?

Cucumbers are frequently consumed by Canadians in all age groups[1]. Unfortunately, cucumbers have been associated with several recalls and outbreaks of foodborne illnesses linked to *Salmonella*[2-5] and *Escherichia coli* O157:H7 (*E.coli* O157:H7)[6].

Cucumbers can become contaminated by bacterial pathogens during production, harvest, post-harvest handling, processing, packaging and distribution. Since cucumbers are often consumed raw, the presence of bacterial pathogens creates a potential risk for foodborne illnesses.

Considering the factors mentioned above and their relevance to Canadians cucumbers were selected for targeted surveys over a three fiscal year period spanning from April 1, 2014 to March 31, 2017. The purpose was to gather baseline information on the occurrence of *Salmonella* species (spp.), *Shigella, E. coli* O157:H7 and generic *E. coli* in this commodity at retail in Canada. Generic *E. coli* is an indicator of the overall sanitation conditions throughout the food production chain. This report details results from the entire survey period.

What Did We Sample?

For this survey, a sample consisted of a single unit (individual consumer-size package(s) or bulk from a single lot) with a total weight of at least 250g. 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, 2017.

A variety of domestic, imported, organic and conventional cucumbers were sampled. Samples were collected throughout the year and in a ratio of imported to domestic samples of 3:1 (2014-15) and 2:1 (2015-2016 & 2016-2017).

What Analytical Methods Were Used and How Were Samples Assessed?

Samples were analyzed using methods published in Health Canada's *Compendium of Analytical Methods for the Microbiological Analysis of Foods* [7] (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* [8].

Table 1 - Analytical Methods and Assessment Criteria for Bacteria in Cucumbers

Bacterial Analysis	Method Identification Number*	Assessment Criteria		
		Satisfactory	Investigative	Unsatisfactory
Salmonella spp.	MFHPB-20 MFLP-38 MFLP-29	Absent in 25g	Not Applicable (N/A)	Present in 25g
Shigella	MFLP-25	Absent in 25g	N/A	Present in 25g
E. coli O157:H7	MFLP-30, MFLP-80	Absent in 25g	N/A	Present in 25g
Generic *E. coli*	MFHPB-19 MFHPB-27	$\leq$ 100 CFU/g or MPN/g	100 < x $\leq$ 1000 CFU/g or MPN/g	> 1000 CFU/g or MPN/g

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

No assessment guidelines had been established in Canada for the presence of *Salmonella* spp. or *Shigella* in cucumbers 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 cucumbers 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.

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* ($100 < x \leq 1000$ Colony Forming Unit (CFU)/g or Most Probable Number (MPN)/g). 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. An unsatisfactory assessment is associated with high levels of generic *E. coli* (> 1000 CFU/g or MPN/g) as it may indicate a breakdown in Good Agricultural Practices, and therefore possibly warranting the initiation of follow-up activities such as the improvement of sanitation conditions along the food chain.

What Were The Survey Results?

Over the course of this study (April 1, 2014 to March 31, 2017), a total of 3071 samples were tested for bacterial pathogens of concern (*Salmonella* spp.*, 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.

Salmonella spp.*, Shigella and E.coli* O157:H7 were not found in any samples. Nineteen samples (0.6%) were found to have elevated levels of generic *E. coli* ($100<x\leq1000$ CFU/g or MPN/g) and three samples (<0.1%) were found to have high levels of generic *E. coli* (>1000 CFU/g or MPN/g).

Table 2 - Assessment Results of Cucumber Samples

Bacterial Analysis	Assessment Results		
	Satisfactory (% of total samples)	**Investigative (% of total samples)**	**Unsatisfactory (% of total samples)**
Salmonella spp.	3049 (99.3%)	N/A	0
Shigella		N/A	0
E. coli O157:H7		N/A	0
Generic *E. coli*		19 (0.6%)	3 (<0.1%)
Total	**3049**	**19**	**3**

Of the 3071 samples tested, 2429 (79.1%) were conventional, 642 (20.9%) were organic (Table 3).

Table 3 - Assessment Results of Cucumber Samples by Production Practice

Production Practice	**Number of Samples Tested** (% of Total Samples)	**Satisfactory**	**Investigative** Generic *E.coli* (100 < x ≤ 1000 CFU/g or MPN/g)	**Unsatisfactory** Generic *E.coli* (> 1000 CFU/g or MPN/g)
Conventional	2429 (79.1%)	2408	18	3
Organic	642 (20.9%)	641	1	0
Total	**3071**	**3049**	**19**	**3**

Of the 3071 samples tested, 951 (31%) were domestic, 2120 (69%) were imported (Table 4).

Table 4 - Assessment Results of Cucumber Samples by Country of Origin

Product Origin	**Number of Samples Tested** (% of Total Samples)	**Satisfactory**	**Investigative** Generic *E.coli* (100 < x ≤ 1000 CFU/g or MPN/g)	**Unsatisfactory** Generic *E.coli* (> 1000 CFU/g or MPN/g)
Domestic	951 (31.0%)	943	6	2
Imported	2120 (69.0%)	2106	13	1
Dominican Republic	8 (0.3%)	8	0	0
Honduras	4 (0.1%)	4	0	0
Jordan	6 (0.2%)	6	0	0
Mexico	1367 (44.5%)	1362	4	1
Netherlands	5 (0.2%)	5	0	0
Spain	167 (5.4%)	166	1	0
United States	518 (16.9%)	511	7	0
United States & Mexico	18 (0.6%)	17	1	0
Other*	5 (0.2%)	5	0	0
Unknown - Imported	22 (0.7%)	22	0	0
Total	**3071**	**3049**	**19**	**3**

*Combined countries which accounted for less than 0.1% of the total.

Domestic sampling was focused in the summer and fall (Table 5) while imported samples were taken throughout the year (Table 6).

Table 5 - Assessment Results of Domestic Cucumber Samples by Season Sampled

Season Sampled	**Number of Samples Tested (% of Samples)**	**Satisfactory**	**Investigative** Generic *E.coli* (100 < x ≤ 1000 CFU/g or MPN/g)	**Unsatisfactory** Generic *E.coli* (> 1000 CFU/g or MPN/g)
Winter (December 1 – February 28)	3 (<1%)	3	0	0
Spring (March 1 – May 31)	33 (3%)	33	0	0
Summer (June 1 – August 31)	583 (61%)	579	3	1
Fall (September 1 – November 30)	332 (35%)	328	3	1
Total	**951**	**943**	**6**	**2**

Table 6 - Assessment Results of Imported Cucumber Samples by Season Sampled

Season Sampled	Number of Samples Tested (% of Samples)	Satisfactory	Investigative Generic *E.coli* (100 < x ≤ 1000 CFU/g or MPN/g)	Unsatisfactory Generic *E.coli* (> 1000 CFU/g or MPN/g)
Winter (December 1 – February 28)	532 (25%)	531	1	0
Spring (March 1 – May 31)	494 (23%)	492	2	0
Summer (June 1 – August 31)	438 (21%)	436	2	0
Fall (September 1 – November 30)	656 (31%)	647	8	1
Total	**2120**	**2106**	**13**	**1**

What Do The Survey Results Mean?

In this survey all (100%) of the cucumber samples analyzed were free of pathogenic bacteria tested for as *Salmonella* spp.*, Shigella* and *E.coli* O157:H7 were not found in any samples. Elevated levels of generic *E.coli* (100 < x ≤ 1000 CFU/g or MPN/g) were found in 19 samples (0.6%) and high levels of generic *E.coli* (>1000 CFU/g or MPN/g) were found in 3 (<0.1%) samples.

The prevalence of *E. coli* O157:H7 (0.0%), *Salmonella* spp. (0.0%) and generic *E.coli* (elevated levels - 0.6% and high levels - <0.1%) in our survey were the same (*E. coli* O157:H7) or lower (*Salmonella* spp. and generic *E. coli*) than the prevalence observed in both a Japanese study[9] and a US study[10]. The Japanese[9] study which was conducted between 1998 to 2008, investigated the microbiological quality of cucumbers at retail and showed the following prevalence rates: *E.coli* O157:H7: 0.0% (0/1315), *Salmonella* spp. 0.2% (2/1315), and generic *E. coli*: 5.9% (78/1315). The US[10] study which started in November 2015 and anticipated to be approximately 18 months in duration, found (as of July 1, 2017) *E. coli* O157:H7 in 0.0% (0/1558) and *Salmonella* in 1.8% (28/1558) of the samples tested. The US study is investigating the microbiological quality of domestic and imported cucumbers sampled at ports of entry, packing houses, manufacturers and distributors. The varying prevalence rates between studies may be due to several reasons such as differences in sanitation practices, sampling locations, product types tested, methodology, study design etc.

No trends were observed with respect to production practice (Table 3), country origin (domestic vs. imported) (Table 4) or season sampled (Tables 5 and 6).

The Canadian Food Inspection Agency (CFIA) conducted appropriate follow-up activities such as additional sampling and facility inspections. Given the perishable nature of the products, the implicated products were no longer available on the market when the samples were declared as unsatisfactory and consequently, no product recalls were issued. In addition, it was not possible to determine the source of the generic *E. coli*, however corrective actions were implemented by the processing facilities.

Overall, our survey results suggest that almost all cucumbers are safe for consumption. They can however be found to have elevated and high levels of generic *E. coli*. Consequently, as with all foods, safe handling practices are recommended for producers, retailers and consumers.

References

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