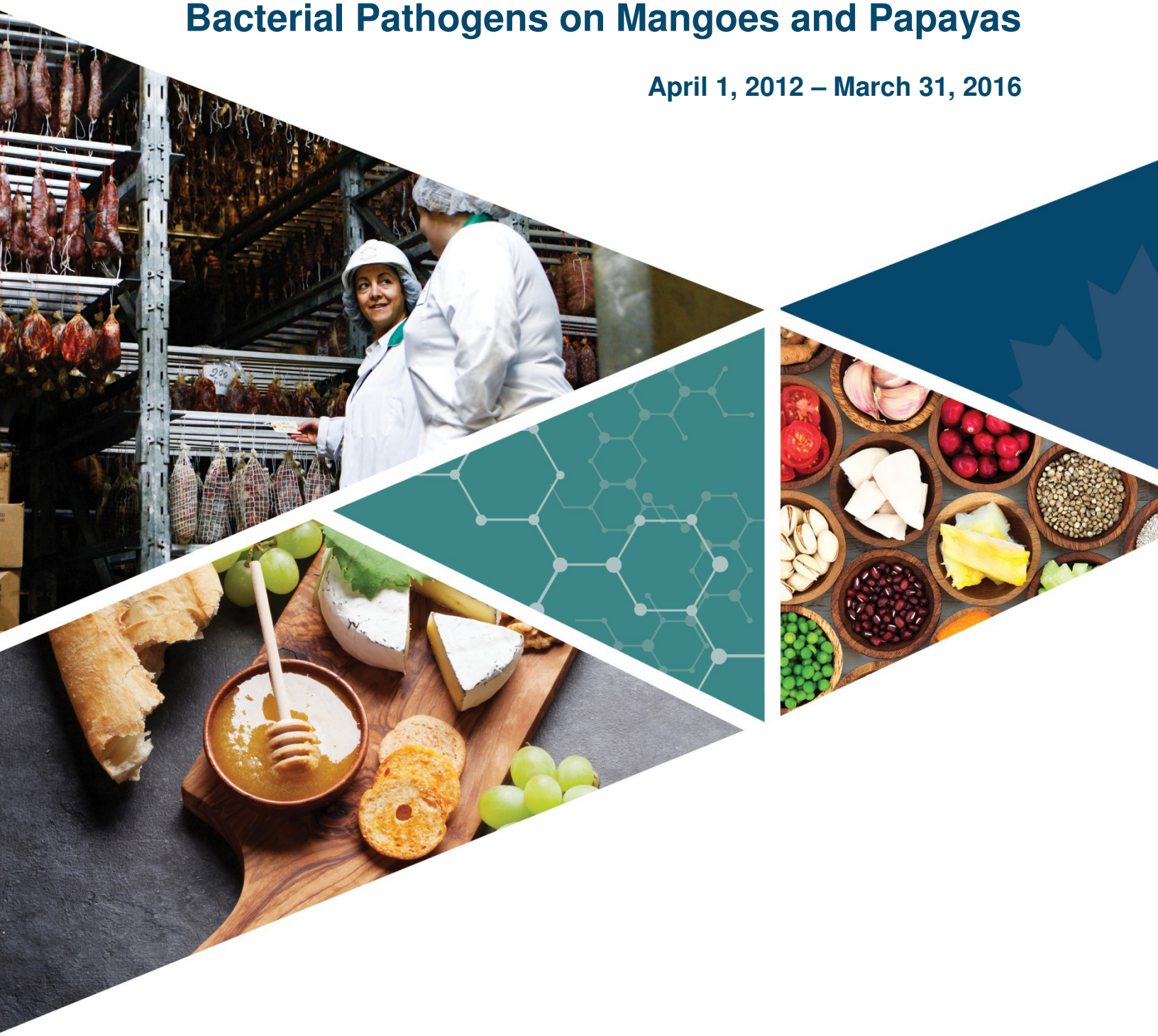
Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Food Microbiology – Targeted Surveys

FINAL REPORT

Bacterial Pathogens on Mangoes and Papayas

April 1, 2012 – March 31, 2016



Canada

Summary

Fresh tropical fruits, such as mangoes and papayas, are consumed in Canada and around the world. Foodborne illness outbreaks associated with mangoes and papayas have been reported worldwide including one in Canada. Therefore, the microbial safety of imported mangoes and papayas remains a concern.

Considering the factors mentioned above and their relevance to Canadians, mangoes and papayas were selected for targeted surveys. The purpose of the survey was to generate baseline information on the occurrence of bacterial pathogens on the surface of mangoes and papayas. Over the course of this study (April 1, 2012 to March 31, 2016), a total of 4710 samples of mangoes (2267, 48.1%) and papayas (2443, 51.9%) were collected from retail locations in 11 cities across Canada and tested for bacterial pathogens of concern: *Salmonella*, *Escherichia coli* (*E. coli*) O157:H7 and *Shigella*, as well as generic *E. coli*. Generic *E. coli* is an indicator of the overall sanitation conditions throughout the food chain from production to the point of sale and its presence at some levels is tolerated on agricultural products.

All mango samples (100%) and over 99% of the papaya samples were found to be free of pathogenic bacteria tested for. *E. coli* O157:H7 and *Shigella* were not found on any samples tested.

Salmonella, a common bacterial pathogen associated with foodborne illnesses, was found on the surface of two (0.08%) papaya samples. The Canadian Food Inspection Agency (CFIA) conducted appropriate follow-up activities. No product recalls were issued as follow up sampling yielded negative test results for one product and the other product was no longer available on the market. No reported illnesses were in association with any of the *Salmonella* contaminated samples.

High levels (>1000 colony forming units (CFU)/mL of rinsate) and elevated levels (100 to 1000 CFU/mL of rinsate) of generic *E. coli* were found on the surface of eight (0.33%) and seven (0.29%) papaya samples respectively. Since these imported fruit samples were sampled in bulk at retail, the surface of the papaya samples may have come in contact with microorganisms at various points from harvest, post-harvest to the point of sale at retail. Consequently it was not possible to determine where the breakdown in sanitation occurred. Therefore, improving sanitation conditions along the food chain was recommended.

The results indicate that almost all of the mangoes and papayas sampled appear to have been produced under Good Agricultural Practices and Good Manufacturing Practices, as there were

very few occurrences of high levels of generic *E. coli* (>1000 CFU/mL of rinsate). Sporadically, *Salmonella* contamination on papaya can occur.

What Are Targeted Surveys?

Targeted surveys are used by the Canadian Food Inspection Agency (CFIA) to focus its surveillance activities on areas of highest health risk. The information gained from these surveys provides support for the allocation and prioritization of the Agency's activities to areas of greater concern. Originally started as a project under the Food Safety Action Plan (FSAP), targeted surveys have been embedded in the CFIA's regular surveillance activities since 2013. Targeted surveys are a valuable tool for generating information on certain hazards in foods, identifying and characterizing new and emerging hazards, informing trend analysis, prompting and refining health risk assessments, highlighting potential contamination issues, as well as assessing and promoting compliance with Canadian regulations.

Food safety is a shared responsibility. The Canadian Food Inspection Agency works with federal, provincial, territorial and municipal governments and provides regulatory oversight of the food industry to promote safe handling of foods throughout the food production chain. The food industry and retail sectors in Canada are responsible for the food they produce and sell, while individual consumers are responsible for the safe handling of the food they have in their possession.

Why Did We Conduct This Survey?

Mangoes and papayas are among the top varieties of tropical fruits, along with avocado, banana and pineapple, that are traded and consumed worldwide[1,2]. Whole mangoes and papayas have been associated with several salmonellosis outbreaks worldwide. Imported mangoes, contaminated by *Salmonella,* were implicated in two separate salmonellosis outbreaks in the USA in 2012[3] with one of them linked to cases of salmonellosis in Canada[4]. Imported papayas were also reported to be the source of a multi-state salmonellosis outbreak in the USA in 2011[5]. Untreated wash water and/or inadequately chlorinated wash water in the postharvest treatment of the tropical fruits were linked to *Salmonella* contamination in several salmonellosis outbreaks associated with mangoes[12, 13] and papayas[11].

Given the above information and information gap regarding the microbial safety of imported tropical fruits, mangoes and papayas were selected for targeted surveys over a three fiscal year (2013-2016) and four fiscal year period (2012-2016), respectively. This report details results of the entire survey period of April 1, 2012 to March 31, 2016.

What Did We Sample?

For this survey, a sample unit consisted of three whole mangoes or papayas from a single lot. All samples were collected from national retail chains and local/regional grocery stores located in 11 major cities across Canada. These cities encompassed four geographical areas: Atlantic (Halifax and Saint John), Quebec (Quebec City, Montreal), Ontario (Toronto, Ottawa), and the West (Vancouver, Kelowna, Calgary, Saskatoon and Winnipeg). The number of samples collected from these cities was in proportion to the relative population of the respective areas. Papaya samples were collected between April 1, 2012 and March 31, 2016 (four fiscal year survey) and mango samples were collected between April 1, 2013 and March 31, 2016 (three fiscal year survey). All samples were randomly collected including organic and conventional products.

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] with the following modification for whole fruits. Briefly, the entire fruit was soaked in a suitable volume of primary enrichment broth and mixed for 30 seconds by manually rubbing the rind. Following mixing, the fruit was submerged and held at room temperature for 30 minutes and again mixed by manually rubbing the rind prior to proceeding with incubation. Prior to incubation, a portion of fruit rinsate was set aside for *E. coli* enumeration. The analytical results of the rinsate indicate the presence/absence of the tested bacterial pathogens on the surface of a whole fruit and the counts of generic *E. coli*/mL of rinsate from a whole fruit. The assessment criteria used in this survey (Table 1) are based on the principles of the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods*[7] and associated methods published in Health Canada's *Compendium of Analytical Methods*[6].

Table 1 Assessment Criteria for Bacteria on Mango and Papaya Samples

Bacterial Analysis	Method Identification Number*	Assessment Criteria		
		Satisfactory	Investigative	Unsatisfactory
Salmonella	MFLP-29 MFLP-38 MFHPB-20	Absent (whole fruit)	Not Applicable (NA)	Present (whole fruit)
E. coli O157:H7	MFLP-30 MFHPB-10	Absent (whole fruit)	NA	Present (whole fruit)
Shigella	MFLP-25	Absent (whole fruit)	NA	Present (whole fruit)
Generic *E. coli*	MFHPB-34	$\leq$ 100 CFU/mL of rinsate	100 < x $\leq$ 1000 CFU/mL of rinsate	> 1000 CFU/mL of rinsate

*The methods used were the published versions at the time of analysis with the modification described above for whole fruits.

No assessment guidelines had been established in Canada for *Salmonella* and *Shigella* in fresh fruits[7] 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 on fruits was considered to be a violation of the *Food and Drugs Act* (FDA) Section 4(1)a[8] and was therefore assessed by the CFIA as unsatisfactory.

Unlike harmful bacterial pathogens (e.g. *Salmonella, E. coli* O157:H7), generic *E. coli* is commonly found in the intestines of humans and most strains are harmless. It is considered to be an indicator organism and levels of generic *E. coli* found in a food product are used to assess the overall sanitation conditions throughout the food chain from production to the point of sale. Its presence at some levels is tolerated on agricultural products. An investigative assessment which may result in further follow-up actions is associated with elevated levels of generic *E. coli* (100 < x $\leq$ 1000 MPN/g). An unsatisfactory assessment is associated with high levels of generic *E.coli* (> 1000 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* of the lot.

What Were the Survey Results?

A total of 4710 samples were analysed for *Salmonella*, *Shigella*, *E. coli* O157:H7 and generic *E. coli.* All mango samples (100%) were assessed as satisfactory. *E. coli* O157:H7 and *Shigella* were not found on any samples tested. Almost all papaya samples (99.3%) were assessed as satisfactory. Elevated levels (100 to 1000 CFU/mL of rinsate) and high levels (>1000 CFU/mL of rinsate) of generic *E. coli* were found on seven (0.29%) and eight (0.33%) of the papaya samples, respectively. *Salmonella* was found on two papaya samples (0.08%). The assessment results of the samples are summarized in Table 2.

Table 2 Assessment Results of Mango and Papaya Samples

Product	Number of Samples	Satisfactory Assessment	Investigative Assessment	Unsatisfactory Assessment	
			Generic *E. coli* 100 - 1000 CFU/mL of rinsate	Generic *E. coli* > 1000 CFU/mL of rinsate	*Salmonella* (whole fruit)
Mango	2267	2267 (100.0%)	0	0	0
Papaya*	2443	2426 (99.3%)	7 (0.29%)	8 (0.33%)	2 (0.08%)

*Papaya samples (346 samples) collected from April 1, 2012 to March 31, 2013 were not tested for *E. coli* O157:H7.

The mango and papaya samples were imported from more than 28 countries, with approximately 86.4% of the samples imported from countries of Latin America and the Caribbean region (Table 3). *Salmonella* positive papaya samples were imported from Mexico and Belize (one sample each). It is important to note that these fruits were sampled in bulk at retail and could have been manipulated by consumers. Therefore, the surface of the papaya samples may have come into contact with microorganisms including bacteria at various points from harvest, post-harvest to the point of sale at retail.

Table 3 Sample Distribution by Country of Origin

Country of Origin	Mangoes	Papayas	Total Number of Samples	Percentage (%)
	Number of Samples	Number of Samples		
Latin American/ Caribbean Region Countries	2038	2030	4068	86.4
Belize	0	155	155	3.2
Brazil	333	242	575	12.2
Costa Rica	0	245	245	5.2
Dominican Republic	35	93	128	2.7
Ecuador	302	2	304	6.4
Guatemala	4	340	344	7.3
Jamaica	10	18	28	0.6
Mexico	986	926	1912	40.6
Peru	363	4	367	7.8
Other Latin American / Caribbean Region	5	5	10	0.2
Non-Latin American / Caribbean Region Countries	58	331	389	8.2
Asian countries	17	5	22	0.5
Australia	8	0	8	0.2
European countries	15	1	16	0.1
Middle Eastern countries	6	0	6	0.1
United States	12	325	337	7.1
Unknown Country of Origin	171	82	253	5.4
Total	**2267**	**2443**	**4710**	**100.0**

What Do the Survey Results Mean?

In this survey, all mango samples (100%) and over 99% of the papaya samples were determined to be free of pathogenic microorganisms tested for. *E. coli* O157:H7 and *Shigella* were not found on any mango or papaya samples.

Salmonella, a common bacterial pathogen associated with foodborne illnesses, was found on the surface of two (0.08%) papaya samples. The CFIA conducted appropriate follow-up activities. No product recalls were issued as follow up sampling yielded negative test results for one product and the other product was no longer available on the market. No reported illnesses were associated with any of the *Salmonella* contaminated papaya samples.

High levels (>1000 CFU/mL of rinsate) and elevated levels (100 to 1000 CFU/mL rinsate) of generic *E. coli* were found on the surface of eight (0.33%) and seven (0.29%) papaya samples respectively. *E. coli* are commonly found in the intestines of humans and most strains are harmless. Generic *E. coli* is an indicator used to assess the overall sanitation conditions under which the fruits were produced. Since these imported fruit samples were sampled in bulk at retail, the surface of the papaya samples may have come into contact with microorganisms at various points from harvest, post-harvest to the point of sale at retail. Consequently it was not possible to determine where the breakdown in sanitation occurred. Therefore, improving sanitation conditions along the food chain was recommended.

There are limited studies regarding the microbial safety and quality of tropical fruits. A few small scale studies have been conducted in tropical countries for the safety of retail tropical fruits and the findings varied. For example, in one study conducted in Singapore[9], *Salmonella* was not found in any of the ten mango samples tested, but in another study conducted in Ethiopia[10] *Salmonella* was isolated from nine of 16 (56%) mango samples. In 2006, *Salmonella* Litchfield infections occurred in Australia, and nine of 38 (24%) retail papaya samples tested positive for *Salmonella* Litchfield during the food safety investigation and the contaminated papayas were linked to the salmonellosis outbreak[11]. The results of these studies are not comparable with the results of our survey due to differences in study design and testing methodologies.

Overall, our survey results suggest that almost all mangoes and papayas on the Canadian market are safe for consumption. Sporadically, papayas can become contaminated by *Salmonella.*

References

1. Food and Agriculture Organization. Medium-Term Prospects for Agricultural Commodities-Projections to the Year 2010 *[online].* 2003. Accessed 2016, http://www.fao.org/docrep/006/y5143e/y5143e1a.htm#bm46

2. Strawn L. K., Schneider K. R. & Danyluk M. D. Microbial Safety of Tropical Fruits *Crit Rev- Food Sci Nutr* 2011; 51**,** 132-45.

3. Centers for Disease Control and Prevention. Multistate Outbreak of *Salmonella* Braenderup Infections Associated with Mangoes 2012. https://www.cdc.gov/salmonella/braenderup-08-12

4. Public Health Agency of Canada. Public Health Notice: Outbreak of *Salmonella* Illness Related to Mangoes. 2012. http://www.phac-aspc.gc.ca/fs-sa/phn-asp/osm-esm-eng.php

5. Centre for Disease Control and Prevention. Multistate Outbreak of Human *Salmonella* Agona Infections Linked to Whole, Fresh Imported Papayas (Final Update) 2011. http://www.cdc.gov/salmonella/2011/papayas-8-29-2011.html

6. Health Canada. *Compendium of Analytical Methods [online].* 2011. Accessed 2016, http://www.hc-sc.gc.ca/fn-an/res-rech/analy-meth/microbio/index-eng.php

7. Health Canada. *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Food - an Interpretive Summary* [online]. 2008. Accessed 2016, http://www.hc-sc.gc.ca/fn-an/res-rech/analy-meth/microbio/volume1-eng.php

8. Department of Justice Canada. *Food and Drug Regulations [online].* 2012. Accessed 2016, http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._870/index.html

9. Seow J.; Agoston, R; Phua, L.; Yuk, H-G. Microbiological Quality of Fresh Vegetables and Fruits Sold in Singapore *Food Control* 2012; 25**,** 39-44.

10. Gultie A; Sahile, S. Microbial Spectrum of Fruit in Gondar Town Markets, North Western Ethiopia *Journal of Microbiology Research* 2013; 3**,** 1-10.

11. Gibbs R., Pingault N., Mazzucchelli T., O'Reilly L., MacKenzie B., Green J., Mogyorosy R., Stafford R., Bell R., Hiley L., Fullerton K. & Van Buynder P. An Outbreak of *Salmonella* Enterica Serotype Litchfield Infection in Australia Linked to Consumption of Contaminated Papaya *J Food Prot* 2009; 72**,** 1094-8.

12. Beatty M. E., LaPorte T. N., Phan Q., Van Duyne S. V. & Braden C. A Multistate Outbreak of *Salmonella* Enterica Serotype Saintpaul Infections Linked to Mango Consumption: A Recurrent Theme *Clin Infect Dis* 2004; 38**,** 1337-8.

13. Sivapalasingam S., Barrett E., Kimura A., Van Duyne S., De Witt W., Ying M., Frisch A., Phan Q., Gould E., Shillam P., Reddy V., Cooper T., Hoekstra M., Higgins C., Sanders J. P., Tauxe R. V. & Slutsker L. A Multistate Outbreak of *Salmonella* Enterica Serotype Newport Infection Linked to Mango Consumption: Impact of Water-Dip Disinfestation Technology *Clin Infect Dis* 2003; 37**,** 1585-90.

14. Strawn L. K. & Danyluk M. D. Fate of *Escherichia coli* O157:H7 and *Salmonella* spp. on Fresh and Frozen Cut Mangoes and Papayas *Int J Food Microbiol* 2010; 138**,** 78-84.

15. U. S. Food and Drug Administration. Analysis and Evaluation of Preventive Control Measures for the Control and Reduction/Elimination of Microbial Hazards on Fresh and Fresh-Cut Produce, Chapter V. Methods to Reduce/Eliminate Pathogens from Produce and Fresh-Cut Produce *[online].* 2015. Accessed 2016, http://www.fda.gov/food/foodscienceresearch/safepracticesforfoodprocesses/ucm091363.htm