



Canadian Food  
Inspection Agency

Agence canadienne  
d'inspection des aliments

# Bacterial Pathogens and Indicators in Oats - April 1, 2018 to March 31, 2020

## Food microbiology - Targeted surveys - Final report





## 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.

Many Canadians consume oats as part of their regular diet in various foods such as oatmeal, granola, cereal, bread, and cookies. The availability of oat products on the market in Canada has increased in recent years because of their nutritional value and related health benefits such as the lowering of blood cholesterol levels when consumed regularly.

Oats have traditionally been consumed around the world as ingredients in foods that involve a cooking or baking step (heat treatment) such as porridges and cookies. In recent years however there has been an increase in popularity of "overnight oatmeal", in which oats are soaked in liquid (such as water or milk) overnight in the refrigerator and consumed the following day without further preparation. While oats do undergo a heat treatment step during processing the presence of pathogenic bacteria in the final product remains a possibility if the heat treatment step did not kill all of the pathogens or if contamination occurred after the heat treatment step. Therefore when oats are eaten by consumers without being subject to a heat treatment step (cooking, baking) as is the case with "overnight oatmeal", the presence of bacterial pathogens creates the potential for foodborne illness.

Considering the factors mentioned above and their relevance to Canadians, oats were selected for a targeted survey. The purpose of this survey was to generate baseline information on the occurrence of pathogenic bacteria and indicator organisms of concern in oats on the Canadian market.

Over the course of this study (April 1, 2018 to March 31, 2020), a total of 318 samples of a variety of oats were collected from retail locations in 11 cities across Canada. All samples were tested for *Salmonella* species (spp.), *Escherichia coli* (*E. coli*) O157, and *Bacillus cereus* (*B. cereus*). Of the 318 samples, 120 samples were tested for *Clostridium perfringens* (*C. perfringens*), *Staphylococcus aureus* (*S. aureus*) and generic *E. coli* and 198 samples were tested for total coliforms and Aerobic Colony Count (ACC). Generic *E. coli*, total coliforms and ACC are considered indicator organisms as their presence in food at elevated levels may be an indicator of poor sanitary conditions in the food production chain.



In this study, all samples tested were found to be free of *Salmonella* spp., *E. coli* O157, *B. cereus* (>10<sup>4</sup> CFU/g), *C. perfringens* (>10<sup>4</sup> CFU/g), *S. aureus* (>10<sup>4</sup> CFU/g), generic *E. coli* (>10<sup>2</sup> MPN/g), total coliforms (>10<sup>4</sup> CFU/g) and ACC (>10<sup>6</sup> CFU/g).

Overall, our survey results show that oats available for sale at retail in Canada have been produced under sanitary conditions and are safe for consumption. However, as with all foods, and especially those that are consumed without cooking, 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. 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

Many Canadians consume oats as part of their regular diet in various foods<sup>1</sup> such as oatmeal, granola, cereal, bread, and cookies. The availability of oat products on the market in Canada has increased in recent years because of their nutritional value and related health benefits such as the lowering of blood cholesterol levels when consumed regularly<sup>2,3</sup>.

Oats are a whole cereal grain grown for their edible seeds and in 2018 Canada produced 15% of the global total (over 3.4 million tons) of oats<sup>4</sup>. After harvesting, oats undergo a milling process to screen out any unwanted materials and remove the indigestible hulls leaving the kernel known as an oat groat. The oat groats are then subject to a steam and extended heat treatment step known as kilning. The kilning process gives the oat groats a nutty flavour and increases their quality by inactivating spoilage enzymes and increases their shelf-life and safety by inactivating potentially harmful bacteria, yeasts and moulds. Oat groats can be consumed whole or can be further processed into various forms. For example, whole oat groats can be cut into steel-cut oats or further steamed and then rolled into other oat varieties such as rolled, quick, or instant oats.



Oats have traditionally been consumed around the world as ingredients in foods that involve a cooking or baking step (heat treatment) such as porridges and cookies. In recent years however there has been an increase in popularity of “overnight oatmeal”, in which oats are soaked in liquid (such as water or milk) overnight in the refrigerator and consumed the following day without further preparation. While oats do undergo a heat treatment step during processing the presence of pathogenic bacteria in the final product remains a possibility if the heat treatment step did not kill all of the pathogens or if contamination occurred after the heat treatment step. Therefore when oats are eaten by consumers without being subject to a heat treatment step (cooking, baking) as is the case with “overnight oatmeal”, the presence of bacterial pathogens creates the potential for foodborne illness.

Considering the factors mentioned above and their relevance to Canadians, oats were selected for a targeted survey. The purpose of this survey was to generate baseline information on the occurrence of pathogenic bacteria and indicator organisms of concern in oats on the Canadian market.

Over the course of this study (April 1, 2018 to March 31, 2020), a total of 318 samples of a variety of oats were collected from retail locations in 11 cities across Canada. All samples were tested for *Salmonella* spp., *E. coli* O157, and *B. cereus*. Of the 318 samples, 120 samples were tested for *C. perfringens*, *S. aureus* and generic *E. coli* and 198 samples were tested for total coliforms and ACC. Generic *E. coli*, total coliforms and ACC are considered indicator organisms as their presence in food at elevated levels may be an indicator of poor sanitary conditions in the food production chain.

## What did we sample

A sample consisted of a single or multiple unit(s) (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. The number of samples collected from these cities was in proportion to the relative population of the respective areas. These cities encompassed 4 geographical areas:

- Atlantic (Halifax and Moncton)
- Quebec (Quebec City and Montreal)
- Ontario (Toronto and Ottawa)
- West (Vancouver, Victoria, Calgary, Saskatoon and Winnipeg)

For this study, 318 samples of oats were collected between April 1, 2018 and March 31, 2020. Various types of oats were collected including steel-cut, rolled, instant and quick oats. Samples included organic and conventional oats of both domestic and imported origin. As oats have a long shelf life (6 months to 24 months), only a small number of samples were collected in each survey year in an attempt to avoid repeatedly sampling products from the same lot.





# 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*<sup>5</sup> (table 1).

**Table 1 - Analytical methods and assessment criteria for bacteria in oats**

Bacterial analysis	Method number <sup>a</sup>	Satisfactory	Investigative	Unsatisfactory
<i>Salmonella</i> spp.	MFHPB-20	Not detected/25g	Not applicable (N/A)	Detected/25g
<i>E. coli</i> O157	MFHPB-10	Not detected/25g	N/A	Detected/25g
<i>B. cereus</i>	MFLP-42	≤10 <sup>4</sup> CFU/g	>10 <sup>4</sup> CFU/g	N/A
<i>S. aureus</i>	MFHPB-21	≤10 <sup>4</sup> CFU/g	>10 <sup>4</sup> CFU/g	N/A
<i>C. perfringens</i>	MFHPB-23	≤10 <sup>4</sup> CFU/g	>10 <sup>4</sup> CFU/g	N/A
Total coliforms	MFHPB-34	≤10 <sup>4</sup> CFU/g	>10 <sup>4</sup> CFU/g	N/A
Generic <i>E. coli</i>	MFHPB-19	≤10 <sup>2</sup> MPN/g	>10 <sup>2</sup> MPN/g	N/A
ACC	MFHPB-18	≤10 <sup>6</sup> CFU/g	>10 <sup>6</sup> CFU/g	N/A

<sup>a</sup>The methods used were the published versions at the time of analysis.

At the time of writing this report, no assessment guidelines had been established in Canada for the presence of indicator organisms or pathogenic bacteria in oats. As *Salmonella* spp. and *E. coli* O157 are considered pathogenic to humans their presence was considered to be a violation of the *Food and Drugs Act* Section 4(1)a<sup>6</sup> and therefore in the absence of assessment guidelines were assessed by the CFIA as unsatisfactory (table 1).

*B. cereus*, *S. aureus* and *C. perfringens* are commonly found in the environment and are bacteria that at elevated levels (> 10<sup>4</sup> CFU/g), can produce toxins capable of causing foodborne illness. Therefore, an investigative assessment which may result in further follow-up actions is associated with elevated levels (> 10<sup>4</sup> CFU/g) of these bacteria. As the results are based on the analysis of 1 unit (n=1), further sampling might be required to verify the levels of the bacteria of the lot. The *B. cereus* method used in this survey is unable to discriminate *B. cereus* from other closely related organisms and therefore results are considered presumptive for *B. cereus*.

Unlike harmful bacterial pathogens (such as *Salmonella*), generic *E. coli* is commonly found in the intestines of animals and humans and most strains are harmless. Total coliforms are a group of bacteria commonly found in the soil, water and 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. Generic *E. coli*, total coliforms 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 is



associated with elevated levels of generic *E. coli* (>10<sup>2</sup> MPN/g), total coliforms (>10<sup>4</sup> CFU/g) and ACC (>10<sup>6</sup> CFU/g) (table 1), and may result in further follow-up actions. As the results are based on the analysis of 1 unit (n=1), further sampling may be required to verify their levels in the lot.

## What were the survey results

In this study, all 318 samples were assessed as satisfactory. All samples were tested for *Salmonella* spp., *E. coli* O157 and *B. cereus*. Of the 318 samples, 120 were tested for *S. aureus*, *C. perfringens* and generic *E. coli*. The other 198 samples were tested for total coliforms and ACC.

*Salmonella* spp., *E. coli* O157, generic *E. coli* (>10<sup>2</sup> MPN/g), total coliforms (>10<sup>4</sup> CFU/g), ACC (>10<sup>6</sup> CFU/g), *B. cereus* (>10<sup>4</sup> CFU/g), *C. perfringens* (>10<sup>4</sup> CFU/g) and *S. aureus* (>10<sup>4</sup> CFU/g) were not found in any of the samples tested.

Sample assessment results can be found in table 2.

**Table 2 – Assessment results of oat samples**

Bacterial analyses	Number of samples tested	Satisfactory
<i>Salmonella</i> spp.	318	318
<i>E. coli</i> O157		
<i>B. cereus</i>		
<i>S. aureus</i> <sup>b</sup>		
<i>C. perfringens</i> <sup>b</sup>		
Generic <i>E. coli</i> <sup>b</sup>		
ACC <sup>c</sup>		
Total coliforms <sup>c</sup>		
Total	318	318

<sup>b</sup> Tested in 120 samples.

<sup>c</sup> Tested in 198 samples.

Samples of oats tested included domestic and imported and organic and conventional types (table 3). Of the 318 samples tested, 195 (61.3%) were domestic, 104 (32.7%) were imported and 19 (6.0%) were of unknown origin (table 3). 214 samples (67.3%) were conventional and 104 samples (32.7%) were organic (table 3).

**Table 3 – Number of oat samples tested by product origin and production practice**

Origin	Conventional	Organic	Total (%)
Canada	143	52	195 (61.3)
Import	66	38	104 (32.7)
Unknown	5	14	19 (6.0)
Total (%)	214 (67.3)	104 (32.7)	318 (100)



A variety of type of oats were collected including steel-cut, rolled, instant and quick oats (table 4).

**Table 4 – Number of oat samples tested by product type**

Product type	Number of samples tested (%)
Steel Cut Oats	103 (32.4)
Quick Oats	101 (31.8)
Rolled Oats	92 (28.9)
Instant Oats	22 (6.9)
Total (%)	318 (100)

## What do the survey results mean

In this survey, *Salmonella* spp., *E. coli* O157, generic *E. coli* (>10<sup>2</sup> MPN/g), total coliforms (>10<sup>4</sup> CFU/g), ACC (>10<sup>6</sup> CFU/g), *B. cereus* (>10<sup>4</sup> CFU/g), *C. perfringens* (>10<sup>4</sup> CFU/g) and *S. aureus* (>10<sup>4</sup> CFU/g) were not found in any of the samples tested.

We are unable to compare our study results with others, as no previously published studies on the microbiological quality and safety of oats were found at the time of writing this report. However, studies have shown that the heat treatment oats receive during the kilning process<sup>7</sup> to increase the quality and shelf-life of the oat groats, also serves to increase their food safety by inactivating potential food-borne illness causing bacteria<sup>8</sup> in the finished product. As all 318 samples tested in our study did not contain bacterial pathogens or indicator organisms at elevated levels, the heat treatment received by the oat samples during production may indeed have contributed to our survey findings.

Overall, our survey results show that oats available for sale at retail in Canada have been produced under sanitary conditions and are safe for consumption. However, as with all foods, and especially those that are consumed without further cooking, safe handling practices are recommended for producers, retailers and consumers.



## References

1. Public Health Agency of Canada, [\*Foodbook Report\*](#). 2015.
2. Health Canada, Bureau of Nutritional Sciences, Food Directorate, Health Products and Food Branch, [\*Oat Products and Blood Cholesterol Lowering. Summary of Assessment of a Health Claim about Oat Products and Blood Cholesterol Lowering\*](#). 2010.
3. Whitehead, A., et al., [\*Cholesterol-lowering effects of oat  \$\beta\$ -glucan: a meta-analysis of randomized controlled trials\*](#). *The American Journal of Clinical Nutrition*, 100(6): 1413-1421. 2014.
4. Statistics Canada, [\*Food available in Canada\*](#). 2019.
5. Health Canada, [\*Compendium of Analytical Methods\*](#). 2011.
6. Department of Justice Canada, [\*Food and Drugs Act\*](#). 2014.
7. Decker, E. A., et al., [\*Processing of oats and the impact of processing operations on nutrition and health benefits\*](#). *British Journal of Nutrition*, 112(S2): S58-S64. 2014
8. Zwer, P., [\*7 - Oats: characteristics and quality requirements\*](#). C. W. Wrigley and I. L. Batey, *Cereal Grains*. Woodhead Publishing: 163-182. 2010.