Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2012/13 Targeted Surveys

Targeted Survey Investigating *Salmonella, Shigella* and Generic *E. coli* in Cantaloupes

RDIMS # 5939059

Canada

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Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and strengthen Canada's food safety system in order to better protect Canadians from unsafe food and ultimately reduce the occurrence of foodborne illness.

Cantaloupes have been associated with numerous outbreaks of foodborne illness worldwide. In recent years, increased surveillance activities have also triggered several non-outbreak associated recalls of cantaloupes in the United States (U.S.) and Canada. The Food and Agriculture Organization of the United Nations/World Health Organization (FAO/WHO) has ranked melons, including cantaloupes, as the second highest priority group of concern in terms of microbiological hazards among fresh fruits and vegetables. Cantaloupes can become contaminated with pathogens during production, harvest, post-harvest handling, processing and distribution. Once contaminated, the bacteria can be difficult to remove because the rough netted surface of the melon provides areas for bacteria to attach and be protected from sanitization. As cantaloupes are consumed raw, the presence of pathogens creates a potential risk for foodborne illnesses. The bacterial pathogen *Salmonella* is the most commonly identified pathogen in cantaloupe-associated outbreaks of foodborne illness.

Considering the factors mentioned above and their relevance to Canadians, cantaloupes have been selected as one of the priority commodity groups of fresh fruits and vegetables for enhanced surveillance under the FSAP. Over the course of a five-year baseline study (2008/09 to 2012/13), approximately 3,500 cantaloupe samples were collected from Canadian retail locations and tested for bacterial pathogens of concern.

The main objective of this targeted survey (2012/13) was to generate baseline surveillance data on the presence and distribution of bacterial pathogens *Salmonella* and *Shigella,* as well as on generic *Escherichia coli (E. coli,* an indicator of fecal contamination) in cantaloupes. A total of 867 cantaloupe samples, including 715 imported and 152 domestically produced whole cantaloupes were analyzed. *Salmonella* and *Shigella* were not detected in any of the samples, and levels of generic *E. coli* were found to be acceptable in all samples. All samples (100%) were assessed as satisfactory. These results suggest that the cantaloupes in the Canadian market sampled during this survey were produced under Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs).

The Canadian Food Inspection Agency (CFIA) regulates and provides oversight to the industry, works with provinces and territories, and promotes safe handling of foods throughout the food production chain. However, it is important to note that the food industry and retail sectors in Canada are ultimately 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. In addition, general advice for the consumer on the safe handling of foods is widely available. The CFIA will continue its surveillance activities and inform stakeholders of its findings.

1 Introduction

1.1 Food Safety Action Plan

In 2007, the Canadian government launched a five-year initiative in response to a growing number of product recalls and concerns about food safety. This initiative, called the Food and Consumer Safety Action Plan (FCSAP) [1], aims to modernize and strengthen Canada's safety system for food, health and consumer products. The FCSAP initiative unites multiple partners in ensuring safe food for Canadians.

The Canadian Food Inspection Agency's (CFIA) Food Safety Action Plan (FSAP) [2] is one element of the government's broader FCSAP initiative. The goal of the FSAP is to identify risks in the food supply, limit the possibility of occurrence of these risks, improve import and domestic food controls, and identify food importers and manufacturers.

Within the FSAP, there are 12 main areas of activity, one of which is risk mapping and baseline surveillance. The main objective of this area is to better identify, assess and prioritize potential food safety hazards through risk mapping, information gathering and analysis of foods in the Canadian marketplace. Targeted surveys are one tool used to test for the presence and level of particular hazards in specific foods.

1.2 Targeted Surveys

Targeted surveys are used to gather information regarding the potential occurrence of hazards in food commodities. The microbiological targeted surveys aim to establish baseline data on priority and/or emerging microbiological hazards in targeted commodities, primarily fresh fruits and vegetables and imported food ingredients. A statistically significant number of samples were collected over five years to allow for seasonal and/or production variations. This work differs from regular CFIA microbiological monitoring activities which test samples of a broad range of commodities for multiple hazards to determine the compliance of defined lots with established microbial standards or guidelines for regulatory purposes.

To identify food-hazard combinations of greatest potential health risk for the targeted surveys, the CFIA uses a combination of scientific literature, documented outbreaks of foodborne illness, and/or information gathered from the Food Safety Science Committee (FSSC), a group of Canadian federal, provincial and territorial subject matter experts in the area of food safety [3].

This targeted survey (2012/13) represents part of the collection of over 3,500 cantaloupe samples over five years (2008/09 – 2012/13), and was designed to gather baseline

information on the occurrence of bacterial pathogens of concern in cantaloupes available to Canadians at retail.

1.3 Codes of Practice, Acts, and Regulations

International food safety standards, codes of practice, and guidelines relating to food, food production and food safety are developed under the joint Food and Agriculture Organization of the United Nations/World Health Organization (FAO/WHO) Codex Alimentarius Commission. Producers of fresh fruits and vegetables are encouraged to follow these international codes of practice. Of relevance for this survey are the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RCP 53-2003) [4] and the *Recommended International Code of Practice - General Principles of Food Hygiene* (CAC/RCP 1-1969, Rev. 4-2003) [5]. These codes address Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) which, when applied, control and reduce the potential for contamination with microbial, chemical, and physical hazards at all stages of the production of fresh fruits and vegetables from primary production to packaging.

Fresh fruits and vegetables available in the Canadian market must comply with the *Food and Drugs Act* (FDA) [6] and the *Food and Drug Regulations* (FDR) [7], which prescribe certain restrictions on the production, importation, sale, composition and content of foods and food products. Section 4(1)a of the FDA prohibits the sale of food contaminated with foodborne pathogens, while sections 4(1)e and 7 prohibit the sale of unsafe food and food produced under unsanitary conditions.

Fresh fruits and vegetables sold in Canada must also comply with the safety requirements of the *Fresh Fruit and Vegetable Regulations* [8] under the *Canada Agricultural Products Act* [9]. These regulations are intended to ensure that fresh fruits and vegetables sold to consumers are safe, wholesome and properly graded, packaged and labelled.

The *Fresh Fruit and Vegetable Regulations*, and the food-related portions of the FDA and FDR are enforced by the CFIA.

The FSAP targeted surveys are primarily conducted for surveillance and not for regulatory compliance purposes. However, results indicating a potential risk to public health for any samples tested under this survey will trigger food safety investigations, including activities such as follow-up sampling, inspections of facilities, and consultations with Health Canada for health risk assessments. Depending on the findings, a recall of the affected product may be warranted.

2 Survey on Cantaloupes

2.1 Rationale

Cantaloupes and other melons have been reported to be responsible for numerous outbreaks of foodborne illness worldwide [10]. From 1998 to March 2013, there were 15 documented outbreaks associated with cantaloupes contaminated with bacterial pathogens (Appendix B). Increased surveillance activities in the U.S. [11] and Canada [12] have triggered several non-outbreak associated recalls between 2008 and March 2013 (Appendix C). *Salmonella* is the most commonly identified pathogen in cantaloupe-associated outbreaks of foodborne illness and in recalled cantaloupes in the U.S. and Canada in recent years. *Shigella* has not been found in any cantaloupes associated with foodborne illness outbreaks, but has been detected in cantaloupes sampled in the US FDA surveys of imported and domestic fresh produce in 1999/2000 [13,14].

Cantaloupes can become contaminated with pathogens during production, harvest, post-harvest handling, processing and distribution. Since cantaloupes sit on top of the soil, they can easily be contaminated with pathogens from the soil through the use of improperly composted manure, contaminated irrigation water, or wildlife feces. Post-harvest handling can also bring cantaloupes into direct contact with pathogens through contaminated processing water or poor hygienic practices of workers handling the cantaloupes [15,16]. Once contaminated, the bacteria can be difficult to remove due to the rough surface of the melon which provides areas for bacterial attachment and protection from sanitization [16, 17].

Melons, including cantaloupes, were identified as the second highest priority group of concern in terms of microbiological hazards among fresh fruits and vegetables during a joint FAO/WHO Experts Meeting in 2007 [18], based on multiple factors, such as historical outbreaks and the potential for contamination.

Based on the above information and the Food Safety Science Committee's recommendations [3], cantaloupes have been selected for targeted surveillance under FSAP. The overall objective is to gather baseline information on the occurrence of bacterial pathogens of concern in cantaloupes available to Canadians at retail. This targeted survey (2012/13) is part of the information collection with a focus on investigating the presence of bacterial pathogens *Salmonella* and *Shigella*, and the presence and levels of generic *Escherichia coli* (*E. coli*) in imported and domestically produced whole cantaloupes.

2.2 Targeted Microorganisms

2.2.1 Bacterial Pathogens of Concern

Salmonella normally live in the intestines of animals such as poultry, swine, wild birds, domestic pets and reptiles. Therefore, *Salmonella* contamination often occurs in food of animal origin (e.g., poultry, eggs, and meat). However, in the last decade, foodborne illnesses of salmonellosis have been increasingly reported to be associated with the consumption of contaminated fruits and vegetables [19]. Cantaloupe associated outbreaks of salmonellosis were found mainly resulting from melon contamination with *Salmonella* in the field and/or post-harvest handling [10].

Humans are the only host of the bacterial pathogen *Shigella*. Food contaminated by infected food handlers with poor personal hygiene, and water contaminated with human feces are the most common causes of shigellosis. Shigellosis illnesses have been known to be associated with consumption of contaminated fruits, vegetables, shellfish and chicken [20].

2.2.2 Generic *E. coli* as an Indicator of Fecal Contamination

Typically, *E. coli* bacteria that inhabit the large intestines of humans and animals are harmless. Due to their regular presence in stools of humans and animals, the occurrence of *E. coli* in foods indicates direct or indirect contamination with fecal matter [20]. The presence of generic *E. coli* in foods can also indicate potential contamination with pathogenic enteric microorganisms, such as *Salmonella*, that also live in the intestines of infectious humans and animals. It is important to note that the presence of generic *E. coli* in food only implies an increased risk of contamination with pathogenic microorganisms but does not conclusively indicate that these pathogenic organisms are present. High levels of generic *E. coli* in fresh produce sold at retail is an indication that contamination has occurred at some point between production and the time of sale.

2.3 Sample Collection

All samples were collected from national chain and local/regional grocery stores, and other conventional retail located in various cities across Canada. The number of samples collected in the various regions was based on the relative proportion of the population in the respective regions. Samples were collected during the 2012/13 fiscal year (April 1, 2012 to March 31, 2013). Domestic samples were collected during the summer months (May - October). Imported samples were collected primarily in the fall, winter, and spring months.

In this survey, a sample consisted of two whole cantaloupes from a single lot. This sampling approach has been used in many retail food surveys and is also used by other

federal partners such as the Public Health Agency of Canada (PHAC) under the FoodNet retail surveillance [21].

Collected samples were required to be shipped under conditions that limited the growth of microorganisms during transit. If issues or questions arose about the conditions in which the sample was shipped, the sample was declared unfit for analysis.

2.4 Sample Distribution

A total of 867 cantaloupe samples were collected, including 715 (82.5%) imported and 152 (17.5%) domestically produced whole cantaloupes. The imported cantaloupe samples originated from the U.S. (36.4%), Guatemala (34.6%), Honduras (15.5%), Costa Rica (9.1%), Mexico (2.1%) and unknown countries (2.4%). The domestic whole cantaloupe samples were obtained from several provinces across Canada.

2.5 Method Details

All samples were analyzed using the analytical methods published in Health Canada's *Compendium of Analytical Methods* for the Microbiological Analysis of Foods [22] (Appendix D). These methods are used for regulatory testing by the CFIA and are fully validated for the analysis of fresh fruits and vegetables, including cantaloupes.

For the detection of *Salmonella* and *Shigella*, samples were analyzed by cultural presence/absence methods. The laboratories had the option of using polymerase chain reaction (PCR)-based screening methods to first screen enrichment broth for the presence of genetic material from the pathogens of interest, followed by cultural confirmation of presumptive positives.

If *Salmonella* or *Shigella* was detected, the isolate would be further characterised by pulsed field gel electrophoresis (PFGE) (i.e., DNA fingerprint) at the CFIA's PFGE Centre and serotyped at either the *Salmonella* Typing Laboratory, Laboratory for Foodborne Zoonoses, PHAC (for *Salmonella*) or the Identification and Serotyping Unit of the Enteric Diseases Program of the National Microbiology Laboratory, PHAC (for *Shigella*).

Enumeration of generic *E. coli* was performed using Petrifilm *E. coli* plates. Briefly, the entire melon was placed into a stomacher bag submerged in buffered peptone broth and a portion of the resulting melon rinsate was used as the sample for enumeration of *E. coli* as described in Appendix D.

2.6 Assessment Guidelines

The assessment criteria used in this survey (Table 1 & Table 2) are based on principles of the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods* [23] and associated methods published in Health Canada's *Compendium of Analytical Methods* [22].

Table 1 Assessment Guidelines for *Salmonella* and *Shigella* spp. in Cantaloupes

Bacterial Analysis*	**Assessment Criteria**	
(Method Identification Number)	**Satisfactory**	**Unsatisfactory**
Salmonella* spp.*	Absent	Present
(MFLP-29 and MFHPB-20)	(whole melon)	(whole melon)
Shigella* spp.*	Absent	Present
(MFLP-26 and MFLP-25)	(whole melon)	(whole melon)

* *Compendium of Analytical Methods* [22].

**No criteria have been established by Health Canada at this time for these bacterial pathogens in fresh fruits and vegetables. However, in the absence of a specified criteria, the presence in foods is considered to be a violation of FDA Section 4(1)a and is therefore assessed by the CFIA as unsatisfactory.

Table 2 Assessment Guidelines for Generic *E. coli* in Cantaloupes

Bacterial Analysis*	**Assessment Criteria**		
(Method Identification Number)	**Satisfactory**	**Investigative**	**Unsatisfactory**
Generic *E. coli*	≤ 100	$100 < x \leq 1000$	> 1000
(MFHPB-34)	CFU/mL of rinsate	CFU/ mL of rinsate	CFU/ mL of rinsate

* *Compendium of Analytical Methods* [22].

Unsatisfactory sample assessments are subject to follow-up actions, such as directed follow-up sampling, inspection of establishment, health risk assessment, and/or product action (e.g., product recall).

Investigative sample assessment might require some form of follow-up activities, for example, further sampling to verify the levels of generic *E. coli* in the samples in question.

2.7 Limitations

Samples tested during this survey were collected at retail locations across Canada, as opposed to monitoring samples that are picked up at distribution points and warehouses. As such, products sampled at retail could be mixed and originate from different shipments and/or suppliers. Though this represents what the Canadian consumer experiences, this imposes certain limitations with respect to the traceability of the products and the identification of the source of contamination in the case of positive results.

Results obtained for a targeted survey sample are from the analysis of a single sample unit. This sampling and testing strategy generally precludes the extrapolation of the laboratory result to the whole production lot as it is not statistically representative. This imposes certain limitations in the interpretation of the results to the specific lot in the absence of additional information.

Finally, given the seasonality, as well as the varying channels of commerce, the source of the products can change dramatically from one season to the next. As such, there is an insufficient number of samples in this survey to carry out a detailed analysis of the results based on country of origin. In cases of positive results, unsatisfactory rates between countries are not considered to be statistically comparable.

3 Results

A total of 867 cantaloupe samples were analyzed for *Salmonella, Shigella* and generic *E. coli* (Table 3). *Salmonella* and S*higella* were not detected in any of the samples. Levels of generic *E. coli* were acceptable in all the samples. All samples were assessed as satisfactory.

Table 3 Summary of Results of Cantaloupe Samples

Product Origin	Number of Samples	Assessment			
		Unsatisfactory		Satisfactory	
		Number of Samples	Percentage of Samples	Number of Samples	Percentage of Samples
Imported	715	0	0	715	100
Domestic	152	0	0	152	100
Total	**867**	**0**	**0**	**867**	**100**

4 Discussion and Conclusion

In the 2012/13 survey, a total of 867 cantaloupe samples were analysed for *Salmonella, Shigella* and generic *E. coli*. All samples were assessed as satisfactory.

The overall finding of this survey suggests that the cantaloupes in the Canadian market sampled during the survey were produced and handled under acceptable GAPs and GMPs.

Cantaloupes have been reported to be responsible for several salmonellosis outbreaks of foodborne illnesses. Food safety authorities have kept cantaloupes as one of the targeted commodities for enhanced surveillance in the U.S. and Canada. Surveys conducted by the US FDA on bacterial pathogens in fresh produce in 1999/2000 identified that 2.4% (4 in 164 samples) of the domestic and 5.3% (8 in 151 samples) of the imported whole cantaloupes were contaminated with *Salmonella* [13-14]. More recent surveys (2005 to 2009) from the U.S. Department of Agriculture (USDA) Microbiological Data Program on fresh produce found that *Salmonella* contaminated cantaloupes were in 0.04% - 0.25% of the tested cantaloupe samples (1,000 ~ 2,000 cantaloupe samples per year) [24]. Similar to the results from the USDA surveys, results from the CFIA's targeted surveys indicate that cantaloupes contaminated with *Salmonella* were found in 0 – 0.8% of the analyzed samples during the 2008/09 - 2012/13 surveys. These surveys' results suggest that contamination of cantaloupes with *Salmonella* could sporadically occur.

While the food industry and retail sectors are ultimately responsible for the food they produce and sell in Canada, and individual consumers are responsible for the safe handling of the food they have in their possession, the CFIA regulates the food industry, provides oversight and promotes safe handling of foods throughout the food production chain. The CFIA will continue its surveillance and inform stakeholders of its findings.

5 Acknowledgement

We would like to express our sincere thanks to Judy D. Greig, Public Health Agency of Canada for providing information on outbreaks (Appendix B).

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Appendix A: List of Acronyms

CDC: Centres for Disease Control and Prevention

CFIA: Canadian Food Inspection Agency

CFU: colony forming unit

E. coli: *Escherichia coli*

FAO: Food and Agriculture Organization of the United Nations

FDA: *Food and Drugs Act*

FDR: *Food and Drug Regulations*

FCSAP: Food and Consumer Safety Action Plan

FSAP: Food Safety Action Plan

GAPs: Good Agricultural Practices

GMPs: Good Manufacturing Practices

HC: Health Canada

MPN: Most Probable Number

PCR: Polymerase Chain Reaction

PHAC: Public Health Agency of Canada

***Salmonella* spp.**: *Salmonella* species

US FDA: the United States Food and Drug Administration

USDA: United States Department of Agriculture

WHO: World Health Organization

°C: Degree Celsius

g: gram

Appendix B: Global Foodborne Disease Outbreaks Associated with Cantaloupes Contaminated with Bacterial Pathogens (1998 – March 2013)

Year	Country	Province/State	Microorganism	Vehicle	Number of Cases	Number of People Hospitalized (deaths)	Source
1998	Canada	Ontario	*Salmonella* Oranienburg	Cantaloupe	20		Can Commun Dis Rep. 1998 Nov 15;24:177-8; discussion 178-9)
2000	United States	Multiple	*Salmonella* Poona	Cantaloupe	47	9	MMWR 2002 Nov 22;51(35):1044-1047
2001	United States	California	*Salmonella* Poona	Cantaloupe	27		CDC
2001	United States	Multiple	*Salmonella* Poona	Cantaloupe	50	9	MMWR Nov 22, 2002;51(35);1044-1047
2002	United States and Canada	Multiple	*Salmonella* Poona	Cantaloupe	58	10	MMWR Nov 22, 2002;51(35);1044-1047
2002	United States	Washington State	*Salmonella* Berta	Cantaloupe	29		CDC
2004	United States	Montana	*Escherichia coli* 0157:H7	Cantaloupe	6	0	Yellowstone City-County Health Department & ProMed
2006	Australia	New South Wales	*Salmonella* Saintpaul	Cantaloupe	100		ProMed & GideonOnLine
2007	United States	California	*Salmonella* Litchfield	Cantaloupe	11	6	CDC
2008	Canada	Multiple	*Salmonella* Litchfield	Cantaloupe	9		CFIA
2008	United States	Multiple	*Salmonella* Litchfield	Cantaloupe	51		CDC
2009	United States and Canada	Multiple	*Salmonella* Carrau	Cantaloupe, honeydew, watermelon (suspect)	US: 32 cases, Canada: 35 cases		PHAC 2009
2011	United States	Multiple	*Salmonella* Panama	Cantaloupe	21	3	CDC
2011	United States	28 states	*L. monocytogenes*	Cantaloupe	147	(30 and one miscarriage)	CDC
2012	United States	24 states	*Salmonella* Typhimurium/Newport	Cantaloupe	261	94(3)	CDC

Information in this appendix was prepared by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC (Public Health Agency of Canada).

Appendix C: Cantaloupe Recalls in the U.S. and Canada (2008 – March 2013)

Date of Issue	Recalled Products	Reason for Recall	Authority
2008-03-22, 25, 26 (3 recalls)	Whole and cut cantaloupes	*Salmonella* spp.	CFIA
2008-03-22, 26, 27, 28 (11 recalls)	Whole and cut cantaloupes	*Salmonella* spp.	USFDA
2008-06-02*	Whole cantaloupes	*Salmonella* spp.	CFIA
2009-08-27	Whole cantaloupes	*Salmonella* spp.	USFDA
2010-10-21	Whole cantaloupes	*Salmonella* spp.	USFDA
2010-12-13*[&]**	Whole cantaloupes	*Salmonella* spp.	CFIA
2011-09-19*	Whole cantaloupes	*Salmonella* spp.	CFIA
2011-09-14	Whole cantaloupes	*L. monocytogenes*	USFDA
2011-09-23	Fresh cut cantaloupes and cut fruits with cantaloupes	*L. monocytogenes*	USFDA
2011-10-06	Fresh cut cantaloupes and cut fruits with cantaloupes	*L. monocytogenes*	USFDA
2012-08-22	Whole cantaloupes	*Salmonella* spp.	USFDA

* These recalls resulted from positive samples collected under FSAP targeted surveys.

** This product recall was limited to one store.

Appendix D: Analytical Methods Used for Microbial Analysis

Bacterial Analysis	Method Identification Number (Date Issued)	Title of Method*
***Salmonella* spp.**	MFLP-29(July 2007)	The Qualicon Bax® System Method for the Detection of *Salmonella* in a Variety of Food and Environmental Samples
	MFHPB-20 (March 2009)	Methods for the Isolation and Identification of *Salmonella* from Foods and Environmental Samples
***Shigella* spp.**	MFLP-26 (February 2006)	Detection of *Shigella* spp. in Foods by the Polymerase Chain Reaction (PCR)
	MFLP-25 (March 2006)	Isolation and Identification of *Shigell*a spp. from Foods
Generic *E. coli*	MFHPB-34 (September 2012) **	Enumeration of *E. coli* and coliforms in Food Products and Food Ingredients using 3M™ Petrifilm™ *E. coli* count plates

∗*Compendium of Analytical Methods* [22].

** Following the *Salmonella* sample set-up procedure as described in MFLP-29 or MFHPB-20, whereby the entire fruit was placed into a stomacher bag submerged in buffered peptone broth, 10mL of the resulting fruit rinsate was used as the sample for *E. coli* enumeration. The 10 mL rinsate sample was prepared for analysis as described in section 6.3 using 0.1 % peptone water or buffered peptone water as the diluent.