



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Bacterial Pathogens and Indicators in Frozen Berries and Frozen-Cut Fruits and Vegetables for Smoothies - April 1, 2017 to March 31, 2020

Food microbiology - Targeted surveys - Final report



Food microbiology targeted surveys – October 2020

Canada 

Summary

Targeted surveys provide information on potential food hazards and enhance the Canadian Food Inspection Agency's (CFIA's) routine monitoring programs. These surveys provide evidence regarding the safety of the food supply, identify potential emerging hazards, and contribute new information and data to food categories where it may be limited or non-existent. They are often used by the agency to focus surveillance on potential areas of higher risk. Surveys can also help to identify trends and provide information about how industry complies with Canadian regulations.

Smoothies have become an increasingly popular beverage in recent years as consumers strive to eat healthier foods. Smoothies which generally consist of pureed fruits and vegetables are viewed by consumers as healthy, convenient alternatives to traditional meals. Consequently, the availability of pre-prepared smoothie ingredients (pre-packaged, ready-to-eat (RTE) frozen fruits and vegetables) have increased to meet consumer demand.

Unfortunately, frozen fruits and vegetables have been associated with recalls and foodborne illnesses outbreaks. There are numerous steps during their production where contamination with pathogens can occur such as during production, harvest, post-harvest handling, processing, packaging, and distribution. Since frozen RTE fruits and vegetables are expected to be consumed without cooking, the presence of bacterial pathogens creates the potential for foodborne illness.

Considering the factors mentioned above and their relevance to Canadians, pre-packaged, RTE frozen berries and frozen-cut fruits and 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, 2017 to March 31, 2020), a total of 2595 samples were collected from retail locations in 11 cities across Canada and tested for *Listeria monocytogenes* (*L. monocytogenes*), and generic *Escherichia coli* (*E. coli*). Furthermore, 1800 of the 2595 samples were also tested for *Salmonella* species (spp.), *E. coli* O157 and Aerobic Colony Count (ACC). ACC and generic *E. coli* are indicators of the overall sanitation conditions throughout the food production chain from production to the point of sale.

Salmonella spp., *E. coli* O157 and generic *E. coli* (>100 MPN/g) were not found in any samples, while *L. monocytogenes* was found in 1/2595 (0.04%) samples and ACC (>10⁴ CFU)/g was found in 61/1800 (3.39%) samples. The CFIA conducted appropriate follow-up activities. For example, in several cases, follow up inspections were conducted at the manufacturer leading to the implementation of corrective actions to remedy sanitation issues. There were no reported illnesses linked to the contaminated products.

Overall, our survey results suggest that almost all pre-packaged, RTE frozen fruits and vegetables are safe for consumption. Regardless, as this commodity is a known potential source of foodborne illness and as with all foods, safe handling practices are recommended for producers, retailers and consumers.

What are targeted surveys

Targeted surveys are used by the 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, 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 CFIA 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

Smoothies have become an increasingly popular beverage in recent years as consumers strive to eat healthier foods. According to a one year survey¹ on Canadian food exposures, fruit smoothies were cited to be consumed by 1 in 4 persons with higher consumption rates observed among persons under 20 years of age. Smoothies which generally consist of pureed fruits and vegetables are viewed by consumers as healthy, convenient alternatives to traditional meals. Consequently, the availability of pre-prepared smoothie ingredients (pre-packaged, RTE frozen berries and cut fruits and vegetables) have increased to meet consumer demand.

Unfortunately, frozen berries and frozen-cut fruits and vegetables have been associated with recalls² and foodborne illnesses outbreaks³⁻⁵. There are numerous steps in their production where contamination with pathogens can occur such as during production, harvest, post-harvest handling, processing, packaging, and distribution. Since frozen RTE fruits and vegetables are expected to be consumed without cooking, the presence of bacterial pathogens creates the potential for foodborne illness.

Considering the factors mentioned above and their relevance to Canadians, pre-packaged, RTE frozen berries and frozen-cut fruits and 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, 2017 to March 31, 2020), a total of 2595 samples were collected from retail locations in 11 cities across Canada and tested for *L. monocytogenes* and generic *E. coli*. Furthermore, 1800 of the 2595 samples were also tested for *Salmonella* spp., *E. coli* O157 and ACC. ACC and generic *E. coli* are indicators of the overall sanitation conditions throughout the food production chain from production to the point of sale.

What did we sample

For this survey, a sample consisted of a single unit (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 4 geographical areas: Atlantic (Halifax and Saint John or Moncton), Quebec (Quebec City, Montreal), Ontario (Toronto, Ottawa), and the West (Vancouver, Kelowna or Victoria, 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, 2017 and March 31, 2020. A wide variety (domestic, import, organic, conventional) of pre-packaged, RTE frozen berries and frozen-cut fruits and pre-packaged mixes of frozen-cut fruits and vegetables for use in smoothies were sampled.

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* ⁶ (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* ⁷.

No assessment guidelines had been established in Canada for the presence of *Salmonella* spp. or *E. coli* O157 in frozen fruits or 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* Section 4(1) and is therefore assessed by the CFIA as unsatisfactory.

The assessment guidelines for *L. monocytogenes* are based on Health Canada's Policy on *Listeria monocytogenes* in RTE foods and is dependent upon the sample type analysed (Category 1, 2A or 2B)⁸. Frozen fruits and vegetables (without cooking instructions) are considered to be Category 2B products (foods in which the growth of *L. monocytogenes* cannot occur throughout the stated shelf life)

Unlike harmful bacterial pathogens (such as *Salmonella* spp.), generic *E. coli* is commonly found in the intestines of animals and humans and most strains are harmless. Similarly, ACC is the total number of generally harmless bacteria that are able to grow in an oxygenated (aerobic) environment. ACC are normal components of the environment and can be found in soil and natural water sources. Both generic *E. coli* and ACC are considered to be indicator organisms and their levels present in a food product are used to assess the overall sanitation conditions throughout the food chain from production to the point of sale. Their presence at some levels is tolerated. An investigative assessment which may result in further follow-up actions is associated with elevated levels of generic *E. coli* ($10^2 < x \leq 10^3$ MPN/g) and ACC ($>10^4$ CFU/g) (table 1). An unsatisfactory assessment is associated with high levels of generic *E. coli* ($> 10^3$ 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* and/or ACC of the lot.

Table 1 - Analytical methods and assessment criteria for bacteria in frozen berries and frozen-cut fruit and vegetables for smoothies

Bacterial analysis	Method identification number ^a	Satisfactory	Investigative	Unsatisfactory
<i>L. monocytogenes</i>	MFLP-28 MFHPB-30 MFLP-74	Absent in 25g	≤ 100 CFU/g (Category 2)	> 100 CFU/g (Category 2)
<i>Salmonella</i> spp.	MFLP-49 MFHPB-20	Absent in 25g	Not Applicable (N/A)	Present in 25g
<i>E. coli</i> O157	MFLP-30 MFHPB-10	Absent in 25g	N/A	Present in 25g
ACC	MFHPB-18	≤ 10 ⁴ CFU/g	> 10 ⁴ CFU/g	N/A
Generic <i>E. coli</i>	MFHPB-19	≤ 10 ² MPN/g	10 ² < x ≤ 10 ³ MPN/g	> 10 ³ MPN/g

^a 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, 2017 to March 31, 2020), a total of 2595 samples were tested for *L. monocytogenes* and generic *E. coli*. Furthermore, 1800 of the 2595 samples were also tested for *Salmonella* spp., *E. coli* O157 and ACC. Sample assessment results can be found in table 2.

Table 2 - Assessment results of frozen berries and frozen-cut fruits and vegetables for smoothies

Bacterial analysis	Number of samples tested	Satisfactory (% total)	Investigative (% total)	Unsatisfactory (% total)
<i>L. monocytogenes</i>	2595	2533 (97.61)	1 (0.04)	0
<i>Salmonella</i> spp. ^b			N/A	0
<i>E. coli</i> O157 ^b			N/A	0
ACC ^b			61 (3.39)	N/A
Generic <i>E. coli</i>			0	0
Total	2595	2533	62	0

^bTested in 1800 samples

Salmonella spp., *E. coli* O157 and generic *E. coli* (>100 MPN/g) were not found in any samples while *L. monocytogenes* was found in 1/2595 (0.04%) sample and ACC (>10⁴ CFU/g) was found in 61/1800 (3.39%) samples. The count of *L. monocytogenes* was determined to be <5 CFU/g and therefore was assessed as investigative as per Health Canada's Policy on *Listeria monocytogenes* in RTE foods⁴.

A variety of pre-packaged, RTE frozen berry and frozen-cut fruit and vegetable product types were analysed and are detailed in table 3.

Table 3 - Assessment results by product type

Product type	Number of samples analysed (% of total samples)	Investigative <i>L. monocytogenes</i> ≤100 CFU/g	Investigative ACC >10 ⁴ CFU/g
Single fruit	1525 (58.8)	1 ^c	37
Mixed fruits	660 (25.4)	0	5
Mixed fruits and vegetables	410 (15.8)	0	19
Total	2595	1	61

^c<5 CFU/g, domestic blueberry

Further details about ACC levels of investigative samples by product type are provided in table 4.

Table 4 – ACC levels of investigative samples by product type

Investigative ACC level (CFU/g)	Single fruit	Mixed fruits	Mixed fruits and vegetables
10 ⁴ < x ≤ 10 ⁵	19	1	10
10 ⁵ < x ≤ 10 ⁶	12	3	4
> 10 ⁶	6	1	5
Total	37	5	19

Sample assessment results by product origin can be found in table 5.

Of the 2595 samples tested, 62.5% (1623/2595) were imported, 12.4% (323/2595) were domestic, 5.6% (146/2595) were a mix of domestic and imported produce and 19.4% (503/2595) were of unknown origin.

Table 5 - Assessment results by product origin

Product origin	Satisfactory	Investigative	Total (%)
Domestic	317	6	323 (12.4)
Domestic and Import	145	1	146 (5.6)
Import	1584	39	1623 (62.5)
Unknown	487	16	503 (19.4)
Total (%)	2533 (97.6)	62 (2.4)	2595 (100)

Further details about ACC levels of investigative samples by product origin are provided in table 6.

Table 6 – ACC levels of investigative samples by product origin

Investigative ACC level (CFU/g)	Domestic	Import	Domestic and Import	Unknown
$10^4 < x \leq 10^5$	4	18	0	8
$10^5 < x \leq 10^6$	1	12	1	5
$> 10^6$	0	9	0	3
Total	5	39	1	16

What do the survey results mean

In this survey, 97.6% of the pre-packaged, RTE frozen berry and cut fruit and vegetable samples analyzed were assessed as satisfactory. *Salmonella* spp., *E. coli* O157 and generic *E. coli* (>100 MPN/g) were not found in any samples. *L. monocytogenes* was found in one (0.04%) sample and ACC (>10⁴ CFU/g) was found in 61 (2.35%) samples.

The prevalence of *Salmonella* spp. (0.0%) and *L. monocytogenes* (0.04%) found in our survey were lower when compared to a Czech study⁹ conducted in 2014 which investigated the presence of *L. monocytogenes* and *Salmonella* spp. in retail pre-packaged (n=55) and bulk frozen vegetables (n=11) and frozen fruits (n=9). The Czech study did not detect *Salmonella* spp. in any of the pre-packaged frozen fruit or vegetable samples. *L. monocytogenes* was not detected in any of the fruit samples, however it was detected in 9/55 (16.4%) and 4/11 (36.4%) of the pre-packaged and bulk frozen vegetable samples respectively. A 2017-2018 study conducted in Spain¹⁰ on frozen retail strawberries (n=31) found similar and lower results compared to our study as no *Salmonella* spp. or generic *E. coli* were found in any of the samples, however *L. monocytogenes* was also not detected and the levels of total aerobic mesophilic microorganisms ranged from <1.70 (detection limit) – 2.76 log₁₀ CFU/g (mean 1.82 log₁₀ CFU/g). The differences observed between studies may be due to various reasons such as differences in product types tested, methodology, study design etc.

Trends were not observed with respect to the contaminated samples when comparing product origin, however it was noted that a disproportionately high percentage of the mixed fruit and vegetable samples were contaminated. This may be due to the more complex nature of the final product (sample composed of a variety of fruits and vegetables) with most of the samples being composed of ingredients from multiple countries.

The CFIA conducted appropriate follow-up activities. For example, in several cases, follow up inspections were conducted at the manufacturer leading to the implementation of corrective actions by the manufacturer to remedy sanitation issues. There were no reported illnesses linked to the contaminated products.

Overall, our survey results suggest that almost all pre-packaged, frozen berries and frozen-cut fruits and vegetables are safe for consumption. Regardless, these commodities are a known

potential source of foodborne illness and as such, safe handling practices are recommended for producers, retailers and consumers.

References

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