Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2009-2010 Targeted Surveys

Targeted Surveys of Bacterial Pathogens in Cantaloupes in the Canadian Market

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Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and strengthen Canada's food safety system to better protect Canadians from unsafe food and ultimately reduce the burden of foodborne illness. As part of the FSAP enhanced surveillance initiative, targeted surveys have been implemented to test priority hazards in various foods.

An increased number of foodborne disease outbreaks associated with fresh produce have been reported and recognized. The increase in outbreaks may be the result of several trends, including: improved disease surveillance, better detection methods for micro-organisms, increased fresh produce consumption and international trade. The complex nature of the micro-organisms identified in contaminated produce, combined with the fact that fresh produce is often consumed raw and not subjected to a kill step during processing further highlights the challenges associated with, and the need to improve, the microbial safety of fresh produce. For this reason, microbial contamination of fresh produce was one of the priorities identified by the Food Safety Science Committee in 2008. Cantaloupes continue to be a priority as one of the fresh produce commodities for the 2009-2010 FSAP targeted survey.

Cantaloupes have been identified as one of the five commodities which have contributed to increased produce-associated foodborne disease outbreaks from 1998-2006. Cantaloupes can be contaminated during their growth, harvesting, processing, transportation and/or preparation, if not handled properly. Once contaminated, cantaloupes are difficult to clean because of the rough netted surface of the melon which provides areas for bacterial attachment and protection from sanitization. In addition, fresh-cut Ready-to-Eat (RTE) cantaloupes are more perishable than intact cantaloupes, thus providing more optimal conditions for bacteria growth, if contaminated.

Taking into account these factors, cantaloupes have been selected for enhanced surveillance under FSAP with an overall objective to gather baseline information on the occurrence of bacterial pathogens of concern in cantaloupes available to Canadians at retail. This targeted survey was designed to gather information on the presence and distribution of:

i) *Salmonella* spp. and *Shigella* spp. in imported and domestic whole cantaloupes; and
ii) *Salmonella* spp. and *Shigella* spp. in imported fresh-cut RTE cantaloupes.

In this survey a total of 1207 retail samples of cantaloupes were analysed, including 593 imported and 302 domestic whole cantaloupe samples, as well as 312 imported fresh-cut cantaloupe samples. These samples were analysed for the presence of bacterial pathogens *Salmonella* spp. and *Shigella* spp. Bacterial pathogens *Salmonella* spp. and *Shigella* spp. were not detected in any of the samples in this survey.

The sample size employed in this survey allows us to conclude that the prevalence of these pathogens in cantaloupes during this study was below 0.33% in whole cantaloupes (895 samples), and less than 0.95% in fresh-cut Ready-to-Eat cantaloupes (312 samples).

1 Introduction

1.1 Food Safety Action Plan

The Food Safety Action Plan (FSAP) (1), which is part of the Government of Canada's broader initiative, the Food and Consumer Safety Action Plan (FCSAP) (2), aims to modernize and strengthen Canada's food safety system.

The Canadian Food Inspection Agency (CFIA) has been given the reponsibility to lead the FSAP in the area of enhanced surveillance of foods. The CFIA works on this initiative with various stakeholders including other federal departments (e.g. Health Canada, the Public Health Agency of Canada, and Agriculture and Agri-Food Canada), provincial, and territorial partners.

As part of the FSAP enhanced surveillance initiative, targeted surveys have been designed and implemented for various foods and asociated hazards. The targeted surveys will provide information to allow the CFIA to address specific questions regarding the levels and presence of various microbiological and chemical hazards in targeted foods in the Canadian market.

1.2 Targeted Surveys

FSAP targeted surveys are designed to: (i) focus on priority and/or emerging food hazard issues, (ii) address areas not covered by regular CFIA monitoring activities, and/or (iii) to enhance existing CFIA sampling activities. The development of the FSAP targeted surveys were based on the information gathered from the *Food Safety Science Committee Summary Report 2008* (3), along with prioritization activities carried out under the FSAP.

1.3 Codes of Practice, Acts and Regulations

At the international level, food safety standards are developed under the joint FAO/WHO Food Standards Programme. Producers of fresh fruits (including cantaloupes) and vegetables are encouraged to follow the internationally accepted standards and codes of practice developed by the Codex Alimentarius Committe, which provide guidance for the safe production of food at international level. The Code of Hygienic Practices for Fresh Fruits and Vegetables (CAC/RCP 53-2003) (4) and Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969) (5) were developed by the Codex Alimentarius Committee on Food Hygiene under the joint FAO/WHO Food Standards Programme. These codes address Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) which, when applied, control and reduce the potential of contamination with microbial, chemical, and physical hazards at all stages of production of fresh fruits and vegetables, from primary production to packaging. They outline basic requirements pertaining to environmental hygiene, hygienic production (related to the

requirements for water, manure, biological control of soil, packing, facility and personal hygiene), handling, storage, transportation and sanitation.

In Canada, food safety is governed through legislation. Fresh fruits (including tomatoes) and vegetables must comply with Sections 4 and 7 of the Food and Drugs Act (FDA) and the Food and Drug Regulations (FDR), which prescribe certain restrictions on the production, importation, sale, composition and content of foods and food products. By virtue of the Section 4 a of FDA the sale of food contaminated with foodborne pathogens is prohibited, while Sections 4 e and 7 prohibit the sale of unsafe food and food produced under unsanitary conditions.

Prohibited sales of food (*Food and Drugs Act*)

4. (1) No person shall sell an article of food that:

a) has in or on it any poisonous or harmful substance;
b) is unfit for human consumption;
c) consists in whole or in part of any filthy, putrid, disgusting, rotten, decomposed or diseased animal or vegetable substance;
d) is adulterated; or
e) was manufactured, prepared, preserved, packaged or stored under unsanitary conditions.

Unsanitary manufacture of food (*Food and Drugs Act*)

7. No person shall manufacture, prepare, preserve, package or store for sale any food under unsanitary conditions.

Sections A.01.040 of the FDR (below) describes prohibitions on the importations of unsafe food.

Importations (*Food and Drugs Regulations*)

A.01.040. Subject to section A.01.044, no person shall import into Canada for sale a food or drug the sale of which in Canada would constitute a violation of the Act or these Regulations.

In order to achieve compliance with Sections 4 and 7 of the FDA, CFIA has developed a *Code of Practice for Minimally Processed Ready-to-Eat Vegetables* (6). This code is intended to provide guidance for the safe manufacturing of minimally processed Ready-to-Eat (RTE) vegetables consisting of raw vegetables that have been peeled, sliced, chopped or shredded prior to being packaged for sale in Canada. This code also applies to minimally processed RTE fruits.

Fresh fruits (including cantaloupes) and vegetables sold in Canada must comply with the FDA and Regulations. Therefore, foodborne pathogens, if detected in any samples tested under this survey, would trigger food safety investigations, including activities such as follow-up sampling, inspections of facilities, and health risk assessment [a]. Depending on the findings, a recall [b] of the affected products may be recommended and/or implemented.

1.4 Potential Pathogenic Bacterial Hazards in Cantaloupes

The consumption level of fresh fruits in Canada has been increasing steadily over the past two decades. According to available data published by Statistics Canada, the availability of fresh fruits increased by 30%, from 59.5 kg/person per year to 73.4 kg/person per year, between 1981 and 2008. During the same time period, it is also reported that the availability of fresh cantaloupes increased significantly (140%) from 1.2 kg/person per year to 2.9 kg/person per year (7). The increased availability of fresh fruits (including cantaloupes) in the Canadian market largely depends on imports. Imported fresh fruits and vegetables accounted for 80% of the total volume of fresh fruits and vegetables in the Canadian market (8).

Cantaloupe is one of the five commodities (leafy green vegetables, leafy herbs, cantaloupes, tomatoes, and green onions) attributed to increased produce-associated foodborne disease [c] outbreaks [d] from 1998-2006, according to reported outbreaks by the U.S. CDC (Centers for Diseases Control and Prevention) (9). Increased monitoring triggered several non-outbreak associated recalls of cantaloupes in the U.S. and Canada (10-13). These recalls were due to the detection of *Salmonella* spp. during the U.S. Food and Drug Administration (FDA) or CFIA routine surveillance sampling (10-13).

The most commonly identified pathogen in the cantaloupe-associated foodborne disease outbreaks was *Salmonella*. *Shigella* was the second most frequently detected bacterial pathogen found in the cantaloupe samples in the U.S. FDA surveys of imported and domestic fresh produce (14;15).

1.4.1 *Salmonella* spp.

Salmonella is a genus of Gram-negative rod-shaped bacteria that normally live in the intestines of animals such as poultry and swine, wild birds, domestic pets, and reptiles. There are over 2500 serotypes of *Salmonella* spp. and virtually all are capable of causing human diseases, known as salmonellosis.

Transmission of *Salmonella* often occurs through the ingestion of contaminated food of animal origin (i.e. meat, poultry, eggs and milk), as *Salmonella* is found naturally in the intestines of warm-blooded animals. *Salmonella* spp. can be excreted in animal faeces and remain viable in the field for a relatively long period of time. Therefore, produce grown in fields can be contaminated by improperly composted manure. Infected humans are another potential source of *Salmonella*. An infected person remains infectious throughout the duration of the illness and continues to excrete the bacteria for some time after symptoms

have stopped (16). Illnesses of salmonellosis have been associated with consumption of fruits and vegetables (e.g. tomatoes, cantaloupes and sprouts), spices, sesame products, and nuts (e.g. peanut products and almonds).

Salmonellosis is one of the most common foodborne illnesses world-wide. The incidence[e] of salmonellosis varies depending on geographic, demographic, socioeconomic and environmental factors. There were approximately 6,000 cases of *Salmonella* infections reported in Canada each year during 2000-2004, according to current available data from the National Notifiable Disease Databases-Summary (17). It is believed that the actual number of infections is much higher due to under-reporting (17). In the United States, an estimated 1.4 million cases occur annually. Of these, approximately 40,000 are laboratory confirmed cases reported to the CDC, the estimated annual cost is approximately US $3 billion (18-19).

1.4.2 *Shigella* spp.

Shigella is a genus of the Enterobacteriaceae family. *Shigella* are Gram-negative, non-motile, non-spore forming, rod-shaped bacteria that are very closely related *to E. coli*. There are four groups or species of *Shigella*: *S. dysenteriae*, *S. flexneri*, *S. boydii*, and *S. sonnei*. *Shigella dysenteriae* are considered the most virulent and can produce a potent cytotoxin [f] known as shigatoxin. *Shigella sonnei* and *S. flexneri* account for a majority of the cases of shigellosis in Canada (17) and the United States (20).

Shigellosis rarely occurs in animals and is principally a human disease. Infection is spread through the faecal-oral route. Food contaminated by infectious food handlers and water contaminated with human faeces are the most common causes of shigellosis.

World-wide, shigellosis remains a common infectious disease. The annual number of shigellosis illnesses and deaths in Asia was estimated to be 91 million and 414,000, respectively (21). In Canada, *Shigella* infections reported to the Notifiable Diseases Reporting System (NDRS) were 1156 cases/year in 2000 and 720 cases/year in 2004 (15). The reported cases declined overall between 2000-2004, with the exception of a spike in 2002 (1355 cases/year). The elevated cases that year related to a foodborne outbreak of S. *sonnei* in Ontario traced back to contaminated pasta salad (17). In the US, a total of 10,336 laboratory confirmed *Shigella* cases were reported to the CDC in 2006, that translates to an average national incidence of 3.5 per 100,000 population (20).

1.5 Foodborne Disease Outbreaks Linked with Cantaloupes

According to the Public Health Agency of Canada (PHAC), there have been 26 documented outbreaks associated with cantaloupes and melons reported world wide since 1954 (appendix C), of which, twelve were cantaloupe-associated outbreaks (Table 1.1) Eleven of these outbreaks were caused by different serotypes of *Salmonella* spp., and one outbreak was caused by *E. coli* O157:H7 (Table 1.1).

Table 1.1 Bacterial Pathogens-Associated Outbreaks Linked with Cantaloupes*

Time	Bacterial Pathogens	Contamination Source	Outbreak Location	Confirmed Cases	Ref
2008	*S**. Litchfield	Rind contamination	USA/multi-state	51	(22)
2008	*S.* Litchfield	Rind contamination	Canada/ multi-provincial	9	**
2007	*S.* Litchfield	Unknown	USA/California	11	**
2006	*S.* Saintpaul	Pre- and post-harvest and processing	Australia	232	(23)
2004	*E. coli* O157:H7	Unknown	USA/Montana	6	**
2002	*S.* Berta	Rind contamination	USA/WA	29	(22)
2002	*S.* Poona	Farm multiple steps	USA /Canada multi-state	58	(24)
2001	*S.* Poona	Rind contamination	USA/multi-state	50	(22)
2001	*S.* Poona	Rind contamination	USA/California	23	(22)
2000	*S.* Poona	Rind contamination	USA/ multi-state	47	(22)
1998	*S.* Oranienburg	Unknown	Canada /ON	22	(25)
1997	*S.* Saphra	Farm/unknown	USA/California	24	(22)

** S: Salmonella;*

*** Appendix C*

Pre-harvest exposure to bacteria in the field is a common route of contamination for cantaloupes. Cantaloupes are grown at ground level and prostrate on top of the soil. Therefore the outer skin of cantaloupes can become contaminated by pathogens that are present in the soil through, for instance, the use of improperly composted manure or contaminated irrigation water. Pre-harvest contaminated melons can become the source of contamination for other melons during the post-harvest washing and cooling steps (22;26). Post-harvest handling can also bring cantaloupes into direct contact with other sources of pathogens, such as contaminated processing water (cleaning and cooling) or poor hygienic practices of workers handling the cantaloupes (27).

Several cantaloupe-associated disease outbreaks have been found to be the result of *Salmonella* spp. contamination during the washing and cooling steps. It was found that the rinds can be inoculated during immersion in contaminated wash water (28). Once the water in the wash tank or coolers is contaminated, it can inoculate large numbers of melons which are subsequently washed in it (28). Cantaloupes are difficult to clean if they are contaminated because of the rough surface of the rind which provides areas for attachment of *Salmonella* spp. and protection from sanitizers (22).

Fresh-cut cantaloupes are more perishable than the whole cantaloupes from which they were prepared. Cutting may transfer micro-organisms from the outer surfaces to the interior tissue and nutrient juice (29). In addition, cantaloupes are non-acidic fruits with relatively neutral pH values ranging from 6.1 to 6.6 (30). This may allow for the proliferation of pathogens when proper sanitation and strict temperature control is not maintained (31).

1.6 Objective of Targeted Surveys

This targeted survey was designed to gather information in the Canadian retail market on the presence and distribution of *Salmonella* spp. and *Shigella* spp. in imported and domestic whole cantaloupes, as well as fresh-cut RTE cantaloupes available in the Canadian market.

2 Sample Collection and Analytical Methods

2.1 Sample Collection

Cantaloupes were sampled for microbiological testing according to the "Guidelines for the national wide surveys in bacteriology of fresh fruits & vegetables and imported peanut/products conducted under Food and Consumer Safety Action Plan – Fiscal year 2009/2010." This survey collected whole imported and domestic cantaloupes and imported fresh-cut RTE cantaloupes (e.g. halved, cubed, etc.) from various retail locations.

A "sample" (n = 1) consisted of two whole cantaloupes from a single lot. The whole cantaloupes were placed in individual plastic bags and care was given to avoid any contamination. A "sample" (n = 1) of fresh cut cantaloupes was a single consumer package weighing no less than 200 g.

As per CFIA procedures, samples were shipped by courier to CFIA laboratories using sufficient ice packs and insulated packing material to ensure that they were between 0 - 7°C upon receipt, and if not , the sample was declared as unfit for analysis and rejected.

2.2 Analytical Methods

All samples were analysed in CFIA laboratories using methods in the *Compendium of Analytical Methods* for the Microbiological Analysis of Foods, the Health Products and Food Branch, Health Canada (Table 2.1) (32).

Table 2.1 Analytical Methods Used for Microbial Analyses

Pathogens	Methods*	Brief Description
***Salmonella* spp.**	MFLP-29	PCR-based screening method
	MFHPB-20	Isolation and confirmation method
***Shigella* spp.**	MFLP-26	PCR-based screening method
	MFLP-25	Isolation and confirmation method

** Compendium of Analytical Methods (32)*

2.3 Assessment Guidelines

The samples were assessed as "satisfactory" or "unsatisfactory" using the criteria provided in Table 2.2.

Table 2.2 Assessment Guidelines for the Cantaloupes

Pathogens and Analysis*	Assessment	
	Satisfactory	**Unsatisfactory**
***Salmonella* spp**.	Not detected	Present in 25 g (fresh cut) or present per whole melon
***Shigella* spp.**	Not detected	Present in 25 g (fresh cut) or present per whole melon

** Compendium of Analytical Methods (32)*

The assessment criteria are based on the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods - an Interpretive Summary* and associated methods published in the HC's *Compendium of Analytical Methods* (32). These methods are used for regulatory testing by the CFIA and are fully validated for the analysis of fresh fruit and vegetable samples, including cantaloupes. Thus the analytical result of this survey was assessed as "unsatisfactory" if *Salmonella* spp. or *Shigella* spp. were present in 25g of an analytical sample unit (if fresh cut) or if *Salmonella* spp. or *Shigella* spp. were present per whole melon analysed, while negative results were assessed as "satisfactory" (Table 2.2).

A "satisfactory" sample assessment indicated that pathogens were not detected and, therefore, no further CFIA action was required.

An "unsatisfactory" sample assessment, if obtained, would trigger a follow-up actions, including food safety investigation, directed follow-up sampling, inspections of establishments, health risk assessment, and/or product action (e.g. product recall).

2.4 Data Analysis and Reporting

Sample information and analytical results were recorded in a Record of Analysis (ROA) of the CFIA's Laboratory Sample Tracking System (LSTS) and reported using Cognos 8 Query Studio data reporting system. The positive results, if obtained, were to be immediately forwarded to the Food Safety Division, Office of Food Safety and Recalls and Fresh Fruits and Vegetables Commodity Program.

2.5 Statistical Consideration

The expected prevalence of pathogens in the population surveyed (d) was determined by using the following formula (33):

$$n = -\ln (1-p) / d/100$$

where n = number of sample units that were sampled and tested, p = probability or confidence level set at 95 % and d =expected prevalence of pathogens.

2.6 Limitations of the Survey

The collection of samples at retail which was employed in this study offered the benefit of being close to the point of consumption and therefore, reflects well the consumer's exposure to the microbiological hazards of concern. However, it imposed certain limitations with respect to the traceability of products in case of positive results, since the samples were collected from bulk or from the units pre-packaged at packers or at the retail level. Further, in this study, a single sample unit (n = 1) was collected from a partial lot displayed at the retail while, typically, the lot acceptance criteria and subsequently a decision pertaining to a lot compliance with respect to microbiological standards are based on the laboratory results obtained for five sample units randomly drawn from the whole production lot. In case of positive results, these factors would have to be taken into consideration during the food safety investigations, health risk and compliance assessments.

3 Results of Targeted Survey

3.1 Overview of Samples Collected

A total of 1207 cantaloupe samples were collected during this survey, 74.2% were whole cantaloupes and 25.8% were fresh-cut RTE cantaloupes. Of the whole cantaloupe samples, 66.3% were imported and 33.7% were domestic (Table 3.1).

Table 3.1 Overview of Cantaloupe Samples Collected

Type of Sample		Collected Samples (n)	Subtotal (%)	Total (%)
Whole	Imported	593	66.3	
	Domestic	302	33.7	
	Subtotal	***895***	***100***	**74.2**
Fresh-cut	Imported	***312***	***100***	**25.8**
Total		**1207**		**100**

3.1.1 Sample Distribution by Province

The geographic distribution of samples was based on commodity production level, population distribution, and the availability of resources in the provinces. The provincial distribution of samples remained consistent among the types of products collected (Figures 3.1 and 3.2). Ontario was the province in which about 50% of the samples were collected. Quebec and Alberta both equally provided about 25% of the samples collected.

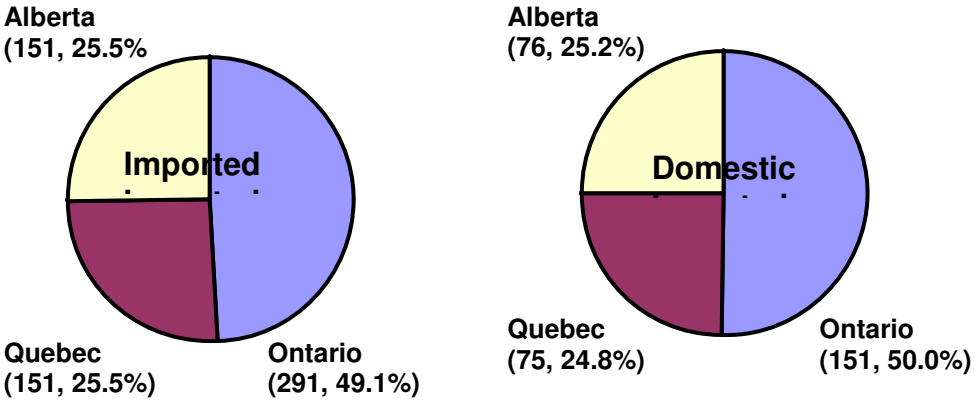

Figure 3.1 Whole Cantaloupe Sample Distribution by Province (n, %)

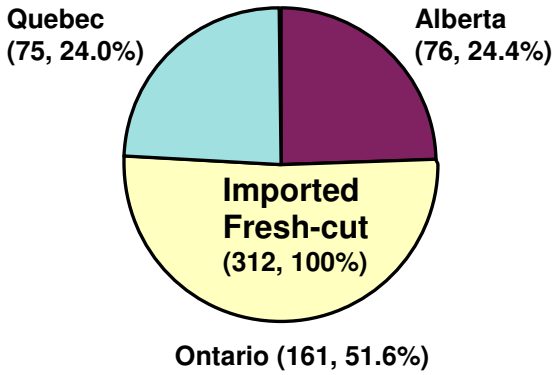

Figure 3.2 Fresh–cut Cantaloupe Sample Distribution by Province (n, %)

3.1.2 Imported Cantaloupes - Sample Distribution by Country of Origin

A total of 905 imported cantaloupe samples, 593 whole and 312 fresh-cut RTE, were collected. Most of the imported cantaloupe samples were from Mexico and Guatemala, with the remaining samples imported from other countries as outlined in Table 3.2.

Table 3.2 Imported Sample Distribution by Country of Origin

Country of Import	Whole Cantaloupes		Fresh-cut Cantaloupes	
	(n)	(%)	(n)	(%)
USA	293	49.4	158	50.6
Guatemala	158	26.6	52	16.7
Honduras	93	15.7	8	2.6
Costa Rica	44	7.4	13	4.2
Mexico	5	0.8	3	1.0
Unidentified	0	0	78	25.0
Total	**593**	**100**	**312**	**100**

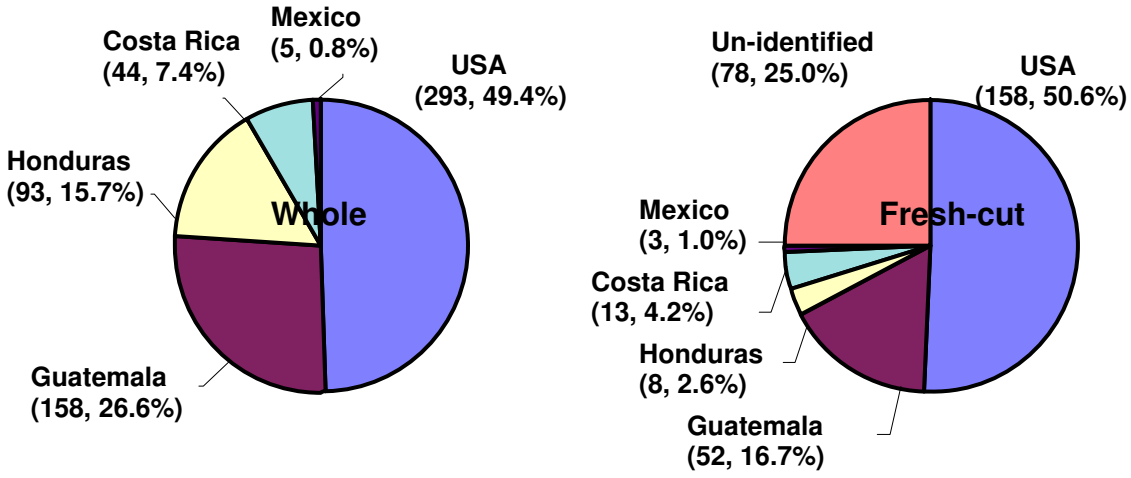

Figure 3.3 Imported Cantaloupe Sample Distribution by Country of Origin (n, %)

3.1.3 Seasonal Distribution

Domestic samples were collected during the summer months (April-September), due to Canada's short domestic growing season. Imported samples were collected throughout the year, but they were primarily collected in the fall, winter, and spring months.

3.2 Assessment of Analysed Samples

Of 1207 cantaloupe samples analysed, 593 imported and 302 domestic whole cantaloupes, and 312 imported freshly-cut cantaloupes were assessed as satisfactory (Table 3.3).

The pathogens, *Salmonella* spp. and *Shigella* spp. were not detected in any of the 1207 samples analysed.

Therefore, all samples were assessed as "satisfactory" as per the survey's assessment criteria.

Table 3.3 Assessment of Analysed Cantaloupe Samples

Type of Products		Sample Analysed (n)	Satisfactory (n)	Satisfactory (%)
Whole	**Imported**	593	593	100
	Domestic	302	302	100
	Subtotal	***895***	***895***	***100***
Fresh-cut	**Imported**	***312***	***312***	***100***
Total		**1207**	**1207**	**100**

4 Discussion and Conclusion

Surveillance of cantaloupes under the FSAP was initiated in the previous fiscal year, 2008-2009. One out of 558 cantaloupe samples was assessed as unsatisfactory due to *Salmonella spp* contamination. This sample was imported from the U.S. (34).

In the 1999-2000 USFDA survey of cantaloupes 11 of 151 (imported) and 5 of 164 (domestic) samples were assessed as unsatisfactory. The contaminated imported cantaloupes originated from Mexico, Costa Rica and Guatemala. *Salmonella* was detected in 8 of 151 (imported) and 4 of 164 (domestic) samples. *Shigella* was detected in 3 of 151 (imported) and 1 of 164 (domestic) samples (14;15).

The 2009-2010 targeted survey of the pathogenic bacteria *Salmonella* spp. and *Shigella* spp. in whole and fresh-cut cantaloupes in the Canadian market was successfully delivered. The presence of bacterial pathogens that can cause foodborne disease is low in cantaloupes available in the Canadian market.

In summary, up-to-date monitoring results obtained in surveys conducted in Canada and the U.S. indicate that the cantaloupes may become contaminated with *Salmonella* and *Shigella*. The epidemiological link between consumption of contaminated cantaloupes and foodborne illness has been established. The cantaloupes implicated in outbreaks were traced back by the U.S. authority to their sources. When implicated cantaloupes and the origin identified, CFIA responded with boarder alerts and intensified directed sampling and testing in order to protect Canadian. It is noted that the domestic cantaloupes were not found contaminated or linked to the foodborne illness. It could be considered that in Canada the Good Agriculture Practices have been effectively employed and their importance together with the sanitary conditions along the whole food continuum can not be overestimated.

5 Future Considerations

Continued monitoring of bacterial pathogens in cantaloupes over several consecutive years is recommended, as it would provide accumulated information on the occurrence of the bacterial pathogens in cantaloupes available in the Canadian market. In addition, a complete record of the country of origin of fresh-cut samples should be sought in future targeted surveys.

6 Acknowledgment

We would like to express our sincere thanks to Judy D. Greig, Laboratory of Foodborne Zoonoses, Public Health Agency of Canada for providing the summary of outbreaks (Appendix C).

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Appendix A: Glossary of Terms

[a] Health risk: Levels of health risk is determined by health risk assessment, Health Canada characterizes health risks into three categories:

- **Health Risk 1** (HR 1): The health risk identified represents a situation where there is a reasonable probability that the consumption/exposure to a food will lead to adverse health consequences which are serious or life-threatening, or that the probability of a foodborne outbreak situation is considered high.

- **Health Risk 2**: The health risk identified represents a situation where there is a reasonable probability that the consumption/exposure to a food will lead to temporary or non-life threatening health consequences, or that the probability of serious adverse consequences is considered remote.

- **Helath Risk Category 3** (HRC 3): This represents a situation where there is a reasonable probability that the consumption/exposure to a food is not likely to result in any adverse health consequence.

[b] Recall is an action by a manufacturer, importer, distributor or retailer to remove unsafe food products from the market to help protect the public. In Canada, food recalls are coordinated by the CFIA. The CFIA classifies recalls into three classes (Class I, Class II or Class III) based on the level of health risk of the food product being recalled.

- **Class I recalls (High risk**): The CFIA will request a Class I recall for a food product when there is a high risk that eating or drinking that product will lead to serious health problems or death. The CFIA issues a public warning for all Class I recall when the product is available for sale or could be in the consumer's home.

- **Class II recalls (Moderate risk)**: The CFIA will requests a Class II recall for a food product when eating or drinking that product will most likely lead to short-term or non-life threatening health problems. The chance of any serious health symptoms is low in healthy populations. The CFIA issues a public warning for some Class II recalls based on the risk assessment and other criteria, such as the severity of symptoms in vulnerable populations (children, pregnant women, seniors, etc.).

- **Class III recalls (Low and no risk**): The CFIA will request a Class III recall when eating or drinking that product will not likely result in any undesirable health effects. Class III recalls can include food products that pose no health and safety risk, but do not follow federal food regulations.

[c] Foodborne disease is defined as a disease, caused by infectious or toxic agents that enter the body through the ingestion of food.

[d] Disease outbreak is the occurrence of cases of disease in excess of what would normally be expected in a defined community, geographical area or season.

[e] Incidence is the number of cases of a disease, arising in a defined population during a stated period, expressed as a proportion, such as x cases per 1000 persons per year.

[f] Cytotoxin: a substance that has a toxic effect on cells**.**

Appendix B: List of Acronyms

CDC: Centres for Disease Control and Prevention

CFIA: Canadian Food Inspection Agency

CFU: colony forming unit

CI: Confidence Interval

E. coli: *Escherichia coli*

FDA: Food and Drug Act

FCSAP: Food and Consumer Safety Action Plan

FSAP: Food Safety Action Plan

GAP: Good Agricultural Practice

GMP: Good Manufacturing Practice

HC: Health Canada

MPN: Most Probable Number

PCR: Polymerase Chain Reaction

PHAC: Public Health Agency of Canada

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

***Shigella* spp.**: *Shigella* species

USFDA: the United States Food and Drug Administration

%: (percentage)

(n): (number)

°**C**: degrees Celsius

g: gram

Appendix C: Outbreaks Associated with Melons*

Year	Country	Province/State	Microorganism	Vehicle	Cases	Hospitalized	Deaths	Source
1954	United States	Massachusetts	*Salmonella* Miami	Watermelon	26			Public Health Report Vol 70, No 3, pp 311-313
1990	United States	Multiple	*Salmonella* Chester	Cantaloupe	245 confirmed 25000 presumptive			Program & Abstracts of the Thirtieth Interscience Conference on Antimicrobial Agents & Chemotherapy, 21-24 Oct. 1990
1991	Canada/US	Multiple	*Salmonella* Poona	Cantaloupe	400			MMWR 1991 Aug 16;40(32):549-552.
1997	United States	California	*Salmonella* Saphra	Cantaloupe	24			J Infect Dis. 1999 180(4):1361-4.
1998	Canada	Ontario	*Salmonella* Oranienburg	Cantaloupe	20			Can Commun Dis Rep. 1998 Nov 15;24(22):177-8; discussion 178-9)
2000	United States	Colorado	*Salmonella* Heidelberg	Melon	4			CDC
2000	United States	Wisconsin	*Escherichia coli* 0157:H7	Watermelon	736			CDC
2000	United States	Multiple	*Salmonella* Poona	Cantaloupe	47	9		MMWR 2002 Nov 22;51(35):1044-1047
2001	United States	Multiple	*Salmonella* Poona	Cantaloupe	50	9	2	MMWR Nov 22, 2002;51(35);1044-1047
2002	United States	Washington	*Salmonella* Berta	Watermelon	29			CDC
2002	Multiple	Multiple	*Salmonella* Poona	Cantaloupe	58	10		MMWR Nov 22, 2002;51(35);1044-1047
2003	United States	Multiple	*Salmonella* Newport	Melon	68			CDC
2003	United States	Colorado	*Shigella sonnei*	Melon	56			CDC
2003	United States	Multiple	*Salmonella* Muenchen	Melon	58			CDC

Year	Country	Province/State	Microorganism	Vehicle	Cases	Hospitalized	Deaths	Source
2004	United States	Montana	*Escherichia coli* 0157:H7	Cantaloupe	6	0		Yellowstone City-County Health Department & ProMed
2004	United States	Wisconsin	Norovirus	Melon	2			CDC
2004	United States	Kansas	Norovirus	Melon	100			CDC
2005	United States	Idaho	Norovirus	Watermelon	18			CDC
2006	United States	New York	*Salmonella* Newport	Watermelon	20	2		CDC
2006	United States	California	Norovirus	Watermelon	14			CDC
2006	Australia	New South Wales	*Salmonella* Saintpaul	Cantaloupe	100			ProMed & GideonOnLine
2006	United States	Virginia	*Campylobacter jejuni*	Watermelon	15	1		CDC
2007	United States	California	*Salmonella* Litchfield	Cantaloupe	11	6		CDC
2007	United States	Pennsylvania	*Salmonella* Litchfield	Melon	30			MMWR 57(28) July 18, 2008
2008	Canada	Multiple	*Salmonella* Litchfield	Cantaloupe	9			CFIA
2008	United States	Multiple	*Salmonella* Litchfield	Cantaloupe	51			CDC

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