Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2011-2012 Targeted Surveys

Targeted Survey Investigating Bacterial Pathogens and Generic *E. coli* in Low-Moisture Foods

RDIMS # 5103950

Canada

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Executive Summary

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

Low-moisture foods, such as dried fruits, spices and dry mixes, have generally been accepted as safe products as they do not support the growth of bacterial pathogens. This assumption has been challenged in recent years by the occurrence of a number of outbreaks and recalls associated with contaminated low-moisture foods in several countries. Bacterial pathogens can be introduced in low-moisture foods via contaminated incoming ingredients or cross-contamination during processing, and survive for extended periods of time in these types of products. The presence of bacterial pathogens in dry foods creates a potential risk for foodborne illness as dry foods can be used as seasonings in ready-to-eat foods (e.g., spices, dried fruits) or reconstituted into foods that would provide conditions suitable for bacterial growth (e.g., gravy mix, powdered milk).

In view of the above information, the Canadian Food Inspection Agency (CFIA) has selected certain low-moisture foods (i.e., spices, dried fruits, dried dairy products, cocoa powder and dry mixes) for enhanced surveillance under the FSAP. Over the course of four years of targeted surveys (2010/11 to 2013/14), approximately 4,400 samples were collected from Canadian retail locations and tested for the presence of bacterial pathogens of concern.

The main objectives of the 2011/12 survey were to generate baseline surveillance data on various bacterial pathogens of concern and on the indicator of fecal contamination generic *E. coli* for a variety of low-moisture foods available in the Canadian market.

A total of 1958 low-moisture foods, including spices (conventional and organic), dried fruits, dry mixes, dried dairy products and cocoa powder, were sampled at retail. *Salmonella* was analyzed in all the products and was detected in only one sample (organic curry powder). *E. coli* O157 and *Shigella* were also analysed in dried fruits and dry mixes (603 samples in total) and were not found in any of the samples. Additionally, *Clostridium perfringens* and *Bacillus cereus*, which are naturally present in the environment but can cause illness when present in foods in high numbers, were analysed in spices (545 samples) and were not found at levels of concern. Generic *E. coli* levels were also found to be acceptable in all samples tested (spices, dried fruits and dry mixes – 1148 samples in total). The *Salmonella* positive sample triggered appropriate follow-up procedures including the recall of the affected product. These results suggest that the vast majority of low-moisture foods sampled during this survey were produced and handled under Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs).

The 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, 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. Moreover, 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 enhance 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's) 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.

Within the current regulatory framework, some commodities, such as meat products traded internationally and inter-provincially, are regulated by specific Acts and Regulations. These are referred to as federally registered commodities. Under the current regulatory framework, the non-federally registered commodities, which are regulated solely under the *Food and Drugs Act* and *Regulations,* encompass 70% of domestic and imported foods. The low-moisture foods investigated in this survey belong to this category. Targeted surveys are primarily directed towards non-federally registered commodities.

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 are collected over several 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 and are aimed 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 (2011/12) was designed to generate baseline surveillance data on the occurrence of microorganisms of concern in a variety of low-moisture foods (spices, dried fruits, dried dairy products, cocoa powder and dry mixes) 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. Food producers and processors across the world are encouraged to follow these international codes of practice. Of relevance for this survey are the *General Principles of Food Hygiene* (CAC/RCP 1-1969) [4], the *Code of Hygienic Practice for Dried Fruits* (CAC/RCP 3-1969)[5] and the *Code of Hygienic Practice for Spices and Dried Aromatic Plants* (CAC/RCP 42-1995)[6]. 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 production and processing of foods and food products, from primary production to packaging.

Low-moisture foods available in the Canadian market must comply with the *Food and Drugs Act* (FDA)[7] and the *Food and Drug Regulations* (FDR)[8], 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.

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

2 Survey on Certain Low-Moisture Foods

2.1 Rationale

Low-moisture foods, which include dry foods such as spices, dried fruits and a variety of dry ingredients, have been implicated in several outbreaks of foodborne illness over the past decades in different regions of the world[9]. The majority of these outbreaks were associated with spices contaminated with *Salmonella* (Appendix B).

Low-moisture foods have been customarily perceived as safe based on the fact that low water activity (i.e., low moisture) prevents the growth of bacterial pathogens. Contamination of low-moisture foods with bacterial pathogens can happen at various steps of production, from the introduction of contaminated incoming ingredients to cross-contamination during processing[10, 11]. Some pathogens (e.g., *Salmonella, E.coli* O157) are able to survive for extended periods of time in dry foods where they can become more resilient to heat processing and therefore be more difficult to eliminate[10]. Other pathogens (*B. cereus* and *C. perfringens*) form spores that can survive for long periods of time in dry foods, and are also resistant to heat[11]. The risk associated with the presence of pathogens in dry foods depends on the end-use of these foods. For example, gravy or a dipping sauce reconstituted from a dry mix could create growth opportunity for pathogens, and could become a source of foodborne illness. Similarly, a contaminated dry ingredient used to add flavour to a ready-to-eat food (e.g., paprika sprinkled on chips) could cause illness if a pathogen like *Salmonella* is present.

The potential presence of *Salmonella* in spices is well documented[11]. A study carried out by the British Health Protection Agency in 2004 determined that the prevalence of *Salmonella* in dried spices and herbs in the United Kingdom (UK) was 1%[12]. Another study conducted by the United States Food and Drug Administration (US FDA) in 2007/2009 on imported spices identified a prevalence of 6.6%[13]. Spore-forming bacteria such as *Bacillus cereus* and *Clostridium perfringens*, which can cause illness when ingested in large numbers, are also commonly found in spices[11]. Irradiation is an effective treatment used to reduce the bacterial load in spices and is allowed in Canada for a limited number of commodities including spices[14]. However, irradiation is not a practice that is permitted under the Canadian Organic Standards[15], and is therefore not an option in the production of organic spices.

The presence of *Salmonella* in dried dairy products and cocoa powder has also been documented[10, 11]. While the production of these two types of ingredients includes a heat treatment sufficient to kill most pathogens, re-contamination during subsequent steps of the processing can occur[11].

Although deemed rare, contamination with *Salmonella* can occur in dry mixes such as dry soups and gravy mixes, the origin being either contaminated ingredients or contamination from the

processing environment[11]. In early 2010, hundreds of dry mix products were recalled in the US and in Canada because they contained an ingredient, hydrolyzed vegetable protein, which was contaminated with *Salmonella*[16, 17].

Pathogens such as *Salmonella*, *Shigella* and *E. coli* O157 can be present on fruits due to fecal contamination or poor hygiene practices during production[11, 18]. However, dried fruits are generally believed to be safe. Sulphur dioxide, a chemical used in the drying of numerous fruits to prevent browning, usually completely eliminates the microflora, including harmful bacteria, present on fruits[18]. A study in the UK determined that, of a variety of ready-to-eat foods sampled between 2003 and 2005, dried fruits had the best microbiological quality[19]. However, there is currently only limited information regarding the microbial contamination of dried fruits.

Based on the above information, a number of dried products (i.e., spices, dried fruits, dry mixes, cocoa powder, and dried dairy products (whey powder and dried milk products)) have been selected for targeted surveillance under FSAP. The overall objective of this surveillance is to generate baseline information on the occurrence of microorganisms of concern in these commodities available to Canadians at retail.

2.2 Targeted Micro-organisms

2.2.1 Bacterial Pathogens of Concern

Salmonella and *E. coli* O157 are naturally found in the intestines of animals, such as poultry and cattle respectively[20]. Most outbreaks associated with these bacterial pathogens are linked to the consumption of contaminated food of animal origin (e.g., chicken, raw milk and beef burger). However, low-moisture foods have also been identified as a potential vehicle for these pathogens[10]. Low-moisture foods can become contaminated during processing by inadequately cleaned equipment or, in some types of foods (spices, dry mixes), by using contaminated ingredients[11]. Ingredients can become contaminated during primary production in the field, by improperly composted manure, contaminated water and/or wildlife feces, as well as during subsequent handling (sorting, drying, packaging)[4, 5, 6].

Humans and higher primates are the only hosts of the bacterial pathogen *Shigella*. Food contaminated by infected food handlers 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]. Even though *Shigella* is believed to be fragile, studies have shown that it can survive in dry environments for several weeks[18], and could therefore be a concern in dried foods.

The infective dose for these pathogens can be as low 10 organisms[20] and therefore their presence alone represents, even at low levels in a food that does not support their growth, a potential health risk.

Clostridium perfringens and *Bacillus cereus* are spore-forming and toxin-producing bacteria that are widely distributed in soil, dust and vegetation. Foods that are heavily contaminated by these bacteria (more than 10^6 organisms/g) can cause illness[20]. It is estimated that *C. perfringens* and *B. cereus* are respectively the second and fifth leading causes of foodborne illness in Canada[21]. Foods that have been associated with *C. perfringens* contamination include poultry, fish, vegetables, dehydrated foods (such as soups, spices and milk), and stews prepared with raw poultry or beef[18]. Foods that have been associated with *B. cereus* contamination include meats, milk, vegetables, fish, spices, sauces, rice, and starchy foods such as potatoes, pasta and cheese products[18, 20].

2.2.2 Generic *E. coli* - 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 the stools of humans and animals, the occurrence of *E. coli* in foods indicates direct or indirect contamination with fecal matter[22]. The presence of generic *E. coli* in foods can also indicate potential contamination with pathogenic enteric micro-organisms, such as *Salmonella* or *E. coli* O157 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 the 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 dry foods sold at retail are an indication that contamination occurred at some point between primary production and final packaging.

2.3 Sample Collection

All samples were collected from national chain and local/regional grocery stores, as well as other conventional retail and natural food stores located across Canada. The number of samples collected in various geographic regions across Canada was based on the relative proportion of the population in the respective regions.

In this survey, a sample consisted of a single sampling unit (e.g., individual consumer-size package(s) from a single lot) with a total weight of at least 150 g. This sampling approach is common for surveys conducted at retail, and is also used by other federal partners such as the Public Health Agency of Canada (PHAC) for the retail component of their FoodNet Surveys[23].

Collected samples were required to be shipped under conditions that limited the growth of microorganisms during transit. Samples were declared unfit for analysis if there were issues regarding the conditions in which they were handled or shipped.

2.4 Sample Distribution

A total of 1958 low moisture food samples were collected from retail and consisted of spices (545 samples), dried fruits (303 samples), dry mixes (300 samples), cocoa powder (293 samples), and dry dairy products (273 samples of whey protein powder and 244 samples of dry milk products). Over 90% of the products sampled were imported (Table 1). There are currently no requirements in Canada to state the country of origin on the label of imported pre-packaged products such as the ones sampled during this survey. Consequently, many of the imported products sampled did not have the country of origin indicated on their label. These products were categorized under "unidentified" in Table 1.

Table 1. Distribution of Samples by Country of Origin

Country	Spices	Dried Fruits	Dry Mixes	Cocoa Powder	Whey Protein	Dry Milk Products
Domestic (Canada)	13 (2.4%)	4 (1.3%)	10 (3.3%)	5 (1.7%)	25 (9.2%)	13 (5.3%)
Austria	-	-	6 (2.0%)	-	-	-
Belgium	-	-	-	7 (2.4%)	-	-
Brazil	-	-	-	3 (1.0%)	-	-
Chile	-	2 (0.7%)	-	-	-	-
China	19 (3.5%)	5 (1.7%)	2 (0.7%)	-	-	1 (0.4%)
Costa Rica	-	1 (0.3%)	-	-	-	-
Croatia	-	-	7 (2.3%)	-	-	-
Dominican republic	-	-	-	6 (2.0%)	-	-
Ecuador	-	3 (1.0%)	-	1 (0.3%)	-	-
Egypt	5 (0.9%)	-	-	-	-	-
France	-	-	-	1 (0.3%)	-	5 (2.0%)
Germany	-	-	-	2 (0.7%)	-	-
Greece	-	3 (1.0%)	-	-	-	-
Guatemala	1 (0.2%)	-	1 (0.3%)	-	-	-
Hungary	1 (0.2%)	-	-	-	-	-
India	41 (7.5%)	1 (0.3%)	19 (6.3%)	-	-	3 (1.2%)
Indonesia	4 (0.7%)	-	2 (0.7%)	-	-	-
Iran	-	3 (1.0%)	-	-	-	-
Ireland	-	-	1 (0.3%)	-	-	12 (4.9%)
Israel	3 (0.6%)	1 (0.3%)	2 (0.7%)	-	-	-
Italy	1 (0.2%)	-	-	2 (0.7%)	-	-
Japan	-	-	14 (4.7%)	-	-	-
Korea	-	-	1 (0.3%)	-	-	-
Lebanon	-	-	1 (0.3%)	-	1 (0.4%)	-

Country	Spices	Dried Fruits	Dry Mixes	Cocoa Powder	Whey Protein	Dry Milk Products
Mexico	-	4 (1.3%)	-	-	-	3 (1.2%)
Netherlands	-	-	-	9 (3.1%)	-	-
New Zealand	-	-	-	-	30 (11.0%)	2 (0.8%)
Norway	4 (0.7%)	-	-	-	-	-
Pakistan	3 (0.6%)	6 (2.0%)	12 (4.0%)	-	-	3 (1.2%)
Peru	5 (0.9%)	-	-	5 (1.7%)	-	-
Philippines	-	36 (11.9%)	8 (2.7%)	-	-	-
Poland	1 (0.2%)	-	2 (0.7%)	1 (0.3%)	-	-
Singapore	-	-	1 (0.3%)	-	-	1 (0.4%)
South Africa	2 (0.4%)	2 (0.7%)	1 (0.3%)	-	-	-
Spain	4 (0.7%)	-	1 (0.3%)	-	-	-
Sri Lanka	10 (1.8%)	-	-	-	-	-
Switzerland	-	-	2 (0.7%)	-	7 (2.6%)	71 (29.1%)
Taiwan	-	-	1 (0.3%)	-	-	-
Thailand	-	11 (3.6%)	16 (5.3%)	-	-	-
Trinidad & Tobago	1 (0.2%)	-	-	-	-	5 (2.0%)
Tunisia	-	3 (1.0%)	-	-	-	-
Turkey	-	51 (16.8%)	2 (0.7%)	-	-	-
United Kingdom	2 (0.4%)	-	2 (0.7%)	20 (6.8%)	1 (0.4%)	1 (0.4%)
United States	43 (7.9%)	69 (22.8%)	106 (35.3%)	101 (34.5%)	140 (51.3%)	70 (28.7%)
Vietnam	4 (0.7%)	-	1 (0.3%)	-	-	-
Unidentified	378 (69.4%)	98 (32.3%)	79 (26.3%)	130 (44.4%)	69 (25.3%)	54 (22.1%)
Total Imported	532 (97.6%)	299 (98.7%)	290 (96.3%)	288 (98.3%)	248 (90.8%)	231 (94.7%)
Total	**545**	**303**	**300**	**293**	**273**	**244**
Grand Total = 1958						

Several types of spices (Table 2), dried fruits, dry mixes and dry milk products (Table 3) were sampled. Overall, about half of the spices sampled were organic.

Table 2. Distribution of Spices by Product Type and Production Practice

Product Type	Organic Samples	Conventional Samples	Total
Paprika	28 (9.5%)	56 (22.4%)	84 (15.4%)
Cumin	32 (10.8%)	21 (8.4%)	53 (9.7%)
Garlic powder	39 (13.2%)	12 (4.8%)	51 (9.4%)
Cinnamon	27 (9.2%)	23 (9.2%)	50 (9.2%)
Pepper, cayenne	23 (7.8%)	16 (6.4%)	39 (7.2%)
Pepper, black	19 (6.4%)	19 (7.6%)	38 (7.0%)
Turmeric	25 (8.5%)	10 (4.0%)	35 (6.4%)
Ginger	13 (4.4%)	20 (8.0%)	33 (6.1%)
Nutmeg	28 (9.5%)	2 (0.8%)	30 (5.5%)
Chili powder	8 (2.7%)	18 (7.2%)	26 (4.8%)
Curry powder	11 (3.7%)	12 (4.8%)	23 (4.2%)
Mustard	10 (3.4%)	13 (5.2%)	23 (4.2%)
Mixed spices	3 (1.0%)	6 (2.4%)	9 (1.7%)
Celery seed/salt	5 (1.7%)	1 (0.4%)	6 (1.1%)
Pepper, chili	2 (0.7%)	4 (1.6%)	6 (1.1%)
Pepper, red	4 (1.4%)	2 (0.8%)	6 (1.1%)
Coriander (ground)	2 (0.7%)	3 (1.2%)	5 (0.9%)
Pepper, white	4 (1.4%)	1 (0.4%)	5 (0.9%)
Anise	4 (1.4%)	-	4 (0.7%)
Allspice	1 (0.3%)	2 (0.8%)	3 (0.6%)
Other*	7 (2.4%)	9 (3.6%)	16 (0.4%)
Total	**295 (100%)**	**250 (100%)**	**545 (100%)**

*Other refers to spice types with only one or two samples.

Table 3. Dried Fruits, Dry mixes and Dry Milk Products by Product Type

Dried Fruits		Dry Mixes		Dry Milk Products*	
Apricot	66 (21.8%)	Soup Mix	126 (42.0%)	Coffee mix	66 (27.0%)
Mango	60 (19.8%)	Seasoning	47 (15.7%)	Infant Formula	46 (18.9%)
Raisin	46 (15.2%)	Sauce Mix	42 (14.0%)	Hot chocolate Mix	33 (13.5%)
Cranberry	32 (10.6%)	Baking Mix	17 (5.7%)	Skim milk powder	24 (9.8%)
Date	15 (5.0%)	Coating Mix	16 (5.3%)	Malt Products	21 (8.6%)
Fig	15 (5.0%)	Gravy	10 (3.3)	Breakfast Drink Mix	20 (8.2%)
Prune	15 (5.0%)	Bouillon Mix	6 (2%)	Meal Replacement/ Weight loss product	11 (4.5%)
Papaya	10 (3.3%)	Dressing or Dipping Sauce Mix	5 (1.7%)	Milk powder	6 (2.4%)
Pineapple	8 (2.6%)	Mashed Potato Mix	5 (1.7%)	Coffee whitener	6 (2.5%)
Plum	6 (2.0%)	Vegetable Mix	5 (1.7%)	Alfredo sauce	4 (1.6%)
Cherry	5 (1.7%)	Rice Mix	4 (1.3%)	Dessert Mix	4 (1.6%)
Blueberry	4 (1.3%)	Fruit Drink Mix	3 (1.0%)	Tea mix	2 (0.8%)
Mixed Fruit	4 (1.3%)	Pancake/Waffle Mix	3 (1.0%)	Skim goat milk	1 (0.4%)
Plantain	4 (1.3%)	Pudding/Pie Mix	3 (1.0%)		
Kiwi	3 (1.0%)	Bread Mix	2 (0.7%)		
Apple	2 (0.7%)	Cream Mix	2 (0.7%)		
Banana	2 (0.7%)	Stuffing	2 (0.7%)		
Currant	2 (0.7%)	Noodle Mix	1 (0.3%)		
Guava	1 (0.3%)	Unspecified	1 (0.3%)		
Peach	1 (0.3%)				
Strawberry	1 (0.3%)				
Tomato	1 (0.3%)				
Total	**303**	**Total**	**300**	**Total**	**244**

Notes: * Samplers were instructed to sample dry milk products that had dry milk listed as the first ingredient

2.5 Method Details

All samples were analysed using the analytical methods published in Health Canada's *Compendium of Analytical Methods for the Microbiological Analysis of Foods*[24] (Appendix C). These methods are used for regulatory testing by the CFIA and are fully validated for the analysis of the products sampled during this survey. A modified version of the method from Health Canada's Compendium was used for *Salmonella* testing, as indicated in Appendix C.

For the detection of *Salmonella*, *Shigella* and *E. coli* O157, samples were analyzed by cultural presence/absence methods. Laboratories had the option of using rapid Polymerase Chain Reaction (PCR) based screening methods to first screen enrichment broths for the presence of DNA from the pathogen of interest, followed by cultural confirmation of presumptive positives.

Bacterial isolates from positive samples were further characterised by pulsed field gel electrophoresis (PFGE, i.e., DNA fingerprint) at the CFIA's PFGE Centre. Serotyping for *Salmonella* spp. was performed at the *Salmonella* Typing Laboratory, Laboratory for Foodborne Zoonoses, Public Health Agency of Canada (PHAC).

Enumeration of generic *E. coli* was accomplished by the most probable number (MPN) procedure. Enumeration of *B. cereus* and *C. perfringens* was accomplished by direct plating procedure.

2.6 Assessment Guidelines

The assessment criteria presented below (Table 4, 5 & 6) are based on the principles of the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods*[25] and associated methods published in Health Canada's *Compendium of Analytical Methods*[24].

Table 4. Assessment Guidelines for Spice Samples

Bacterial Analysis* **(Method Identification Number)**	**Assessment Criteria**		
	Satisfactory	**Investigative**	**Unsatisfactory**
***Salmonella* spp.** (MFLP-29 modified and MFHPB-20 if required for confirmation)	Absent in 25 g	N/A	Present in 25 g
Bacillus cereus (MFLP-42)	$\leq 10^4$ CFU/g	$10^4 < x \leq 10^6$ CFU/g	$> 10^6$ CFU/g
Clostridium perfringens (MFHPB-23)	$\leq 10^4$ CFU/g	$10^4 < x \leq 10^6$ CFU/g	$> 10^6$ CFU/g
Generic *E. coli* (MFHPB-19)	$\leq$ 100 MPN/g	100 < x $\leq$ 1,000 MPN/g	> 1,000 MPN/g

** Compendium of Analytical Methods*[24].

Table 5. Assessment Guidelines for Dry Mix* and Dried Fruit Samples*

Bacterial Analysis** **(Method Identification Number)**	**Assessment Criteria**		
	Satisfactory	**Investigative**	**Unsatisfactory**
***Salmonella* spp.** (MFLP-29 modified and MFHPB-20 if required for confirmation)	Absent in 25 g	N/A	Present in 25 g
***E. coli* O157** (MFLP-30, MFLP-30 Supplement 2 & MFLP-80 if required for confirmation)	Absent in 25 g	N/A	Present in 25 g
***Shigella* spp.** (MFLP-26 & MFLP-25 if required for confirmation)	Absent in 25 g	N/A	Present in 25 g
Generic *E. coli* (MFHPB-19)	≤ 60 MPN/g	60 < x ≤ 1,000 MPN/g	> 1,000 MPN/g

* No criteria have been established by Health Canada at this time for *E. coli* O157 and *Shigella* spp. in dry mixes, or for any bacteria in dried fruits. However, in the absence of a specified criteria, presence of bacterial pathogens in foods is considered to be a violation of FDA Section 4(1)a and the detection of generic *E. coli* at levels above 1,000 CFU/g or MPN/g is considered to be a violation of FDA Section 7, and are therefore assessed by the CFIA as unsatisfactory.
** *Compendium of Analytical Methods*[24].

Table 6. Assessment Guidelines for Cocoa Powder, Dry Milk Products and Whey Protein Samples

Bacterial Analysis* **(Method Identification Number)**	**Assessment Criteria**	
	Satisfactory	**Unsatisfactory**
***Salmonella* spp.** (MFLP-29 modified and MFHPB-20 if required for confirmation)	Absent in 25 g	Present in 25 g

* *Compendium of Analytical Methods*[24].

Based on the current regulatory standards and microbiology testing criteria, samples were assessed as either "satisfactory," "unsatisfactory" or "investigative." Unsatisfactory samples 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). Samples assessed as investigative require some follow-up activity. This could include, for example, further sampling to verify the levels of generic *E. coli* in the samples in question.

2.7 Survey Limitations

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.

The number of samples collected and analysed during this survey (i.e., 545 samples of spices, 303 of dried fruits, 244 of dry milk products, 293 of cocoa powder, 273 of whey protein and 300 of dry mixes) is very limited considering the wide selection of product types and origins available to Canadians under each category. The results of this survey only provide a snapshot of the microbiological quality of these commodities, and care must be taken when interpreting and extrapolating these results.

3 Results

3.1 Spices

A total of 545 spice samples were analysed for *Salmonella*, *C. perfringens, B. cereus* and generic *E. coli*, an indicator of fecal contamination. *Salmonella* was detected in one sample of organic curry powder. *Salmonella* Infantis (6,7:r:1,5) was identified from the isolate of the positive sample. As a result of this finding, the CFIA initiated a food safety investigation which resulted in the recall of the affected product. *C. perfringens, B. cereus* and the indicator generic *E. coli* were not found at levels exceeding the satisfactory threshold in any of the samples.

The one contaminated sample of domestic organic curry powder was assessed as unsatisfactory and the remaining 544 samples were assessed as satisfactory.

Table 7. Summary of Results for Spices Analysed for *Salmonella* spp., *B. cereus*, *C. perfringens* and Generic *E. coli*

Production Practice	Origin	Number of Samples	Assessment		
			Satisfactory	Investigative	Unsatisfactory
Conventional	**Domestic**	4	4	0	0
	Imported	246	246	0	0
	Sub Total	250	250 (100%)	0	0
Organic	**Domestic**	9	8	0	1
	Imported	286	286	0	0
	Sub Total	295	294 (99.7%)	0	1
Grand Total		**545**	**544(99.8%)**	**0**	**1 (0.2%)**

3.2 Dried Fruits and Dry Mixes

Salmonella, *Shigella* and *E. coli* O157 were not detected in any of the samples of dried fruits and dry mixes that were tested, and generic *E. coli* was not found at levels exceeding the satisfactory threshold. All samples were assessed as satisfactory.

Table 8. Summary of Results for Dried Fruits and Dry Mixes Analysed for *Salmonella* spp., *Shigella* spp., *E. coli* O157:H7 and Generic *E. coli*

Product Type	Number of Samples	Assessment		
		Satisfactory	Investigative	Unsatisfactory
Dried Fruits	303 (4 domestic)	303	0	0
Dry Mixes	300 (10 domestic)	300	0	0
Total	**603**	**603 (100%)**	**0**	**0**

3.3 Dry Milk Products, Whey Protein and Cocoa Powder

The bacterial pathogens *Salmonella* was not detected in any of the samples of the dry milk products, cocoa powder and whey protein that were tested. All samples were assessed as satisfactory.

Table 9. Summary of Results for Dry Milk Products, Whey Protein and Cocoa Powder Analysed for *Salmonella* spp.

Product Type	Number of Samples	Assessment	
		Satisfactory	Unsatisfactory
Dry Milk Ingredients	244 (13 domestic)	244	0
Whey Protein	273 (25 domestic)	273	0
Cocoa Powder	293 (5 domestic)	293	0
Total	**810**	**810 (100%)**	**0**

4 Conclusion and Discussion

In this survey (2011/12), 99.95% of the low moisture food samples analysed were assessed as satisfactory. Only one sample was assessed as unsatisfactory due to the detection of *Salmonella*. Levels of *B. cereus* and *C. perfringens* were found to be acceptable in all spice samples. Levels of generic *E. coli* were found to be acceptable in all the samples tested for this organism (spices, dried fruits and dry mixes). *Shigella* and *E. coli* O157 were not detected in the any of the dried fruit and dry mixes samples. The *Salmonella* positive sample (organic curry powder) triggered appropriate follow-up procedures including the recall of the affected product. It is important to note that there were no reported illnesses associated with the consumption of the contaminated product sampled during this survey.

The overall finding of this survey suggests that the vast majority of low-moisture foods sampled during this survey were produced and handled under good GAPs and GMPs. However, sporadic contamination with *Salmonella* can occur and can represent a food safety risk.

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

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Appendix A: List of Acronyms and Abbreviations

B. cereus: *Bacillus cereus*

CFIA: Canadian Food Inspection Agency

CDC: Centres for Disease Control and Prevention

CFU/g: colony forming units per gram

C. perfringens: *Clostridium perfringens*

E. coli: *Escherichia coli*

FAO: Food and Agriculture Organization of the United Nations

FDA: Food and Drug Act

FCSAP: Food and Consumer Safety Action Plan

FSAP: Food Safety Action Plan

GAPs: Good Agricultural Practices

GMPs: Good Manufacturing Practices

HPB/MFHPB: Health Protection Branch/ Microbiology Food Health Protection Branch

MFLP: Microbiology Food Laboratory Procedures

MPN: Most Probable Number

NM: non-motile

PCR: Polymerase Chain Reaction

PFGE: Pulsed Field Gel Electrophoresis

PHAC: Public Health Agency of Canada

spp.: species

UK: United Kingdom

US FDA: United States Food and Drug Administration

WHO: World Health Organization

g: gram

Appendix B: Examples of Foodborne Disease Outbreaks Associated With Low-Moisture Foods Contaminated with Microbial Pathogens (1993-2011)*

Year	Micro-organisms	Vehicle	Country	Cases	Source
1993	*Salmonella*	Paprika and paprika-powdered potato chips	Germany	1,000	Giedon online & ProMed May 21, 2007 (Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)
1993	*Salmonella* Tennessee	Powdered infant formula	Canada, USA	3	See reference #10
1996	*Salmonella* Anatum	Powdered infant formula	UK, France	>12	See reference #10
1999	*Salmonella* Java PT Dundee	Desiccated coconut	UK	168	See reference #10
2002	*Salmonella* Braenderup	Curry powder used by caterers	England	20	CDR Archives (Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)
2002	*Salmonella* Agona	Anise seed in herbal tea	Germany	40	Biometrical Journal 46(S1):140. Emerg. Infect. Dis. 11(7) 2005 (Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)
2005	*Salmonella* Typhimurium	Cake mix used in cake batter ice cream	USA	26	See reference #10
2007	*Salmonella* Wandsworth & *Salmonella* Typhimurium	Seasoning mix & broccoli powder (coating a snack puff)	USA (China for dried broccoli powder)	69 & 18	See reference #26

Year	Micro-organisms	Vehicle	Country	Cases	Source
2007	*Bacillus cereus*	Spice blend used in couscous dish	France	146	European Food Safety Authority 2007 (Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)
2007-2008	*Salmonella* Senftenberg	Fennel seed	Serbia	14	See reference #26
2008	*Salmonella* Give	Powdered infant formula	France	8	See reference #10
2008	*Salmonella* Rissen	Ground pepper imported, packaged and distributed by a California company	USA	87	Oregon Depart. of Human Services Public Health Division (Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)
2009	*Bacillus Cereus*	Rosepaprika (spice)	Denmark	48	The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Foodborne Outbreaks in 2009 (Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)
2009-10	*Salmonella* Montevideo	Salami products made with contaminated Imported Black and Red Pepper	USA	272	CDC (Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)
2010	*Bacillus cereus*	White pepper	Denmark	112	EU 2010 report ((Information provided by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC)

*The data presented in the above table were collected from several sources of information, such as peer-reviewed journals, newspapers, press releases, health units, national laboratory and government websites.

Appendix C: Analytical Methods* Used for Microbial Analysis

Bacterial Analysis	Method Identification Number (Date Issued)	Title of Method*
***Salmonella* spp.**	MFLP-29 (July 2007, modified)**	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
***E. coli* O157:H7/NM**	MFLP-30 (May 2003, Supplement 1 May 2005 & Supplement 2 November 2006)	The Dupont Qualicon Bax® System Method for the Detection of *E. coli* O157:H7 in Raw Beef and Fruit Juice
	MFLP-80 (March 2008)	Isolation of *E. coli* O157:H7 or NM in Foods
B. cereus	MFLP-42 (May 2011)	Isolation and Enumeration of the *Bacillus cereus* Group in Foods
C. perfringens	MFHPB-23 (November 2001)	Enumeration of *Clostridium perfringens* in Foods
Generic *E. coli*	MFHPB-19 (April 2002)	Enumeration of Coliforms, Faecal Coliforms and of *E. coli* in Foods

* All methods used are published *in the Compendium of Analytical Methods* (23)

** MFLP-29 was performed as written with the following modification: Secondary enrichment was performed as outlined for cantaloupes, i.e., transferred from buffered peptone broth as specified to RVS and TBG broths (Rappaport-Vassiliadis Soya Peptone broth and Tetrathionate Brilliant Green broth) and incubated for 24 ± 2 h at 42.5°C. After incubation 2 ml from each of RVS and TBG are combined to one sample and analysis proceeds at step 7.3.1.4 of the method.