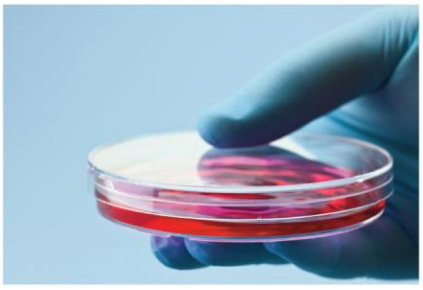
Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Microbiology Annual Report

2011/12

National Microbiological Monitoring Program



Foods of Plant and Animal Origin

RDIMS #3666622

Canada

TABLE OF CONTENTS

Executive Summary

The Government of Canada verifies that food produced and/or sold in Canada meets federal food safety standards to ensure Canadians have confidence in what they buy. The Canadian Food Inspection Agency (CFIA) monitors and regulates food products that are produced domestically and moved inter-provincially, or are imported. Within Canada, all food products must comply with the *Food and Drugs Act* and *Regulations*, which set out criteria for safe food and clearly prescribe restrictions on the production, importation, sale, composition and content of food.

The National Microbiological Monitoring Program (NMMP) is one of many tools utilized by the CFIA to verify that domestically produced and imported products meet Canadian standards. It is designed to sample and test a broad range of imported and domestic commodities for multiple hazards, including microbial hazards and extraneous material. The testing carried out under the NMMP covers red meat and poultry products, shell eggs and egg products, dairy products, fresh fruits and vegetables and processed fruit and vegetable products.

As CFIA focuses its monitoring activities towards specific food-related hazards that may impair the health and safety of Canadians, it is important to note that most testing is in commodities that are not further processed by the consumer as well as in raw food, that if not properly cooked, can lead to illness. It is generally accepted that proper precautions taken in the home will destroy any bacteria that may be present.

During the 2011/12 fiscal year under the NMMP, 14307 tests were performed on 5234 domestic and imported products. Specifically, 9049 tests were performed on 3678 domestic products and 5258 tests were performed on 1556 imported products to verify they were compliant with Canadian standards. Results indicated that domestic products were 99.0% compliant and imported products were 98.0% compliant. Overall, a 98.7% compliance rate for combined domestic and imported products was observed.

In addition to testing food products, wash water samples and surface swabs taken within the food production environment are used to verify that food products are produced under sanitary conditions. This type of environmental sampling was performed in domestic establishments to verify the operator systems' ability to control the presence of pathogens within the processing environment. During 2011/12, there were 2300 tests performed on 1878 environmental samples which were assessed as 97.5% compliant.

The results of the 2011/12 NMMP sampling activities demonstrate that the products available in the Canadian marketplace are for the majority compliant with national standards.

1. General Introduction

The Canadian Food Inspection Agency (CFIA) is Canada's federal food safety, animal health and plant protection enforcement agency. It is responsible for the administration and enforcement of 13 Acts, including the *Food and Drugs Act*, *Food and Drug Regulations*, the *Canada Agricultural Products Act* and the *Meat Inspection Act*. The CFIA delivers 14 inspection programs related to foods, plants and animals across Canada. One of the Agency's roles is to ensure the safety of the Canadian food supply and enforce standards established by Health Canada. This is achieved through a series of activities that range from the inspection of federally-registered establishments to border inspections, laboratory testing and the performance of food safety investigations, risk assessments and recalls on unsatisfactory results.

The Government of Canada ensures the implementation of various measures pertaining to food safety to ensure Canadians have confidence in the quality and safety of the foods they eat. Within Canada, all food products must comply with the *Food and Drugs Act* and *Regulations* that specify the safety of food and prescribe certain restrictions on the production, importation, sale, composition and content of foods and food products. There are three main parties involved in the quality and food safety continuum; the consumer, the industry and the regulatory bodies (CFIA, Health Canada, provincial/territorial governments and municipal authorities). While the regulatory bodies oversee the development, monitoring and enforcement of food safety regulations, it is the industry that is responsible for implementing systems and practices to ensure the production of safe food.

It is the responsibility of the consumer to ensure proper food safety practices are adhered to in the home, and this area of food safety lies outside of the CFIA's jurisdiction. There are several ways in which consumers can contribute to the safety of their food. Consumers should ensure foods are stored and maintained under proper conditions to minimize bacterial growth. Consumers should take steps to prevent cross-contamination between raw and ready-to-eat (RTE) foods while shopping at the grocery store, during transport, meal preparation and storage. Raw foods, such as ground red meat and poultry products, must be cooked sufficiently to ensure that an adequate core temperature is reached in order to kill any pathogens present. Restaurants and catering services are also responsible for implementing these food safety measures. More information on safe food handling practices and the prevention of foodborne illnesses can be found on Health Canada's Food and Nutrition website for Healthy Canadians: http://www.healthycanadians.gc.ca/eating-nutrition/index-eng.php.

There are many Canadian standards pertaining to food safety. To ensure all food-related issues are addressed these Canadian standards are supplemented by International standards. In addition to criteria and guidance material generated by the Government of Canada, both the CFIA and Health Canada actively participate in the Codex Alimentarius Commission that establishes standards, guidelines and codes of practice for the production of safe foods internationally. The primary purpose of these standards is to protect the health of consumers, ensure fair trade practices, and promote global implementation of food safety standards and codes of practice. Producers are encouraged to follow the international codes of practice developed by the Codex Alimentarius Commission that provide guidance for the safe production of food. The codes address Good Agricultural Practices and Good Manufacturing Practices to control and reduce the potential for contamination with microbial, chemical and physical hazards at all stages of production. They outline basic requirements pertaining to environmental hygiene, hygienic production (including water, manure, soil biological control, packing, facility sanitation and personal hygiene), handling, storage, transportation, maintenance and sanitation.

The CFIA oversees the design, implementation and reporting of testing for allergen, chemical and microbial food safety hazards. These sampling and testing activities are an integral part of the tools used by the Agency to verify that food production practices are in compliance with applicable Acts, standards and guidelines. They demonstrate the quality of products available in the Canadian marketplace, assuring consumers that the government has systems in place to ensure the food they consume is safe. In addition, sampling activities support international trade and demonstrate equivalency with trading partners.

This report summarizes the sampling and testing activities performed in the area of microbial hazards in food under the National Microbiological Monitoring Program (NMMP). During 2011/12, the Agency implemented a variety of microbiological sampling activities such as (i) monitoring by random sampling of the food supply to verify compliance, (ii) risk-based sampling through enhanced sampling of specific food/hazard combinations that are of greater concern to human health and (iii) directed sampling, which focuses on specific food/hazard combination contamination issues or concerns. These activities cover the sampling and testing of domestic and imported foods of both plant and animal origin, for various microbial hazards of concern. Results are assessed for compliance and follow-up and enforcement action is taken when necessary.

The purpose of this report is to inform Canadians of the results obtained through the monitoring activities (which includes risk-based sampling) of the CFIA's NMMP. Analytical results from directed sampling activities are not included in this report.

Refer to Appendix A for a list of acronyms and abbreviations and Appendix B for a glossary of terms commonly used in this report.

2. Responsibilities of the CFIA

The CFIA is responsible for the administration and enforcement of 13 Acts and numerous sets of Regulations. The CFIA carries out its responsibilities through the implementation of a variety of compliance verification activities, including inspections, audits, monitoring, grading, sampling, testing and reporting. Inspections of domestic facilities and imported foods are performed regularly. These inspection activities can include the sampling and submission of food for microbial analysis to verify the products were produced in compliance with all relevant Acts and Regulations. In cases of non-compliance the Agency implements appropriate follow-up actions and risk management steps to protect the health of Canadian.

2.1. Legal Authority

Although there are multiple Acts enforced by the CFIA, the most relevant to the NMMP are the *CFIA Act* and the *Food and Drugs Act* and *Regulations*. The *CFIA Act* defines the Agency and its responsibilities.

CFIA Act

11. (1) The Agency is responsible for the administration and enforcement of the *Agriculture and Agri-Food Administrative Monetary Penalties Act, Canada Agricultural Products Act, Feeds Act, Fertilizers Act, Fish Inspection Act, Health of Animals Act, Meat Inspection Act, Plant Breeders' Rights Act, Plant Protection Act* and *Seeds Act.*

(2) The Agency is responsible for the enforcement of the *Consumer Packaging and Labelling Act* as it relates to food, as that term is defined in section 2 of the *Food and Drugs Act.*

(3) The Agency is responsible for
(*a*) the enforcement of the *Food and Drugs Act* as it relates to food, as defined in section 2 of that Act; and
(*b*) the administration of the provisions of the *Food and Drugs Act* as they relate to food, as defined in section 2 of that Act, except those provisions that relate to public health, safety or nutrition.

(4) The Minister of Health is responsible for establishing policies and standards relating to the safety and nutritional quality of food sold in Canada and assessing the effectiveness of the Agency's activities related to food safety.

The *Food and Drugs Act* clearly prescribes certain restrictions on the production, sale, composition and content of foods and food products. Section 2 provides clear definitions of the various food safety components, such as "food", "unsanitary conditions" and "inspector", and Section 4(1) of the Act (below) describes prohibitions on the sale of food. From the standpoint of microbial hazards and extraneous material the most important restrictions are those detailed in Sections 4(a), (b), (c) and (e) and Section 7.

Food and Drugs Act

Prohibited sales of food

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, etc., of food

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

2.2. *Enforcement Actions*

CFIA compliance and enforcement actions occur all along the supply chain and involve numerous stakeholders and jurisdictions. However, it is the responsibility of the food producer or importer to comply with all relevant Acts and Regulations. When microbial contaminants are detected in food products, a food safety investigation may be performed to determine if a violation has occurred. This may include consultation with Health Canada to determine whether or not the product poses a potential health risk to consumers or sensitive segments of the population (e.g. elderly, immuno-compromised, children, pregnant women). Where non-compliance is discovered there are a variety of measures that can be used to ensure a return to compliance and safety. As the degree of severity of the non-compliance increases, more stringent enforcement actions are used as determined on a case-by-case basis. Enforcement tools available include a letter of non-compliance, seizure and detention of the product, confiscation, refusal of entry, recall, disposal or destruction of the product, suspension or cancellation of license, administrative monetary penalties and/or prosecution.

3. Sampling Plans: Definitions and Terminology

Sampling plans include protocols that detail various components required to define the activities involved in sampling and testing for microbial contaminants. The intent is to obtain a sample that is representative of the commodity being produced. To accurately assess the microbial quality of the sample the potential for contamination must be controlled and the integrity of the sample must be maintained throughout the sampling and analytical process.

3.1. Sampling Plan Design

There are two types of sampling plan designs commonly used for the microbial analysis of food: variable and attribute. It is the availability of data that determines what type of sampling plan is most appropriate (ICMSF 7, 2002). For example, a variable sampling plan is used when the underlying distribution of the microorganism within a particular commodity is known, or can be easily determined based on existing data. It employs the use of multiple variables to determine the quality of the commodity on a graduated continuum ranging from 'very good' to 'very bad'. As Canadian manufacturers must continuously monitor and test their processes and products to ensure they maintain quality control and produce safe food, they have extensive proprietary databases of information from which to draw conclusions and utilize variable sampling plans. Since there is no legislative obligation for all industries to share this data with the CFIA on a routine basis, the CFIA does not use variable sampling plans. However, in certain situations this information may be shared with the CFIA as part of the program design.

Where little or no information is available regarding the distribution of a microbial hazard within a food commodity, the use of an attribute sampling plan is more effective. Based on the tools and information utilized by the CFIA, attribute sampling plans effectively support the Agency's monitoring activities. In this type of sampling plan, each sample is representative of the microbial quality of the entire lot of product. Each sample is analyzed and assessed according to only two or three assessments of quality.

Attribute sampling plans can be further divided based on the number of categories against which the results are assessed (e.g. presence/absence or satisfactory/investigative/unsatisfactory). These are commonly referred to as 2- and 3-class sampling plans. A 2-class plan in one in which a qualitative analysis is performed to determine the presence or absence of the target microorganism. This type of sampling plan classifies the food lot as either acceptable or defective. Based on the analysis of the sample, the entire lot represented by the sample is implicated and assessed based on the presence (defective) or absence (acceptable) of the microorganism. A 2-class plan is suitable when there is zero tolerance towards the presence of a microorganism. Under the

NMMP it is used when testing for pathogens that can induce illness when only a few cells (e.g. 10-100) are ingested and their presence in food is not acceptable. For example, when *Salmonella* spp. is detected in a lunch meat sample, the entire associated lot is assessed as unsatisfactory (defective) and not fit for human consumption.

Alternatively, a 3-class attribute plan is one in which a quantitative analysis is performed to determine the level or concentration of the microorganism by quantifying the number of colony forming units (CFU) of the organism present (refer to section 5.4 for more information on CFU). This type of plan offers three attribute classes: acceptable, marginally acceptable and defective. The NMMP uses 3-class plans when the presence of some cells of the organism in question or certain amounts of extraneous material are tolerated. The use of 3-class plans is dependent on the specific food-hazard combination of concern. They may be used for the assessment of indicator organisms (those that do not cause illness) or some pathogens that are not considered to represent a health risk if present in low numbers. For example, within the NMMP this applies to the presence of indicator organisms such as generic *Escherichia coli* in a variety of different food commodities.

The CFIA cannot test all lots of food produced domestically or imported as this would be overwhelming. Therefore the CFIA implements a randomized approach to test representative subsamples of these foods. For the microbiological food testing activities summarized in this report the CFIA implements 2-class and 3-class attribute sampling plans for multiple reasons: (i) it is logistically impossible for CFIA to test all foods for all microbial hazards at all times, (ii) there are no extensive databases available for each food/hazard combination of interest, (iii) there is little or no information about the conditions under which imported foods are produced and (iv) these sampling activities are used as one of many tools to verify compliance by industry with food safety standards, therefore large numbers of samples are not required.

3.2. Types of Sampling Activities

Food sampling and testing are part of the CFIA's daily activities and the majority of samples under the NMMP are tested for multiple organisms. The CFIA microbiological food testing activities summarized in this report involved two types of sampling to verify industry compliance with food safety standards and guidelines. The most common type of sampling implemented by the NMMP during 2011/12 was monitoring sampling, which involves the unbiased and random selection of samples. The analysis of these samples is intended to provide information on the occurrence or level of contamination in a pre-defined type of food. Typically the sampled lots are not held, and distributed for sale before the analytical results are known.

Risk-based sampling was also used, but to a lesser extent. This is an enhanced monitoring activity designed to provide information on the occurrence or level of contamination in a targeted sample population. This type of sampling is used to monitor areas known to pose a higher risk and sampling is designed using predetermined factors known to contribute to the potential level of risk to the consumer. As an example of risk-based sampling, the number of samples to be taken at each federally registered RTE meat establishment is calculated annually, based on individual establishment profiles and the level of risk to the consumer. These profiles may include parameters such as production volume, type of products produced, and the use of antimicrobial agents or lethality treatments. Because they are identified as being high risk, the sampled lots are voluntarily held by the establishment until the analytical results are known.

There are a variety of other sampling activities that are implemented as appropriate by the Agency. Targeted surveys are information gathering studies used to determine the occurrence of contaminants in foods, but are usually limited in scope and duration. They may involve testing programs for microorganisms that are not included as part of the NMMP, such as certain parasites and viruses. In addition, targeted surveys may include pilot projects or baseline surveys, where an extensive amount of information is gathered to develop a large database that may contribute to future decisions, activities and policies. Furthermore, sampling and testing blitzes are used to obtain a snapshot concentrated in time to assess compliance with food safety requirements at selected locations. For example, the CFIA may coordinate border blitzes, and the scheduling of these blitzes is not announced.

When routine sampling and monitoring programs identify the presence of a risk, an effective control strategy is to use directed sampling and compliance activities to assess the extent and depth of the issue. When specific issues around food safety are identified, there are several sampling activities, also known as follow-up sampling that may be implemented.

Directed sampling involves the biased selection of samples and is directed at the product or type of product where a hazard has been found. It is used to investigate any suspected food safety issues that could pose a potential health risk. This type of sampling may be triggered by consumer complaints, visual inspections of operators or unsatisfactory findings within any of the other types of sampling programs, including industry implemented sampling.

Compliance sampling encompasses in-depth sampling directed at specific samples suspected of not being in conformance with specific food safety regulations and guidelines. The product is usually detained until the test results are available.

Legal sampling is performed under conditions where legal action is anticipated. Rigorously sound procedures are critical during the sampling and testing of these samples. For example, the establishment of a chain of custody for the sample is essential if legal proceedings are expected to ensue.

Data obtained as a result of these sampling activities may be used to support risk analysis activities, which can include public notices, recalls, plant closures, or a hold and test strategy. When monitoring activities indicate that a contaminant in a given food commodity presents a potential risk, sampling plans may be adjusted, but only to the point that such effort will aid in the understanding of the problem or facilitate regulatory control. Increased sampling from a monitoring perspective permits the study of trends, geographical variation and seasonal prevalence over time, thereby aiding in the design of effective control strategies. However, merely increasing the number of samples taken without a strategy that addresses the benefits is of little value.

The different scopes of sampling performed in Canada are comparable to what is implemented internationally, including in the United States, which is Canada's major trading partner. The terminology used to describe the various sampling activities performed within Canada is in-line with the United States Department of Agriculture's Food Safety and Inspection Service and the Codex Alimentarius Commission.

4. Food Safety Analyses

The microorganisms identified for analysis are widely accepted as being known to occur in particular food items and associated processing technique used in the preparation of food. Some microorganisms are pathogenic and can cause illness when consumed. Microorganisms that do not cause illness and do not always imply the existence of a food-related health hazard are referred to as indicator organisms. Their presence can indicate unsanitary practices and conditions under which bacteria could contaminate the food products. In addition to the presence of microbial hazards, there are other variables that may either be directly responsible for a food safety concern or used as indicators of food safety. These include physical hazards, the presence of central nervous system tissue and intrinsic factors such as pH and water activity. The following section provides descriptions of the types of analyses performed by the CFIA, highlighting and explaining the food safety issues of concern. The specific descriptions of the pathogens that the Agency tests for provide a brief summary of the most common human symptoms associated with infection. The list of symptoms is not meant to be all-inclusive.

4.1. Pathogens

Amongst all microorganisms, only a relatively small number present in food are deemed pathogenic (i.e. illness-causing). Depending on the pathogen's ability to inflict harm, the ingestion of a few viable cells may be sufficient to develop an infection and trigger illness. The severity of infection can range from mild diarrhoea, stomach upset and flu-like symptoms to serious illness or death. In some cases it is not the presence of the pathogen itself that is of concern, but the presence of its metabolic toxins. Typically these organisms and their toxins produce mild to moderate reactions amongst the general healthy population, and full recovery is reached over a short period of time. However, pathogens may continue to be shed through faeces for several weeks post recovery. Some infected persons may show no signs or symptoms of illness, while more sensitive individuals within the population (e.g. elderly, immuno-compromised, children, pregnant women) may be at greater risk of experiencing more severe reactions and complications.

***Escherichia coli* O157:H7**

This pathogen is commonly found in the intestinal tracts of cattle and other ruminants (e.g. sheep), but is rarely found in pigs and poultry. *Escherichia coli* O157:H7 may be introduced to the outer surface of the meat and the processing facility during slaughter. Contamination may also occur, although to a lesser extent, through contact with infected persons handling the food along the production line. Improperly cooked or raw ground beef is the most notable source of foodborne illness related to this organism. However, there are other sources of infection including other types of undercooked meat and poultry, fermented meat products, non-pasteurized milk and fruit juices, non-chlorinated

water and the surfaces of leafy greens (Health Canada, 2012). The ingestion of a low number of cells (10-100) of *E. coli* O157:H7 can lead to gastrointestinal illness, and in rare instances may result in haemolytic uremic syndrome or kidney disease, which can be fatal (FDA, 2012).

Verotoxigenic *Escherichia coli*

Verotoxigenic *E. coli* (VTEC) also referred to as Shiga-toxigenic *E. coli* (STEC), includes *E. coli* O157:H7 and other non-O157 serogroups, which currently include *E. coli* O111, O26, O121, O103, O145 and O45, that produce verotoxins. Testing is performed in certain commodities that have been identified internationally, where VTECs are potential pathogens of concern. It is the verotoxins that result in disease, and can induce illness locally or systemically throughout the body. VTECs can cause influenza-like symptoms, which may progress to bloody diarrhoea, hemorrhagic colitis, acute and chronic kidney disease, thrombotic thrombocytopenic purpura (blood clotting), neurological sequelae (neurological damage) or death (FDA, 2012).

Listeria monocytogenes

There are more than six species of *Listeria*, of which *L. monocytogenes* is pathogenic to humans. *L. monocytogenes* is widely distributed in nature, occurring in soil, sewage, vegetation, stream water, silage, animals and humans (Health Canada, 2012). *L. monocytogenes* is a hardy organism that is resistant to drying, freezing and high salt concentrations. However, *L. monocytogenes* can be destroyed by thoroughly cooking products. It can grow readily at refrigeration temperatures and in vacuum-packed meat products (Montville *et al*., 2012). As such, foods most commonly associated with outbreaks of listeriosis include deli meats, pâté, soft cheeses, raw fish and shellfish. Although exposure to *L. monocytogenes* is common, the incidence of listeriosis is rare, and immuno-compromised individuals, pregnant women, newborns and the elderly are the most susceptible to infection. In healthy individuals infection may result in short term mild gastrointestinal illness, but amongst the susceptible population *L. monocytogenes* can cause influenza-like symptoms and serious effects such as miscarriage, meningitis (inflammation around the brain), septicaemia (blood poisoning) or death (Health Canada, 2010a).

***Salmonella* spp.**

There are more than 2500 serotypes of *Salmonella*, of which only a subset cause human illness. It is present throughout the environment and easily spread within a flock or herd. In extreme cases, human *Salmonella* infections can lead to typhoid fever and a condition known as Reiter's Syndrome, which causes chronic joint pain, irritation of the eyes and painful urination (FDA, 2012; Health Canada, 2012). Highly pathogenic, resistant to cold temperatures and capable of surviving for long periods of time in adverse conditions,

Salmonella is a food safety concern across all commodities. Sources of human salmonellosis are foods of animal origin, particularly raw or undercooked meat and poultry, shell eggs and non-pasteurized egg and dairy products, as well as a variety of foods of plant origin, including spices, sprouts, sesame products, and vegetables (Health Canada, 2012). Contamination of red meat and poultry may occur during slaughter, while fresh produce may be contaminated in the field through the use of improperly composted manure.

Staphylococcus aureus

Humans are natural carriers of *Staphylococcus aureus*, with the nasal cavity being the main site for colonization. It can also be found in warm blooded animals, most notably dairy cows. Hence, *S. aureus* is of concern in a variety of dairy products. *S. aureus*-related illness is caused by metabolic toxins, referred to as enterotoxins, which cause irritation of the lining of the stomach and intestinal tract. The enterotoxins are fast-acting, and symptoms may appear within one to seven hours of consuming contaminated food. Symptoms include nausea, vomiting, diarrhoea, dehydration, muscle cramps, changes in blood pressure and pulse rate and occasionally death (FDA, 2012). The *S. aureus* enterotoxins of most concern to humans are resistant to freezing, commercial pasteurization and some sterilization processes (Montville *et al*., 2012).

***Shigella* spp.**

Humans and high primates are the only known natural carriers of *Shigella* spp. It is easily transmitted through the faecal-oral route with most cases of infection resulting from the ingestion of faecal contaminated food or water. Contamination with *Shigella* spp. is primarily due to poor personal hygienic practices of food handlers, and can occur anywhere along the food continuum (Health Canada, 2012). The presence of only 100 cells can lead to widespread foodborne and waterborne outbreaks of shigellosis. Symptoms of *Shigella*-related illness includes diarrhoea, fever and stomach cramps. Illness may lead to serious complications such as reactive arthritis, haemolytic uremic syndrome, kidney failure or death (Mayo Clinic, 2012). *Shigella dysenteriae* produces toxins responsible for more serious bouts of diarrhoea, called dysentery, dehydration and sometimes death (FDA, 2012). Foods most commonly associated with shigellosis outbreaks include leafy green vegetables, commercially prepared salads, dairy products and poultry (FDA, 2012). *Shigella* spp. are easily destroyed by cooking food properly.

Trichinella spiralis

Trichinellosis, due to the parasitic roundworm *Trichinella spiralis*, is caused primarily through the ingestion of infected raw and undercooked pork. The worm can be destroyed by the use of appropriate processing techniques, such as cooking, freezing or curing. Current advice to Canadian consumers is to ensure pork is cooked to a minimum internal

temperature of 71ºC (Health Canada, 2010b). Because of modern production methods of raising pigs in confinement and high quality feed, *T. spiralis* in Canadian domestic swine populations has become quite rare. However, *Trichinella* infection involving other species of the parasite is endemic in various wildlife hosts in Canada. As such, human infection in Canada is typically associated with the consumption of wild game, particularly walrus or bear (McIntyre *et al*., 2007). Nevertheless, precautions are warranted due to the potential for the introduction of *T. spiralis* into domestic swine herds.

Human infection from *T. spiralis* has severe effects on health. Symptoms include typical gastrointestinal and flu-like symptoms but of greater concern is fluid retention and swelling around the eyes, muscular pain and stiffness, high fever, and laboured breathing (Forsythe, 2011). Penetration of the parasite through the intestinal wall and migration to the muscle sites can be an extremely painful and long-enduring disease. With early diagnosis, treatment often leads to complete recovery, but muscle pain and weakness may persist (McIntyre *et al*., 2007).

4.2. Indicator Organisms

It is important to note that most microorganisms found in foods are non-pathogenic and do not cause serious illness or disease. Amongst these are indicator organisms which are useful in evaluating the effectiveness of microbial control measures (e.g. hygienic conditions, overall sanitation), the presence of which may signal whether or not food has been contaminated, subjected to insufficient heat treatment or produced using contaminated ingredients.

Coliforms

Coliforms are present in the intestinal tracts of humans and animals and widely distributed in nature (soil, water and vegetation). As such, their presence indicates that faecal or environmental contamination may have occurred. These organisms require the same conditions for survival and growth as some pathogens that can cause illness (Forsythe, 2011), therefore their presence indicates the potential for viable pathogens to be present. Laboratory methods for total aerobic colony counts (ACC) detect all bacteria, including coliforms that may grow under the temperature and environmental conditions specific to the individual methods. Testing for the presence of coliforms is an economical way to test and identify contaminated foods that have been held under conditions supportive of microbial growth. In a food processing environment, the presence of coliforms is an effective method to determine the relative degree of sanitation, as their numbers increase in direct relation to levels of contamination, and can be an important component of the facility's quality control program.

Faecal coliforms only reside in the intestinal tracts of warm-blooded animals and humans. These coliforms may be introduced into the processing environment through poor hygienic practices of food handlers, intestinal contamination at slaughter, improperly composted manure and untreated water supplies (Health Canada, 1999; CAC, 2003). As such they are useful in determining the level of sanitary control within an establishment. Generic *E. coli* is the primary species in the faecal coliform group, and considered to be the best indicator of faecal contamination or unsanitary processing (Forsythe, 2011). The amount of generic *E. coli* present can be used as a predictor of the possible presence of pathogens. Although *E. coli* is represented by many serotypes, the majority are not pathogenic. However, the use of indicator organisms should not negate the testing of pathogens, including *E. coli* O157:H7, due to their potential to induce serious illness.

Mould

Moulds are multi-cellular, filamentous living organisms that thrive in warm moist environments, and can be visually detected. Although there are benefits to the use of moulds in the manufacturing of some foods (e.g. some types of cheese and sausages) the appearance of mould on most food contributes to decomposition and is not desirable by the consumer. Mould is typically associated with reduced shelf-life and economic loss due to poor aesthetic quality of the product, but rarely causes serious illness. Through microscopic examination, the detection of mould filaments in canned products can indicate that appropriate manufacturing conditions, including quality ingredients and proper heat treatment, have not been implemented. Mould spores are easily destroyed by heat.

4.3. Testing Intrinsic Factors for Viability

There are various intrinsic factors (such as pH, water activity, nutrients, fat content) that can be used to determine the viability or growth of microorganisms in any environment. Microorganisms react to different environmental conditions, and have preferential conditions under which they flourish. Although any one factor can create an environment that inhibits growth of the bacteria, the combination of two or more unfavourable factors is more effective in restricting bacterial growth and viability. Testing for these intrinsic factors, also referred to as safety parameters, reveals if microorganisms of concern could survive and grow in that particular food. They can provide useful information regarding the potential for growth of pathogens that may be present and contribute to assessing the risk posed to the consumer.

Salt Content

Salt is one of the oldest methods used for preservation. It restricts bacterial growth by binding to water molecules within the food, therefore reducing the amount of water available for metabolic activities (water activity). When sufficient amounts of salt are

used the water activity is reduced to a level below that required for most microorganisms to grow. As such, salt content may be one of the factors used to assess the level of risk associated with processed products.

pH

Acetic acid (vinegar) is commonly used in the preservation of pickled products. It is the creation of an acidic environment that contributes to the preservation of the food. The term pH is a measurement of acidity. Every microorganism has an optimal pH range for growth. Commonly it is in the slightly acidic to neutral range (i.e. 5.6 to 7.5), and most microorganisms cannot survive below pH 4.4 (Montville *et al*., 2012). Knowing the pH of the food helps determine the types of microorganisms capable of surviving in that particular food, and therefore helps narrow the scope of assessment.

Water Activity (a_w)

Metabolic activities of any organism can only occur in the presence of water which is needed to dissolve nutrients, remove cellular waste and is essential for some metabolic reactions. The amount of water required for these processes varies between organisms. Water activity (a_w) is a measure of the amount of water freely available for metabolic activities and is not bound in tissues or other components. This differs from moisture content which is the sum of chemically bound water and unbound water (a_w). Every microorganism has an optimal range of water activity for growth. Foodborne pathogens are usually inhibited by water activity of 0.92 or less (Montville *et al*., 2012). As with pH, by measuring water activity, it is possible to determine the types of microorganisms that could be viable in a particular food.

4.4. Non-Microbial Indicators

The CFIA uses validated methods and technology to obtain results in a timely manner. However, not all methods are designed to determine the presence or absence of micro-organisms. In some instances, information may be gained by analysing for a non-microbial indicator to determine the potential for microbial contamination and growth. Such tests may be performed to identify manufacturing processes that could support the introduction of potential food safety hazards.

Species Verification as an Indicator of Sanitary and Fraudulent Practices

Species verification is conducted to detect adulteration of meat products claiming to be derived from one species with that from another species. An operator may fraudulently substitute less expensive types of meat for some or all of the more expensive meat declared on the label. Adulteration may also occur due to the improper cleaning of equipment and contamination during processing. From a food safety perspective, species

verification is performed to assess the effectiveness of sanitation procedures within the establishment.

Central Nervous System Tissue Screening for BSE

More commonly known as Mad Cow Disease, Bovine Spongiform Encephalopathy (BSE) is a progressive, degenerative neurological disease caused by a misfolded protein (prion), and is resistant to breakdown by heat, enzymes or disinfectants. In cattle, BSE occurs as a result of dietary exposure to feed containing infected meat and bone meal. Presently, there is no test to diagnose BSE in live animals, and it can only be diagnosed through the detection of the abnormal prion in brain tissue collected at post mortem. The BSE prion is also believed to be able to infect humans, causing Variant Creutzfeld-Jakob Disease (vCJD; FDA, 2012), through the human consumption of contaminated meat products from BSE infected cattle. BSE and vCJD are members of a family of diseases known as Transmissible Spongiform Encephalopathies characterised by the degeneration of brain tissue giving it a sponge-like appearance and leading to death (FDA, 2012).

Since it is known that humans may develop vCJD through the consumption of meat products containing the BSE prion, beef products containing ground, finely textured meat are tested for the presence of central nervous system (CNS) tissue. CNS tissue, identified as specified risk material (CFIA, 2008), implies that meat mechanically separated from the vertebral column has been included in the meat product and there is potential for the presence of brain and other nervous system tissues. It is important to note that the detection of CNS tissue in a meat product does not necessarily mean the BSE prion is present. To proactively avoid the occurrence of vCJD in humans due to the consumption of BSE contaminated meat, CNS tissue is not permitted in meat products (CFIA, 2008).

Phosphatase Test for Pasteurization

Pasteurization of milk and milk products is essential for microbial safety of these foods as they are often sold as RTE products. Pasteurization is a heat process intended to kill pathogens such as *E. coli* O157:H7. Phosphatase is an enzyme present in cow's milk that is inactivated by the pasteurization process. In order to determine if dairy products have been subjected to a pasteurization process or contaminated by raw milk, the food is tested for the presence of phosphatase.

4.5. Physical Hazards

A physical hazard in a food product consists of any object capable of inflicting a puncture, wound or cut, or is of sufficient size to cause choking if swallowed. Dangerous extraneous (foreign) material such as glass and metal fragments would fall under this category. In some cases shell fragments and pieces of bone (undesirable parts) could also be classed as physical hazards.

The potential presence of injurious extraneous material in processed foods must be addressed through the implementation and verification of control processes (i.e. Good Manufacturing Practices). Appropriate controls include frequent inspections and maintenance of the processing equipment, and possibly the use of an x-ray machine or metal detector to scan the final product. Due to logistic and financial reasons, the latter are not viable options for most establishments; therefore processors must diligently monitor their equipment and packaging material for defects. Special attention to handling, including any equipment coming in contact with glass jars, is required to ensure that no chipping or breakage occurs within the operating environment. Verification of the adequacy of these quality control procedures is essential.

5. National Microbiological Monitoring Program

The CFIA operates the NMMP to test for the presence of pathogens in foods deemed to pose the greatest risk to consumers. The NMMP is designed to sample and test a broad range of imported and domestic commodities for multiple hazards, including red meat and poultry products, shell eggs and egg products, dairy products, fresh fruits and vegetables and processed fruit and vegetable products. Results from this testing enable the CFIA to make decisions concerning the acceptability of food based on its microbial quality. Based on these considerations and knowledgeable experts, the selection of specific foods and pathogens are prioritized on the basis of potential risk and likelihood of contamination. Food-hazard combinations deemed to pose the greatest potential health risks, recent outbreaks of foodborne illness, emerging food-hazard combinations and historical levels of compliance are taken into consideration when designing the plans.

5.1. Rationale

The primary purpose of the NMMP is to determine the level of compliance of the food industry with safety practices and standards. In addition, the NMMP contributes to the following:

1. To provide data for the comparative risk associated with domestic and imported sources of foods, thus allowing an estimation of equivalency for trade purposes.

2. To provide information on the effectiveness of control measures, as well as the effectiveness of program interventions with respect to improving food safety.

3. To independently confirm the degree of deviation from Good Manufacturing Practices, Good Hygienic Practices or Hazard Analysis Critical Control Point programs as demonstrated by industry testing. This is assessed from non-compliances found in the monitoring program. When rates of non-compliance exceed acceptable levels further control activities may be triggered.

4. To assess the occurrence of adulterated food products containing pathogens. Domestic producers and importers in violation of Canadian standards are placed on an enhanced inspection until there is appropriate compliance.

Through the use of clearly defined sampling guidelines and criteria the results of the microbiological testing of domestic and imported foods are designed to be meaningful and quickly alert authorities of potential food safety issues.

5.2. Product Sampling

Microbial contamination is generally not evenly distributed throughout a commodity. Most foods are not homogeneous by nature; therefore microorganisms establish themselves in pockets where conditions are most favourable for their survival. It is essential that the samples taken for analysis properly represent the commodity as a whole. Therefore when sampling lots, batches or shipments of food several samples are randomly taken from various points in time and/or space. Each of these is referred to as a sub-sample, and most commonly five sub-samples are taken for each sample. When sampling domestic commodities along the production line, sub-samples may be taken at different times during the production day but at the same point within the processing line.

The sub-samples are randomly selected and collected using sterile techniques to prevent contamination during the sampling process. They are transported to the laboratory under conditions that maintain sample integrity and support reliable and accurate analytical results. It is critical that the samples do not become contaminated during these steps. It is also important that the samples are maintained at an appropriate temperature that does not encourage the growth of nor kill the potential microorganisms (pathogenic and indicator), and prevents the sample from spoiling.

The sampling activities conducted in the NMMP are designed through the determination of sampling priority, sampling frequency, sample size and method of sample selection. These activities are conducted for regulatory purposes and are intended to verify the implementation and effectiveness of the food safety systems used within food processing establishments. Sampling plans must specify the microbial hazard of concern, the food product to be sampled, number of samples to be collected, point of sampling within the food chain and geographic location, techniques for aseptic sampling, shipping and storage conditions, analytical methodology and assessment criteria.

Bacterial contamination can occur at any point along the farm to fork continuum. Sampling by the CFIA is dependent upon jurisdictional boundaries, manufacturing processes, and origin of the product. For domestic products, CFIA's monitoring plans are designed to allow for the selection of samples during the visual inspection of food at processing establishments. During processing there are critical control points where kill steps are applied to prevent, eliminate or reduce microbial hazards to acceptable levels. Domestic commodities are sampled at points where processing should render the microorganisms of concern, based on their virulence, as either (i) absent or (ii) at such low levels that by the time the food reaches the consumer there has not been sufficient growth of the microbes to render the food as being unsafe for consumption. As the CFIA does not have jurisdiction in exporting countries, the sampling of imported food is restricted to ports of entry and distribution facilities. This limits the information

pertaining to the exact conditions the food was exposed to during processing and handling. Nevertheless, imported foods are expected to meet the same safety standards as domestic products.

5.3. Environmental Sampling

Bacterial contamination can occur at any point along the production chain. An understanding of certain critical steps during production can provide valuable information as to where contamination may occur and insight on how to prevent it. As such, an effective environmental testing strategy will allow both the food producer and the CFIA to intervene before contamination of the food occurs. The choice of testing site is highly dependent on the food, the processing facility and the controls that are in place. However, the CFIA does not have the authority to perform environmental sampling in establishments exporting to Canada.

Microorganisms can thrive anywhere ideal conditions exist. Therefore, surfaces and tools that come in direct contact with the food are swabbed and recirculated water used during processing is also tested. Surfaces that do not come in direct contact with the food, including rollers, air ducts and drains may also be tested. These sites may become a source of contamination for food and food contact surfaces through employee movement, dust and air flow. Hence, in addition to the effective sanitation of direct food contact surfaces, establishments must also ensure that bacteria do not become established in other parts of the processing area.

Environmental sampling procedures allow the swabbing of five to ten sites for each sample submitted for analysis, allowing for multiple potential sources of contamination to be assessed. Even if no pathogens are detected in the product, environmental sampling can be used to identify the presence of pathogens within the manufacturing environment, identify system controls which need to be reviewed and prevent future contamination of products.

Similar to product sampling, environmental samples are collected using aseptic techniques and transported to the laboratory under conditions that support the integrity of the sample for analysis. It is critical that the samples do not become contaminated during these steps, and are maintained at an appropriate temperature that does not encourage the growth of nor kill the potential pathogen.

5.4. Methodology for Pathogens

The CFIA laboratories analyze samples using a variety of conventional and DNA-based methods designed to meet regulatory standards in order to assess the microbial safety of food. In order to ensure the laboratory procedures and analytical results are reliable, are internationally recognized (i.e. to maintain the confidence of our trading partners) and will withstand legal scrutiny, CFIA laboratories are accredited by the Standards Council of Canada as complying with internationally recognized standards (ISO 17025).

At the laboratory for each product or environmental sample a portion of the sub-samples are usually pooled and analyzed as a single unit. When required, the sub-samples may be analyzed individually to provide more information about the distribution and quantity of microorganisms within the sample.

Rapid screening methods are utilized as an effective way to quickly identify compliant samples, thus allowing for their timely release into the market. These methods allow for rapid processing and reporting, and results may be available within 24-72 hours of sample receipt at the laboratory. If results of the screening method indicate the targeted microorganism(s) may be present the sample is flagged for further testing to confirm its presence.

Potentially positive samples (i.e. presumptive positives) are further tested using a cultural method to determine whether or not the pathogen of concern is present. Cultural methods allow for the isolation and identification of specific types of viable microorganisms by using a gel or liquid medium. Following the enrichment phase, the microorganism is isolated and the identity of the pathogen is confirmed. In some cases, DNA-based methods are used for confirmatory testing. These methods can accelerate the identification process for pathogens in foods ensuring unsafe food is removed from the marketplace in a timely manner. Results from cultural methods are usually available within two to five days after the confirmation method has commenced.

In some situations it is desirable to know how much contamination has occurred. For this, enumeration methods provide a direct or estimated count of the number of viable organisms present. These counts may be expressed as colony forming units (CFU/mL or CFU/g) or most probable number (MPN). Enumeration results are usually reported within one to five days.

During foodborne illness outbreak investigations, epidemiological evidence is combined with microbial testing of suspect foods to determine the source of contamination. In these situations it is not enough to simply identify the genus (i.e. *Listeria* spp.) or species (i.e. *L. monocytogenes*) of the organism responsible for the infection, but further

characterization may be required for source attribution and confirmation. For example, not all colonies of *L. monocytogenes* are of the same genetic composition. Differences exist in their DNA profiles which result in unique DNA patterns that are used to identify subpopulations of organisms, referred to as strains. Genotyping or serotyping is the term used to describe the characterization of these strains at the molecular level. Pulse-Field Gel Electrophoreses (PFGE) technology enables DNA-based subtyping (sometimes referred to as "DNA fingerprinting") of foodborne pathogens. This analysis enables further characterization of the bacterial pathogen as a means to identify outbreaks in a timely fashion, or as a means to link clinical cases to a foodborne cause.

5.5. Assessment Criteria

Assessment criteria are used to set clear limits and ensure a consistent approach in determining if food products are safe for consumption and produced under conditions compliant with food safety standards. The laboratory test results are compared to criteria specific to the food and microbial organism of concern.

Generally, there is zero tolerance for the presence of pathogens in food which may induce serious illness when few cells are consumed. Thus the assessment criteria used by the CFIA for pathogens, such as *E. coli* O157:H7, clearly state that the presence of such organisms in food is unacceptable. In such cases, the entire lot of food can be considered unsatisfactory for human consumption, and appropriate actions are immediately taken to mitigate the risk to consumers.

The CFIA also uses assessment criteria to determine the acceptable level of indicator organisms. Although indicator organisms, such as generic *E. coli*, do not pose a health risk their presence is used as a measure of sanitary quality. Very low levels of indicator organisms are considered acceptable as they are commonly present in the food source and environment. These levels are innate to the processing environment and pose no health risk, therefore no action is required. Slightly elevated levels of indicator organisms are also acceptable, however they are an indication that a minor failure in sanitary controls has occurred within the processing establishment. In such circumstances, the food is considered to be investigative and appropriate follow-up activities are taken. This includes the identification and correction of the source of failure by the establishment in order to return to acceptable operational sanitation standards as quickly as possible. The presence of indicator organisms at high levels in food is an indication of gross contamination or major non-compliance issues in the processing environment. When these levels are detected, the food and associated lot are typically deemed to be unsatisfactory and unfit for human consumption. Although it does not directly pose a health risk, the high levels are the result of system failures that could also lead to the presence of pathogens in the food. Appropriate follow-up actions are taken.

All other food safety tests performed are assessed in the same manner as pathogens or indicator organisms. Whether there is zero tolerance or a gradient of acceptable levels is dependent on the interpretation of the results and the implied level of risk to the consumer. For example, there is zero tolerance for the presence of CNS tissue in beef due to BSE requirements. In contrast, with regards to pH and water activity, there is a range of values that is used to determine the potential risk for conditions which may support the survival or growth of microorganisms.

5.6. Statistical Considerations

The NMMP is one of many tools utilized by the CFIA to verify domestically produced and imported products comply with Canadian standards. Therefore it is not designed to provide statistical estimates of the compliance rate of food. For example, if no compliance issues are detected in 300 samples of a particular product, with 95% confidence one may infer that the non-compliance rate in the defined food is less than 1.00%. However, 300 samples for testing may not be available for all products, and the precision of such inferences decreases as the number of samples decreases. Nevertheless, smaller sample numbers can still be used to verify the effectiveness of industry practices.

This report is the first publication of the results of the NMMP's sampling and testing activities. As such its scope is limited to the assessment of compliance and non-compliance results identified through sampling and testing activities conducted over a 12 month period. Therefore caution must be used when interpreting the results of this report. Over a longer period of time (e.g. five years) the information gathered during these monitoring activities can be combined and used to perform more extensive analyses on the food supply, including trending and seasonal variation.

6. Results of the 2011/12 National Microbiological Monitoring Program

There are a variety of microbial hazards inherently present within agricultural environments, domestic herds and the products of animal and plant origin intended for human consumption. During the process of harvesting these raw commodities, microbes from the field may be carried along with the intended food. Subsequently cross contamination of food products may occur. Handling of these products by improperly trained workers may also be a source of contamination when employees do not practice effective hygienic procedures. As such, CFIA inspectors across Canada monitor domestic food processing establishments and imported foods for a variety of microbial food safety hazards and regulatory requirements. Under the NMMP, random food and environmental samples are taken for laboratory analysis to verify compliance with food safety regulations and product standards.

The results of the 2011/12 NMMP are described below. Each commodity group (red meat and poultry products, shell eggs and egg products, dairy products, fresh fruits and vegetables and processed fruit and vegetable products) is considered separately. The number of tests performed, the number of satisfactory, investigative (where appropriate) and unsatisfactory results and the overall compliance rate are listed for each commodity group. In addition, a breakdown of country of origin is provided for imported products.

6.1. Red Meat and Poultry Products

Meat has historically been implicated in a significant proportion of human illness associated with foodborne disease. During slaughter and processing, contamination can be spread by contaminated surfaces and equipment (CAC, 2005). Since it is expected that meat products, such as raw chicken, will be thoroughly cooked prior to consumption, the pathogens present in raw meat should be destroyed by the cooking process. If certain cuts of meat are consumed raw or undercooked, the internal temperature of the meat may not be sufficiently high to kill all pathogens. For this reason, the CFIA focuses its testing activities on RTE meat products as well as those that could be consumed in a partially cooked state, such as beef.

Most RTE meat products are subjected to a combination of treatments intended to destroy pathogens, for example this may include heat treatment, fermentation, spices and/or smoking. Dry cured products, such as salamis and hams, do not receive heat treatment but are required to be free of pathogens, such as *E. coli* O157:H7, though low levels of *S. aureus* are acceptable.

Every establishment processing or packaging meat products that is federally registered is monitored by CFIA inspectors. Random samples are taken for laboratory analysis to verify compliance with applicable food safety regulations and product standards, including the *Meat Inspection Act* and *Regulations*.

The CFIA is implementing a pilot project to determine the prevalence of *Salmonella* spp. and *Campylobacter* spp. in raw poultry at various points throughout the food chain. Upon completion of this survey, national microbiological monitoring activities will resume, taking into account the results of this study.

6.1.1. Ready-To-Eat Meat Products

In Canada, all federally registered RTE meat establishments are inspected by the CFIA, and both product and environmental samples are tested on a regular basis. RTE meat products include all species of meat and are defined as food items subjected to an adequate heat treatment or other kill step thus decreasing the number of bacteria and minimizing the chance of pathogenic strains surviving. They require no further cooking by the consumer prior to consumption. This includes products consumed "as-is" or warmed to a palatable temperature. RTE meats have been associated with outbreaks of foodborne disease due to recontamination from raw or undercooked products while being handled in processing establishments, catering establishments and in the home kitchen.

During 2011/12, RTE meat products were sampled and tested for the following pathogens of concern: *E. coli* O157:H7 (on fermented RTE meat only), *L. monocytogenes* and *Salmonella* spp. The results are summarized in Table 1. There were 1560 tests performed on 1120 domestic products determined to be 99.6% compliant. The 0.4% non-compliance was due to four samples testing positive for *L. monocytogenes*. In addition, 342 tests were performed on 169 imported RTE meat products. These imported products were 98.2% compliant with two samples testing positive for *Salmonella* spp. and one sample testing positive for *L. monocytogenes*. Although the majority of Canada's imported RTE meat products are from the United States (>82%; Table 2), all three unsatisfactory samples were from Italy.

Combining these results, a total of 1902 analytical tests were performed on 1289 RTE meat products with a compliance rate of 99.5%. Overall, *L. monocytogenes* was detected in 5 samples and *Salmonella* spp. was detected in two samples. *E. coli* O157:H7was not detected in any of the domestic or imported fermented RTE meat samples analyzed.

Table 1: Compliance Rates of Domestic and Imported Ready-To-Eat Meat Products

Source	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance	Unsatisfactory Parameters (# samples)
Domestic	1560	1120	1116	4	99.6	*L. monocytogenes* (4)
Imported	342	169	166	3	98.2	*L. monocytogenes* (1), *Salmonella* spp. (2)
Total	1902	1289	1282	7	99.5	*L. monocytogenes* (5), *Salmonella* spp. (2)

Table 2: Imported Ready-To-Eat Meat Products Analyzed, by Country of Origin

Country of Origin	# Samples	# Satisfactory	# Unsatisfactory
AUSTRIA	1	1	0
BELGIUM	1	1	0
BRAZIL	1	1	0
CROATIA	1	1	0
FRANCE	10	10	0
ITALY	10	7	3
ROMANIA	1	1	0
SPAIN	2	2	0
THAILAND	3	3	0
UNITED STATES	139	139	0
Total	169	166	3

6.1.2. Raw Ground Beef/Veal and Trims

Trimmings from cuts (e.g. pieces of meat remaining after steaks, roasts are removed) and boneless chucks are used as ingredients of raw ground meat products. In Canada, all federally registered meat establishments producing trims intended for grinding and all establishments producing raw ground beef or veal are sampled. The intent of this monitoring is to ensure the trims are not contaminated, thus avoiding the risk of spreading the microbial hazard during the grinding process. Contamination of whole intact pieces of meat occurs on the outer surface of the meat during slaughter and is easily spread when further manipulation of the meat occurs. The production of ground meat products involves the pooling of meat from multiple animals. During the grinding process bacteria present on the surface of the intact cuts and trims can be distributed throughout the meat. The grinding process minces and mixes the meat increasing the surface area available for microorganisms to attach. For ground meat products this is the most likely point in production for cross contamination to occur.

Trims and ground products are tested for *E. coli* O157:H7 as well as generic *E. coli*. Although generic *E. coli* does not pose a health risk it is used as an indicator of sanitary control in the plant. In 2011/12 a total of 1853 analytical tests were performed on 275 domestic trims and 613 domestic ground beef/veal samples (Table 3). Of the domestic samples, four trims and one ground beef were assessed as unsatisfactory due to the presence of *E. coli* O157:H7. The trims and ground beef displayed compliance rates of 98.5% and 99.8% respectively. Due to the small volume of imports, only two imported beef trims (one each from Australia and New Zealand) and two imported ground products (from the United States) were sampled for analysis (Table 4). No *E. coli* O157:H7 was detected in any of the imported products. Overall, 1861 tests were performed on 892 beef/veal trims and raw ground beef/veal products, with 99.4% determined to be compliant.

Table 3: Compliance Rates of Domestic and Imported Raw Ground Beef/Veal and Trims

Product Type	# Tests	# Samples	# Satisfactory	# Investigative	# Unsatisfactory	% Compliance
Domestic Ground Meat	1282	613	590	22	1	99.8
Domestic Trims	571	275	266	5	4	98.5
Imported Ground Meat	4	2	2	0	0	100
Imported Trims	4	2	2	0	0	100
Total	1861	892	860	27	5	99.4

Table 4: Imported Raw Ground Beef/Veal Products and Trims Analyzed by Country of Origin

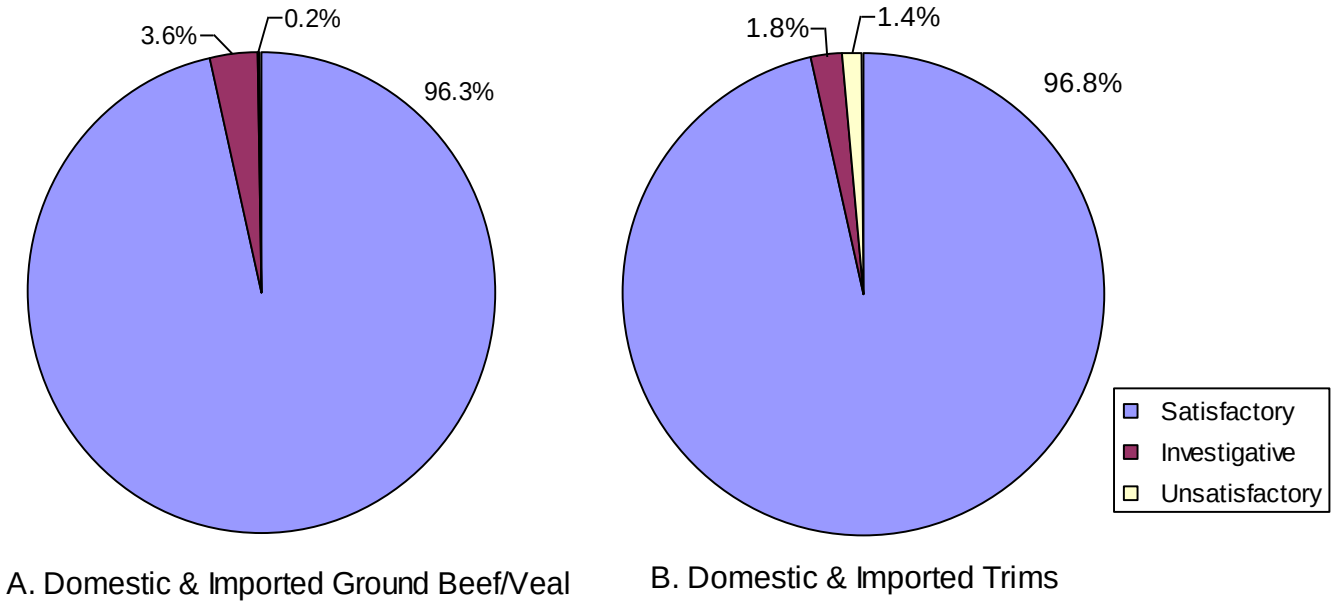
Product Type	Country of Origin	# Samples	# Satisfactory	# Unsatisfactory	% Compliance[a]
Ground Meat	UNITED STATES	2	2	0	100
Trims	AUSTRALIA	1	1	0	100
Trims	NEW ZEALAND	1	1	0	100

[a] Due to small sample numbers, the significance of these test results should be interpreted with caution.

High levels of generic *E. coli* are used to indicate a breakdown in sanitation procedures within processing establishments. During 2011/12, no high levels of generic *E. coli* were detected in any of the imported samples (Table 4). However, high levels were detected in five domestic trims and 22 domestic ground beef samples. Since generic *E. coli* does not represent a health risk to consumers, these samples were deemed to be compliant but

were assessed as investigative. As depicted in Figure 1, a total of 96.3% of the domestic and imported raw ground beef/veal products were assessed as satisfactory, 3.6% were investigative due to the presence of generic *E. coli* and 0.2% were unsatisfactory due to the presence of *E. coli* O157:H7. Likewise, 96.8% of the domestic and imported trims were assessed as satisfactory, 1.8% were investigative and 1.4% were unsatisfactory.

Figure 1: Microbial Assessment (%) of Domestic and Imported Raw (A) Ground Beef/Veal and (B) Trims



6.1.3. Raw Mechanically Separated and Finely Textured Beef

In Canada there are three producers of mechanically separated beef and finely textured beef. During 2011/12, 38 samples were tested, of which one was considered to be adulterated due to the presence of central nervous system (CNS) tissue.

The CFIA tests mechanically separated beef and finely textured beef to verify the absence of CNS tissue. The presence of CNS tissue implies that bones from the vertebral column have been included in the meat product and there is potential for the presence of brain tissue. If a product in distribution is found to contain CNS tissue it will be recalled. If the product is not in the markets, it may be sent for edible rendering (e.g. extraction of fats and oils) or disposal.

6.1.4. Raw Meat: Pork and Wild Boar

The results of routine monitoring of Canadian pork indicate the risk of *T. spiralis* infection is virtually nonexistent. However, precautions must remain in effect due to the presence of *T. spiralis* in wildlife and the potential for sporadic transfer to domestic herds. Meat processing operators are responsible for implementing and maintaining records of all parameters required for process control. The analytical methodology for testing *T. spiralis* in pork allows for tissues from up to 100 animals to be pooled and submitted for analysis. In 2011/12, 318 samples representing over 31,000 animals (market hogs, breeder hogs and wild boar) were tested for *T. spiralis*. All were assessed as satisfactory.

6.1.5. Species Verification

From a food safety perspective species verification is used as an indication of sanitary control within an establishment. The CFIA tests meat products with label claims indicating they are composed of a single or a combination of specific species. Selected products are those that have been ground to the point where it is impossible to determine through visual examination what species has been used. This sampling includes raw ground meat products, RTE products and other products which have received heat treatment.

In 2011/12 a total of 610 species verification tests were performed on 156 meat products, of which 98.1% were compliant (Table 5). Of the 121 domestic meat products sampled 98.3% were compliant, with two single species raw meat products indicating the presence of beef and pork meat. Thirty-five imported meat products from six countries were sampled (Table 6). Of these, 97.1% were compliant. One single species product from the United States was positive for beef and pork meat.

Table 5: Species Verification Compliance Rates of Domestic and Imported Meat Products

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic	477	121	119	2	98.3
Imported	133	35	34	1	97.1
Total	610	156	153	3	98.1

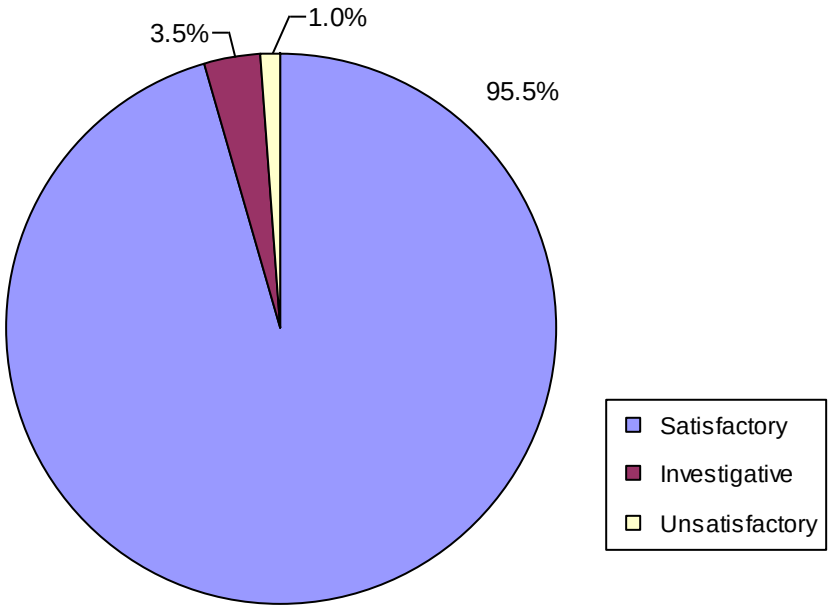
Table 6: Number and Types of Imported Single Species Meat Products Sampled by Country of Origin

Country of Origin	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
AUSTRALIA	1	1	0	100
CHILE	1	1	0	100
NEW ZEALAND	3	3	0	100
SPAIN	1	1	0	100
UNITED STATES	3	2	1	66.7
URUGUAY	26	26	0	100
Total	35	34	1	97.1

6.1.6. Environmental Testing

In addition to product sampling, 1062 environmental samples from over 230 domestic federally registered establishments producing RTE meat products were analyzed for *Listeria* spp. The 1062 samples represented more than 8500 food contact surfaces within the production environments. Environmental sampling at the establishment is another tool for monitoring sanitation practices and the potential for environmental contamination of the products. The presence of *L. monocytogenes* is not tolerated in the production environment and its detection results in an unsatisfactory assessment. In some cases, environmental samples do not test positive for *L. monocytogenes* but may be positive for other *Listeria* spp. Since these species do not induce illness in humans but indicate a lack of sanitary control, the presence of other *Listeria* spp. in the environment results in an investigative assessment. Regardless, when *Listeria* spp. or *L. monocytogenes* is detected the establishment is required to implement corrective actions to remove the bacteria from the production environment, in order to prevent possible contamination of products with *L. monocytogenes*. Of the 1062 environmental samples analyzed (Figure 2), 11 (1.0%) were assessed as unsatisfactory due to the detection of *L. monocytogenes* and 37 (3.5%) as Investigative due to the presence of other *Listeria* spp. Overall, 95.5% of the environmental samples were satisfactory.

Figure 2: Environmental Analysis (%) of Domestic Federally Registered Meat Establishments Producing Ready-To-Eat Meat Products



6.2. Shell Eggs and Egg Products

Under the NMMP, imported shell eggs are tested for *Salmonella* spp. while domestic and imported processed egg products are tested for ACC, coliforms, *L. monocytogenes* and *Salmonella* spp. In Canada, eggs are graded, sized and packed at egg grading stations registered by the CFIA. Within domestic shell egg grading stations, environmental sampling and testing is performed on wash water for ACC while surface swabs from areas before and after grading are tested for *Salmonella* spp. Environmental sampling in domestic egg processing establishments includes the random selection of food-contact surfaces or non-food contact surfaces from either the pre-operational stage or production stage for each sampling activity. The samples taken prior to production (pre-operational stage) are tested for *Salmonella* spp. while samples taken during production are tested for *Salmonella* spp. and *L. monocytogenes*.

6.2.1. Shell Eggs

The United States is the sole importer of shell eggs in Canada. A total of 315 imported samples were subjected to 315 tests for *Salmonella* spp. No *Salmonella* spp. was detected. In domestic egg grading establishments, the CFIA implements environmental testing to verify the adequacy of sanitary practices. Results from this environmental testing are discussed below in section 6.2.3.

6.2.2. Egg Products

Domestic and imported egg products were tested for ACC, coliforms, *L. monocytogenes* and *Salmonella* spp. A total of 1260 tests were performed on 319 domestic egg products, of which 99.1% were deemed to be compliant (Table 7). Of the three samples assessed as unsatisfactory, two displayed high levels of ACC and one tested positive for *L. monocytogenes*. As is the case with imported shell eggs, the United States is Canada's only source of imported egg products. During 2011/12, a total of 25 imported egg products were subjected to 100 tests, with 100% compliance. Hence, overall 1360 tests were performed on 344 domestic and imported egg products with a compliance rate of 99.1%.

Table 7: Compliance Rates of Domestic and Imported Egg Products

Source	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic	1260	319	316	3	99.1
Imported	100	25	25	0	100
Total	1360	344	341	3	99.1

6.2.3. Environmental Testing

A total of 1186 tests were performed on 764 environmental samples, including wash water and surface swabs (Table 8). The overall compliance rate was 95.3% with 36 samples deemed unsatisfactory.

There are four critical points in the production environment which are sampled in order to verify sanitary controls: water used to wash the eggs, water used to wash the baskets containing the eggs, surfaces in areas containing ungraded eggs and surfaces in areas containing graded eggs. In total, 339 wash water samples were subjected to 339 tests for ACC (Table 8). Of these, 20 contained high levels of ACC indicating inadequate sanitary practices, while the remaining 94.1% were compliant. In the shell egg grading establishments, each environmental sample consisted of swabbing 5 surfaces in the ungraded egg areas and 5 surfaces in the graded egg areas. At the lab these swabs were pooled into two (one for the ungraded area swabs and one for the graded area swabs) and tested for *Salmonella* spp. Therefore for each environmental sample there were two tests for *Salmonella* spp. In total 748 tests for *Salmonella* spp. were performed on 374 environmental samples representing 3740 surfaces within the shell egg grading establishments. Of these 96.0% were compliant, with the detection of *Salmonella* spp. in 15 samples.

In domestic egg product processing establishments, sampling was performed either during the pre-operational stage or during production. The sampling consisted of swabbing either food contact surfaces or non-food contact surfaces. Samples taken prior to production (pre-operational stage) were tested for *Salmonella* spp. while samples taken during production were tested for *Salmonella* spp. and *L. monocytogenes*. A total of 99 tests were performed on 51 samples (Table 8), representing 510 surfaces within the processing plants. Of these, one sample tested positive for *Salmonella* spp., for a compliance rate of 98.0%.

Table 8: Compliance Rates of Environmental Samples from Domestic Shell Egg Grading Stations and Egg Product Processing Establishments

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Shell Egg Wash Water	339	339	319	20	94.1
Shell Egg Environmental Swabs	748	374	359	15	96.0
Egg Products Environmental Swabs	99	51	50	1	98.0
Total	1186	764	728	36	95.3

6.3. Dairy Products

Dairy samples are analyzed for coliforms, generic *E. coli*, *Salmonella* spp., *L. monocytogenes*, and *S. aureus.* Phosphatase testing is only performed when claims of pasteurization need to be confirmed. Establishments producing products such as canned milk, frozen dairy products, milk based powders, fermented dairy products, and butter are subject to visual inspections by CFIA inspectors. Samples of these types of products are taken under directed sampling activities for investigative purposes only.

6.3.1. Fluid Milk Products

During 2011/12, a total of 95 milk products were sampled at dairy producers and analyzed for generic *E. coli* and *L. monocytogenes*. This included all grades of milk, chocolate milk, coffee creams, and specialty products (Table 9). A total of 190 analytical tests were performed and the samples were deemed to be 100% compliant. No *L. monocytogenes* was detected in any of the samples and all levels of generic *E. coli* were within compliance limits. Due to the extensive volume of milk production within Canada, these types of products are typically not imported, as such all samples collected were domestically produced.

Table 9: Compliance Rates of Domestic Fluid Milk Products

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Skim Milk	16	8	8	0	100
1% Milk	30	15	15	0	100
2% Milk	74	37	37	0	100
Homogenized (3.25%) Milk	6	3	3	0	100
Chocolate Milk	44	22	22	0	100
Cream[a]	12	6	6	0	100
Specialty Milk[b]	8	4	4	0	100
Total	190	95	95	0	100

[a] Cream includes 10%, 18% and whipping cream.

[b] Specialty milk includes omega-3 fortified milk, egg nog, organic and goat milk.

6.3.2. Cheese Products

The other most commonly consumed dairy product is cheese. Cheese is a manufactured product for which the probability of microbial contamination is incurred due to handling and fermentation practices. As such, domestic and imported cheeses were sampled and analyzed for generic *E. coli*, *E. coli* O157:H7, *Salmonella* spp., *S. aureus*, and *L. monocytogenes*. Phosphatase testing was performed when deemed appropriate.

Domestic samples consisted primarily of traditional cheeses, such as cottage cheese, cheddar, mozzarella, brie, and cheese slices. However, some producers use "non-traditional" methods that do not use bacteria to coagulate the cheese. These types of cheeses, including paneer and channa, were also selected for analysis. In total 339 domestic traditional cheeses and 12 domestic non-traditional cheese products were subjected to 1555 tests (Table 10). The traditional cheeses were 97.1% compliant with 10 samples assessed as unsatisfactory. Four samples tested positive for *L. monocytogenes*, four samples were positive for *S. aureus*, and two samples were positive for *Staphylococcal* enterotoxins. The 12 domestic non-traditional cheese products were assessed as 100% compliant.

A variety of cheeses imported from 21 countries were also tested. In total 268 imported traditional cheese were subjected to 1199 tests and 95.9% of these products were deemed to be compliant (Table 10). The 11 samples assessed as unsatisfactory were imported from four countries (Table 11). One sample from Egypt and three samples from Italy were unsatisfactory due to high levels of generic *E. coli*. One sample from Portugal was unsatisfactory due to the presence of *S. aureus*. While from France one sample had high levels of generic *E. coli*, three samples contained *S. aureus*, one sample contained *L. monocytogenes* and one sample contained *L. monocytogenes* and *S. aureus*. Reflective of the fact that many imported cheeses come from France, 46% of the samples selected and 55% of the unsatisfactory products were from France.

Table 10: Compliance Rates of Domestic Traditional and Non-Traditional Cheeses and Imported Traditional Cheeses

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic Traditional Cheese	1506	339	329	10	97.1
Domestic Non-Traditional Cheese Products	49	12	12	0	100
Imported Traditional Cheese	1199	268	257	11	95.9
Total	2754	619	598	21	96.6

Table 11: Number of Imported Cheese Samples Analyzed by Country of Origin

Country of Origin	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
ARGENTINA	1	1	0	100
AUSTRIA	1	1	0	100
BELGIUM	3	3	0	100
BULGARIA	1	1	0	100
DENMARK	4	4	0	100
EGYPT	2	1	1	50.0
FINLAND	2	2	0	100
FRANCE	124	118	6	95.2
GERMANY	9	9	0	100
GREECE	9	9	0	100
ISRAEL	6	6	0	100
ITALY	35	32	3	91.4
NETHERLANDS	10	10	0	100
NORWAY	3	3	0	100
POLAND	2	2	0	100
PORTUGAL	5	4	1	80
SPAIN	6	6	0	100
SWEDEN	1	1	0	100
SWITZERLAND	16	16	0	100
UNITED KINGDOM	10	10	0	100
UNITED STATES	17	17	0	100
Unknown	1	1	0	100
Total	268	257	11	95.9

6.3.3. Environmental Testing

In addition to testing domestic traditional cheese, the manufacturers were also subjected to environmental testing. Environmental sampling allows for early identification and prevention of *L. monocytogenes* contamination in the finished products. When environmental samples were collected, cheese products manufactured within the same production period were also taken for analysis. Each environmental sample represents 5 to 10 different food contact surfaces within the production environment, and is analyzed for *L. monocytogenes*. In 2011/12, a total of 52 environmental samples, representing approximately 500 food contact surfaces, were tested and deemed to be 100% compliant. No *L. monocytogenes* was detected in any of the environmental samples or the concurrently acquired cheese samples.

6.4. Fresh Fruits and Vegetables

Under the NMMP a wide variety of fresh fruits and vegetables grown under various conditions, including organic and conventional farming methods, field and greenhouse grown, are tested. Due to seasonal limitations, the bulk of domestically produced samples are collected during the months of July to October. However, both domestic produce grown in greenhouses and imported produce are available year round and are sampled accordingly.

Products, such as herbs, sprouts and fresh-cut produce, are tested for generic *E. coli*, *E. coli* O157:H7, *Salmonella* spp. and *Shigella* spp. Additional produce specific testing included faecal coliforms (sprouts), *L. monocytogenes* (RTE fresh-cut produce) and verotoxigenic *E. coli* (leafy vegetables, sprouts, herbs, green onions). Sampling includes whole fruits and vegetables that may be consumed raw and RTE fresh-cut produce such as coleslaw, salad, carrots, mushrooms and melons. RTE fresh-cut produce is defined as fruits and vegetables that have been washed and/or minimally processed (peeled, cored, chopped, sliced) and are intended to be consumed raw.

6.4.1. Fresh Vegetables and Ready-To-Eat Fresh-Cut Vegetables

The sampling of imported and domestic fresh vegetables was primarily composed of leafy greens, tomatoes, herbs, peppers, green onions and sprouts. In addition to produce intended for local markets (for sale to the general public), institutional sized bags of shredded lettuce, spring mix and spinach destined for restaurants, hospitals or institutions were also sampled. Similar types and numbers of domestic and imported vegetables were tested (Figure 3).

In total, 692 fresh vegetables and 100 RTE fresh-cut vegetables were subjected to 3327 tests (Table 12). Amongst the 316 domestic fresh vegetables, 60 samples were sprouts and of these, six were assessed as unsatisfactory due to high levels of generic *E. coli* and faecal coliforms. As such, the domestic fresh vegetables were 98.1% compliant. Domestic RTE fresh-cut vegetables were assessed as 100% compliant with all 17 samples deemed to be satisfactory. No pathogens were detected in any of the domestic vegetables.

Imported vegetables were deemed to be 100% compliant, with 376 imported fresh and 83 RTE fresh vegetables subjected to testing. The imported vegetables sampled were from 13 different countries (Figure 4), however produce from the United States and Mexico accounted for more than 94% of the total number sampled. Overall, 99.2% of the domestic and imported fresh and RTE fresh-cut vegetables sampled were assessed as satisfactory. No pathogens were detected in any of the samples.

Figure 3: Number and Types of Domestic and Imported Vegetables (Fresh and Ready-To-Eat Fresh-Cut) Sampled for Testing

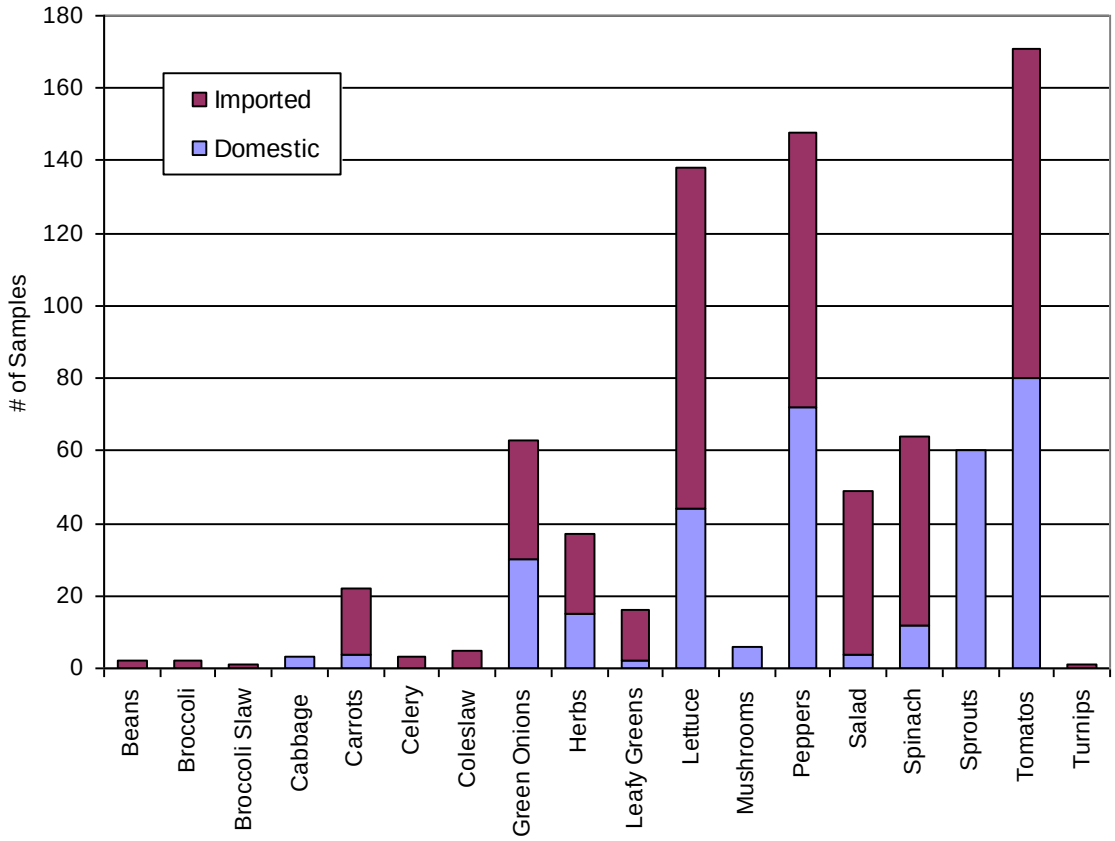
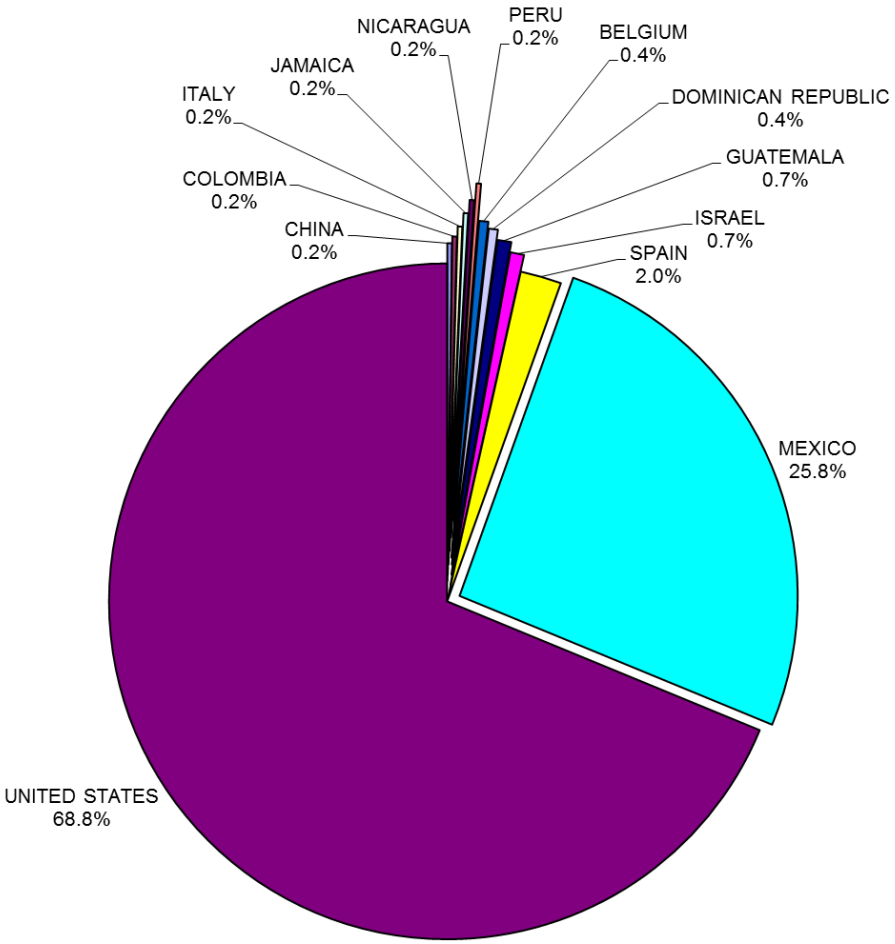


Table 12: Compliance Rates of Domestic and Imported Fresh Vegetables and Ready-To-Eat Fresh-Cut Vegetables

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic Fresh Vegetables	1407	316	310	6	98.1
Domestic RTE Fresh-Cut Vegetables	85	17	17	0	100
Imported Fresh Vegetables	1410	376	0	0	100
Imported RTE Fresh-Cut Vegetables	425	83	83	0	100
Total	3327	792	786	6	99.2

Figure 4: Countries of Origin of Imported Vegetables (Fresh and Ready-To-Eat Fresh-Cut) Sampled for Testing



6.4.2. Fresh Fruits and Ready-To-Eat Fresh-Cut Fruits

A total of 202 fresh and RTE fresh-cut fruits were subjected to a total of 828 analytical tests (Table 13). Based on consultation and the prioritization of food-hazard combinations deemed to pose the greatest potential health risks during the design phase of these plans, melons and berries were predominantly represented (Figure 5). Overall, 99.5% of the fresh fruits sampled were assessed as satisfactory, with no pathogens detected. The 45 domestic fresh and seven domestic RTE fresh-cut fruits were subjected to 218 tests. They were determined to be 97.8% and 100% compliant, respectively. One domestic fresh fruit was assessed as unsatisfactory due to high levels of generic *E. coli*. No pathogens were detected in any of the domestic or imported fruits sampled. In total, 147 imported fresh and two imported RTE fresh-cut fruits were subjected to 610 tests and assessed as 100%

compliant. The imported fruits sampled were from eight different countries (Figure 6) and produce from the United States and Mexico accounted for more than 85%.

Figure 5: Number and Types of Domestic and Imported Fresh Fruits and Ready-To-Eat Fresh Cut Fruits

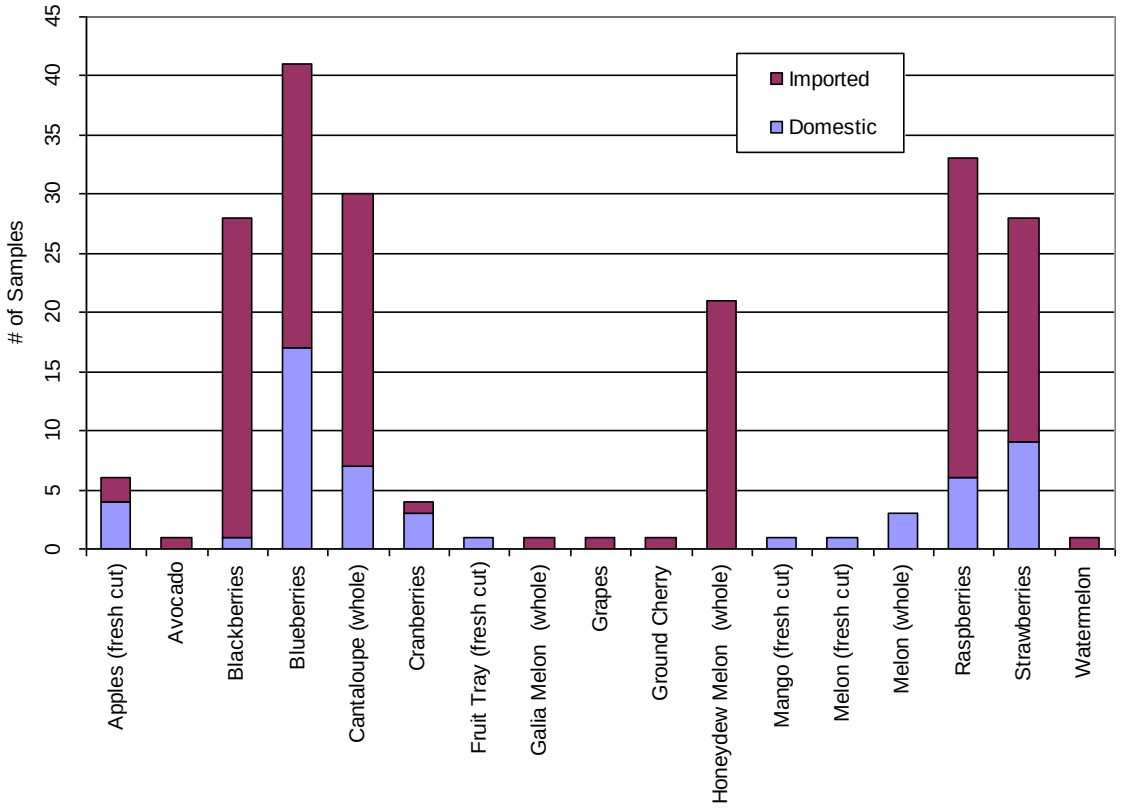
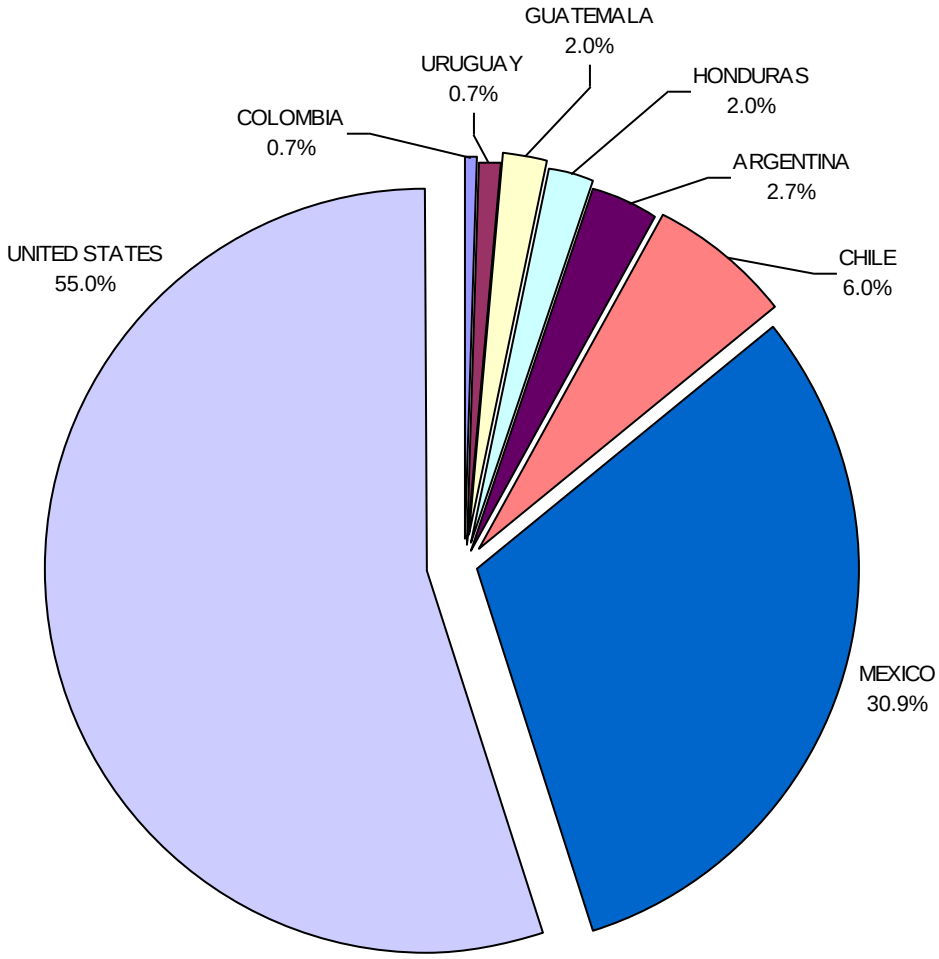


Table 13: Compliance Rates of Domestic and Imported Fresh Fruits and Ready-To-Eat Fresh-Cut Fruits

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic Fresh Fruit	183	46	45	1	97.8
Domestic RTE Fresh-Cut Fruit	35	7	7	0	100
Imported Fresh Fruit	600	147	147	0	100
Imported RTE Fresh-Cut Fruit	10	2	2	0	100
Total	828	202	201	1	99.5

Figure 6: Countries of Origin of Imported Fruits (Fresh and Ready-To-Eat Fresh-Cut) Sampled for Testing



6.5. Processed Fruit and Vegetable Products

Under CFIA's monitoring activities processed fruit and vegetable products are sampled and tested. Commodities selected included low acid foods in hermetically sealed containers (e.g. canned vegetable products, vegetable soups); acidified low acid canned foods (foods treated so all components have an equilibrium pH of 4.6 or less; e.g. fermented or acidified pickled products, horseradish, acidified canned vegetables); frozen fruits and vegetables; acid foods (e.g. canned fruits, canned tomato products); low water activity foods (e.g. jams, jellies, pie filling); opaque juices and other processed products packaged in glass containers.

With the exception of frozen foods, these types of products are packaged in cans, glass jars and tetra packs. The packaging process includes heat treatment to ensure sterility of the environment within the container. Therefore these packaged products were not subjected to microbial analysis. Depending on the hazard of concern these products may be visually examined for mould filaments and extraneous material, or tested for physio-chemical parameters (pH, water activity, salt content) to determine their quality and safety. In the absence of heat treatment, frozen foods were subjected to microbial analysis including aerobic colony counts, generic *E. coli*, *L. monocytogenes* and *Salmonella* spp.

6.5.1. Canned Tomato Products

Canned tomato products, including stewed tomatoes and tomato juice, were tested for non-viable mould filaments in order to assess the quality of the tomatoes used. Nine domestic and 17 imported canned tomato products were sampled and tested (Table 14). Of these two domestic and eight imported products contained a high number of mould filaments, resulting in 77.8% and 52.9% compliance respectively. Although the presence of mould does not pose a health risk to consumers it is an indication that bruised or damaged tomatoes were used. Overall only 61.5% of the canned tomato products sampled were deemed to be compliant.

Table 14: Compliance Rates of Domestic and Imported Canned Tomato Products

Source	# Tests	# Samples	# Satisfactory	# Investigative	# Unsatisfactory	% Compliance
Domestic	9	9	6	1	2	77.8
Imported	17	17	7	2	8	52.9
Total	26	26	13	3	10	61.5

The majority of Canada's imported tomato products are products of Italy, as such most of the samples submitted for analysis were from Italy (Table 15). Of the 17 imported samples tested eight samples were assessed as unsatisfactory due to a high number of

mould filaments, and two samples were assessed as investigative due to moderate counts of mould filaments. All of the unsatisfactory and investigative samples were from Italy.

Table 15: Number of Imported Canned Tomato Products Analyzed by Country of Origin

Country of Origin	# Samples	# Satisfactory	# Investigative	# Unsatisfactory	% Compliance
GREECE	1	1	0	0	100
ITALY	15	5	2	8	46.7
UNITED STATES	1	1	0	0	100
Total	17	7	2	8	52.9

6.5.2. Acidified Low-Acid and Pickled Products

Acidified low-acid products and pickled products, including eggplant, sauerkraut, pickles, olives, and red beets, are sold in cans or jars. Pickled products require refrigeration in order to maintain their shelf-life, while the acidified low-acid products can be stored at room temperature. All of these products were tested for pH, water activity and salt content, and those requiring refrigeration were also tested for *L. monocytogenes*.

During 2011/12, a total of 307 tests were performed on 30 samples (Table 16). No *L. monocytogenes* was detected. Six domestically produced and two imported pickled products were subjected to 33 analytical tests and deemed to be 100% compliant. In total, 274 analytical tests were performed on 22 imported acidified low-acid shelf-stable products. All were assessed as satisfactory and therefore 100% compliant. The 24 imported products were from 13 countries (Table 17).

Table 16: Compliance Rates of Domestic and Imported Acidified Low-Acid Products and Pickled Products

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic Pickled	20	6	6	0	100
Imported Pickled	13	2	2	0	100
Imported Acidified Low-Acid	274	22	22	0	100
Total	307	30	30	0	100

Table 17: Number of Imported Acidified Low-Acid Products and Pickled Products by Country of Origin

Country of Origin	# Samples
BOSNIA	1
BULGARIA	1
GREECE	3
INDIA	4
IRAN, ISLAMIC REPUBLIC OF	1
ITALY	2
LEBANON	1
MEXICO	1
NETHERLANDS	1
SPAIN	2
TURKEY	1
UNITED STATES	5[a]
VIET NAM	1
Total	24

[a] Includes two refrigerated pickled products.

6.5.3. Processed Products in Glass Containers

Products packaged in glass containers, including relish, artichoke paste, pickled peppers, pickles, pimentos and opaque juices are sampled and analyzed for the presence of glass fragments. For each sampling activity 24 jars were assessed to determine the presence, size and number of glass fragments within each container. During 2011/12, 216 tests were performed on nine samples (24 jars per sample) and determined to be 88.9% compliant (Table 18). The nine imported samples were from six countries of origin. One sample from India was assessed as unsatisfactory due to the presence of glass particles in eight of the 24 jars.

Domestic establishments that package their products in glass are subject to facility inspections by the CFIA. As such, domestic samples in glass containers are submitted for testing for investigative purposes only.

Table 18: Testing and Compliance Rates of Imported Products Packaged in Glass Containers by Country of Origin

Country of Origin	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
INDIA	2	1	1	50.0
ITALY	1	1	0	100
JAMAICA	1	1	0	100
MACEDONIA	1	1	0	100
SPAIN	1	1	0	100
UNITED STATES	3	3	0	100
Total	9	9	1	88.9

6.5.4. Frozen Vegetables

Frozen produce is not exposed to any processes effective enough to destroy all microorganisms of concern and may therefore pose a microbial health risk to the consumer. Storage under these conditions typically does not support the growth of microorganisms, yet is not adequate to destroy all types of microbes and their toxins. Therefore when these products are thawed, there is the potential for microbial growth to occur.

Typically frozen vegetables require thorough heating or cooking prior to serving. These products are clearly labelled with cooking instructions intended to kill any pathogens that may be present. Because it is expected that the product will be cooked prior to consumption, these foods were not tested for pathogens. Instead, they were tested for indicator organisms (ACC and generic *E. coli*) to verify the implementation of effective sanitary procedures within the processing environment. However there are some types of frozen vegetables that are not clearly labelled with cooking instructions, for example frozen spinach. These types of products are not always subjected to cooking prior to consumption, and therefore were tested for *L. monocytogenes*.

In total 24 domestic and 71 imported frozen products were sampled, with a compliance rate of 90.5% (Table 19). Of the domestic samples, 20 presented cooking instructions and four did not. Together the samples were subjected to a total of 55 analyses. Respectively, they were deemed to be 100% and 50% compliant, with two of the frozen samples without cooking instructions being assessed as unsatisfactory due to the presence of *L. monocytogenes*.

Table 19: Microbial Testing and Compliance Rates of Domestic and Imported Frozen Vegetables

Product Type	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic	40	20	20	0	100
Domestic - Without cooking instructions	15	4	2	2	50.0
Imported	176	63	56	7	88.9
Imported - Without cooking instructions	9	8	8	0	100
Total	240	95	86	9	90.5

The imported samples were comprised of 63 displaying cooking instructions and eight without cooking instructions (Table 19). These were subjected to a total of 185 analyses. The products which did not contain cooking instructions were 100% compliant, no *L. monocytogenes* was detected. With a compliance rate of 88.9%, of the 63 imported samples that required cooking, seven of these were assessed as unsatisfactory due to high levels of ACC. Additionally, two products were assessed as investigative due to the presence of moderate levels of ACC (Table 20). The 71 imported products were from 16 different countries, of which 51% were from China, Egypt and the United States.

Table 20: Percentage, Number and Assessment of Imported Frozen Vegetables by Country of Origin

Country of Origin	% of Samples	# Samples	# Satisfactory	# Investigative	# Unsatisfactory	% Compliance
BELGIUM	5.6	4	4	0	0	100
CHILE	2.8	2	2	0	0	100
CHINA	25.4	18	15	2	1	94.4
COSTA RICA	2.8	2	1	0	1	50.0
ECUADOR	1.4	1	1	0	0	100
EGYPT	11.3	8	7	0	1	87.5
FIJI	5.6	4	4	0	0	100
FRANCE	7.0	5	5	0	0	100
GUATEMALA	1.4	1	1	0	0	100
INDIA	8.5	6	4	0	2	66.7
MEXICO	5.6	4	3	0	1	75.0
PERU	2.8	2	2	0	0	100
PHILIPPINES	2.8	2	1	0	1	50.0
TAIWAN	1.4	1	1	0	0	100
UNITED STATES	14.1	10	10	0	0	100
VIET NAM	1.4	1	1	0	0	100
Total	100	71	62	2	7	90.1

6.5.5. Frozen Fruits

Unlike most frozen vegetables, frozen fruits do not require heating or cooking prior to consumption. Since these products are not subjected to any treatments to kill potential pathogens, and do not display cooking instructions on their packages, they can pose a potential microbial health risk to consumers. A variety of frozen fruits, including berries, bananas, mangos, pineapple and honeydew melon, were tested for *L. monocytogenes*. Overall 15 samples of domestic and imported frozen fruit were analyzed for *L. monocytogenes*, and deemed to be 100% compliant (Table 21). The 11 imported samples originated from seven countries (Table 22).

Table 21: Compliance Rates of Domestic and Imported Frozen Fruits

Source	# Tests	# Samples	# Satisfactory	# Unsatisfactory	% Compliance
Domestic	4	4	4	0	100
Imported	11	11	11	0	100
Total	15	15	15	0	100

Table 22: Number of Imported Frozen Fruits by Country of Origin

Country of Origin	# Samples
CHILE	3
ECUADOR	3
GUATEMALA	1
MEXICO	1
PERU	1
THAILAND	1
VIET NAM	1
Total	11

7. Summary

The NMMP is designed to sample and test a broad range of imported and domestic commodities for multiple hazards. Food-hazard combinations deemed to pose the greatest potential health risks, recent outbreaks of foodborne illness, emerging food-hazard combinations and historical levels of compliance are taken into consideration during the annual designing of the NMMP. Sampling plans are developed to test a variety of commodities including red meat and poultry, shell eggs and egg products, dairy products, fresh fruits and vegetables and processed fruit and vegetable products. The defined assessment criteria are based on Canadian and international standards, and are specific to the food and microbial organism of concern.

Sampling activities are conducted for regulatory purposes and are used to verify that food production practices are in compliance with applicable standards, acts, and guidelines. They demonstrate quality products are available in the Canadian marketplace and assure consumers that the government has systems in place to ensure the food they consume is safe. During the 2011/12 fiscal year, under the NMMP, 5234 domestic and imported products were sampled and tested. A variety of testing (e.g. microbial hazards, extraneous material) was performed to verify the products were safe for consumption: 9049 tests were performed on 3678 domestic products and 5258 tests were performed on 1556 imported products. These were assessed as 99.0% and 98.0% compliant, respectively. Combined 14307 analyses were conducted on 5234 food products and deemed to be 98.7% compliant.

Environmental sampling was performed in various domestic establishments. It is an effective tool used to determine the efficacy of the operator's system to control the presence of pathogens within the processing environment. It is used to identify the presence of pathogens within the manufacturing environment and prevent downstream contamination of products. During the 2011/12 fiscal year, 2300 tests were performed on 1878 environmental samples from domestic establishments. Of these, 97.5% were compliant.

Results indicate the vast majority of food products tested were safely produced and maintained under sanitary conditions, and therefore safe for consumption. While periodical contamination did occur, all samples were subject to food safety investigations and appropriate follow-up activities were conducted by the CFIA.

8. References

Canadian Food Inspection Agency (CFIA). *Overview of Canada's BSE Safeguards.* 2008. Accessed January 30, 2013. Available at URL: http://www.inspection.gc.ca/english/anima/disemala/bseesb/bseesbfs2e.shtml

Codex Alimentarius Commission (CAC). *Code of Hygienic Practices for Fresh Fruits and Vegetables*. CAC/RCP 53-2003. Accessed September 12, 2013. Available at URL: http://www.codexalimentarius.net/download/standards/10200/CXP_053e.pdf.

Codex Alimentarius Commission (CAC). *Code of Hygienic Practices for Meat.* CAC/RCP 58-2005. Accessed September 12, 2013. Available at URL: http://www.lnciq.gov.cn/ywpd/spjy/ywcs/201202/P020120202419685224238.pdf.

Food and Drug Administration (FDA). *Bad Bug Book: Foodborne Pathogenic Microorganisms and Natural Toxins Handbook*. 2nd Edition. 2012. Available at URL: http://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/UCM297627.pdf~~http://www.fda.gov/Food/FoodSafety/FoodborneIllness/default.htm~~

Forsythe, S.J. *The Microbiology of Safe Food*. 2nd Edition. Blackwell Publishing Ltd., 2011: 214.

Health Canada. *Guidelines for Raw Ground Beef Products Found Positive for Escherichia coli O157:H7*. 1999. Accessed September 12, 2013. Available at URL: http://www.hc-sc.gc.ca/fn-an/legislation/guide-ld/guidelines_raw_ground_beef-directives_boeuf_hache_cru-eng.php.

Health Canada. *Healthy Living: Listeria and Food Safety*. 2010a. Accessed January 30, 2013. Available at URL: http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/food-aliment/listeria-eng.php

Health Canada. *Food and Nutrition: Safe Internal Cooking Temperatures*. 2010b. Accessed January 30, 2013. Available at URL: http://healthycanadians.gc.ca/eating-nutrition/safety-salubrite/cook-temperatures-cuisson-eng.php~~http://www.hc-sc.gc.ca/fn-an/securit/kitchen-cuisine/cook-temp-cuisson-eng.php~~

Health Canada. *Food and Nutrition: Food-Relate Illnesses*. 2012. Accessed January 30, 2013. Available at URL: http://www.hc-sc.gc.ca/fn-an/securit/ill-intox/index-eng.php

International Commission on Microbiological Specifications for Foods (ICMSF) Microorganisms in Food 7: *Microbiological Testing in Food Safety Management*. Springer, 2002: Chapters 4 & 7.

Mayo Clinic. *Diseases and Conditions*. 2012. Accessed January 30, 2013. Available at URL: http://www.mayoclinic.com/health/DiseasesIndex/DiseasesIndex

McIntyre, L, Pollock, S.L., Fyfe, M. Gajadhar, A., Isaac-Renton, J., Fung, J., and Morshed, M. *Trichinellosis from Consumption of Wild Game Meat*. 2007. Canadian Medical Association Journal, 176(4): 449-451.

Montville, T.J., Matthews, K.R., and Kniel, K.E. *Food Microbiology, An Introduction*. 3rd Edition. AMS Press, 2012: Chapters 13, 16 & 25.

For further information please visit:
CFIA's Consumer Center website at
http://www.inspection.gc.ca/food/consumer-centre/eng/1299093858143/1303766424564

Health Canada's Healthy Canadians website at:
http://www.healthycanadians.gc.ca/eating-nutrition/poisoning-intoxication/index-eng.php

Appendix A: Acronyms and Abbreviations

ACC	Aerobic Colony Count
a_w	Water Activity
BSE	Bovine Spongiform Encephalopathy
CFIA	Canadian Food Inspection Agency
CFU	Colony Forming Unit
CNS	Central Nervous System
E. coli	*Escherichia coli*
FDA	Food and Drug Administration
ICMSF	International Commission on Microbiological Specifications for Foods
L. monocytogenes	*Listeria monocytogenes*
MPN	Most Probable Number
NMMP	National Microbiological Monitoring Program
RTE	Ready-To-Eat
S. aureus	*Staphylococcus aureus*
spp.	Species
T. spiralis	*Trichinella spiralis*
vCJD	Variant Creutzfeld-Jakob Disease
VTEC	Verotoxigenic *Escherichia coli*

Appendix B: Glossary of Terms

Acidified low-acid food means a naturally low-acid food which has been treated in a manner so that all components attain an equilibrium pH of 4.6 or below by the time thermal processing and cooling is completed.

Colony-forming unit (CFU) is defined as a single colony (group of bacterial cells) on an agar plate that in theory arises from a single bacterial cell.

Extraneous material is the presence of a foreign object from an outside source, such as metal, glass or hair, in a food product.

Finely textured beef refers to an edible beef product obtained by removing most of the bone and cartilage from a comminuted beef product from which the bone and cartilage had not been previously removed. These products do not contain more than 0.15% of calcium or any bone particles larger than 1.5 mm in size, with a maximum of 20% of the bone particles larger than 1 mm in size.

Heat treatment is the application of heat. In the food industry the two most commonly used methods of heat treatment for killing food microbes are pasteurization and sterilization.

Mechanically separated beef means an edible beef product that does not contain more than 0.027% of calcium for every one per cent of protein in the product or any bone particles larger than 2 mm in size and that was obtained by removing most of the bone and cartilage from a comminuted beef product from which the bone and cartilage had not been previously removed, as per the Meat Inspection Regulations, 1990.

Medium is a liquid or gel-like substance composed of specific nutrients required to support the growth of specific bacteria while inhibiting the growth of other competitive. It is used in laboratory methodology to positively identify microorganisms of concern.

Most probable number (MPN) is a statistical method for estimating small populations of bacteria.

Pasteurization is a heat treatment intended to kill non-spore-forming pathogens and spoilage organisms.

Processed refers to food that has been subjected to a process intended to assure preservation of that food over a period of time. Examples include canned, cooked, frozen, dehydrated, concentrated, pickled or otherwise prepared food.

Raw refers to food that is uncooked or partially-cooked. Raw food may require further processing prior to consumption, for example heat treatment of ground beef.

Ready-to-eat (RTE) fresh cut produce is defined as fresh fruits or vegetables that have been washed and minimally processed, such as peeled, cored, sliced, chopped and/or shredded, prior to packaging.

Ready-to-eat (RTE) meat is a meat product that has been subjected to a lethality process sufficient to inactivate pathogens and/or their toxins or spores. These types of products do not require further preparation or cooking prior to consumption. Products may need to be washed, thawed or exposed to sufficient heat to warm the product without cooking it.

Serotype refers to a distinctive type of organism, referred to as subspecies, within a specific species of bacteria or virus.

Sterilization is a heat treatment process intended to destroy all living microorganisms.

Trims are pieces of meat, fat and other tissues removed from carcasses during the process of deboning and making specific cuts of meat (i.e. steaks, ribs).

Water activity (a_w) is the amount of water freely available for metabolic activities supporting bio-chemical reactions and microbial growth. This water is not bound to tissues or components.