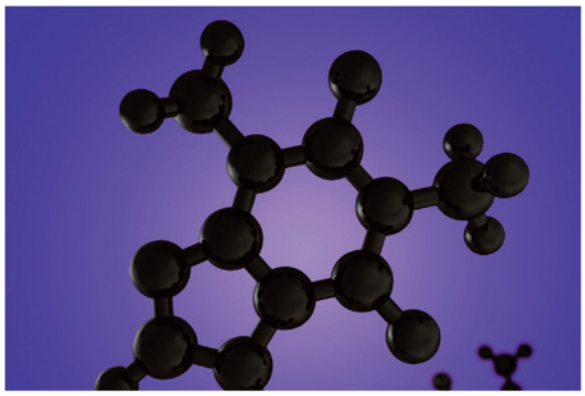
Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2009-2010 Targeted Surveys

Chemistry



Pesticide Residues in Fresh Fruit and Vegetables

TS-CHEM-09/10-09

Canada

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1. Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and enhance Canada's food safety system. As a part of the FSAP enhanced surveillance initiative, targeted surveys are used to test various foods for specific hazards.

The main objective of the pesticide residues in fresh fruit and vegetables targeted survey was to provide baseline surveillance data for pesticide residues in those foods sold intra-provincially (i.e., non-federally registered and not imported). This will assess the potential exposure of Canadians who obtain their fresh fruit and vegetables from a geographically localized region.

Currently federally registered agricultural commodities are monitored by the Canadian Food Inspection Agency (CFIA) under the National Chemistry Residue Monitoring Program (NCRMP). The 2009-2010 Pesticide Residues Survey targeted apples, small berries, leafy greens (i.e., lettuce) and tomatoes that are traditionally outside the CFIA core activities. For the purposes of this targeted survey, non-federally registered foods are those foods that are sold within the province they are produced/grown (i.e., the foods do not cross the provincial boundary). In total, 1000 apples, 943 small berries, 525 lettuce and 610 tomato samples were collected in CFIA's four operational areas (Atlantic, Quebec, Ontario and West).

The 3078 samples collected were analysed for over 400 different pesticide residues. Fifty percent of the apple samples collected contained no detectable pesticide residues. While 50.5%, 71.8% and 76.7% of small berries, leafy greens and tomatoes contained no detectable pesticide residues, respectively. In total there were 84 different pesticide residues detected. Less than one percent (11 samples) of the total 3078 samples collected contained pesticide residues in violation of established Maximum Residue Limits. Seven of the 11 violations occurred in leafy greens followed by three violations in small berries, and one violation in tomatoes. All violations were assessed and appropriate follow-up actions reflecting the magnitude of the health risk were taken. The overall compliance rate of this targeted survey was 99.6%.

2. Introduction

2.1. Food Safety Action Plan

The Food Safety Action Plan (FSAP) aims to modernize and enhance Canada's food safety system. The FSAP unites multiple partners in ensuring safe foods for Canadians.

Within FSAP, the Canadian Food Inspection Agency (CFIA) gained increased capacity to monitor potential food risks and to prevent unsafe food products from entering the Canadian marketplace. The CFIA fulfils this mandate through an enhanced surveillance initiative which includes targeted surveys. The CFIA works on these targeted surveys with input from other CFIA departments, Health Canada and Provincial and Territorial representatives.

2.2. Targeted Surveys

Targeted surveys are pilot surveys used to gather information regarding the potential occurrence of chemical residues in defined food commodities. The surveys are designed to answer specific questions. Therefore, unlike monitoring activities, testing of a particular chemical hazard is targeted to commodity types and/or geographical areas. Due to the vast number of chemicals hazards and food-commodity combinations, it is not possible, nor should it be necessary, to use targeted surveys to identify and quantify all chemical hazards in foods. To identify food-hazard combinations of greatest potential health risk, the CFIA uses a combination of media reports, scientific literature and/or a risk-based model developed by the Food Safety Science Committee.

As part of CFIA's core activities, many agricultural commodities are currently being monitored under the National Chemical Residue Monitoring Program (NCRMP) for the presence of pesticide residues. The monitoring is conducted on imported and inter-provincially traded (federally registered) commodities which fall under the *Canadian Agricultural Products Act* (CAP Act). The purpose of this targeted survey was to compliment the provincial monitoring of the fresh fruits and vegetables that fall outside the CAP Act. Fresh fruits and vegetables, which are not the focus of the CFIA's core activities, were chosen in this targeted survey (i.e., foods that do not cross provincial boundaries).

In addition, the CFIA has expanded testing for pesticide residues using a LC-MS methodology. The results from this targeted survey will allow for a direct comparison between foods traded across provincial borders (includes imports) and those sold locally.

2.3. Acts and Regulations Relating to Pesticide Residues

The *Canadian Food Inspection Agency Act* stipulates that the CFIA is responsible for enforcing restrictions on the production, sale, composition and content of foods and food products as outlined in the *Food and Drugs Act & Regulations* (FDAR).

Health Canada's Pest Management Regulatory Agency (PMRA) is responsible for the registration and regulation of pesticides and the establishment of maximum residue limits (MRLs) under the *Pest Control Products Act* (PCPA). The MRL is the maximum amount of residues that are expected to remain in or on food products when a pesticide is used according to label directions. The test results are then evaluated by the CFIA as follows:

- Pesticide residues found on all commodities sold within Canada must comply with the corresponding established MRL or PMRL.
- In the absence of a MRL or PMRL, pesticide residues must comply with the Canadian General MRL of 0.1 ppm as stated in the section B.15.002(1) of the *Food and Drug Regulations*.
- MRLs and PMRLs equally apply to domestically-produced and imported foods.

All established MRLs and proposed MRLs can be found at the following websites:

MRLs – http://www.hc-sc.gc.ca/cps-spc/pest/part/protect-proteger/food-nourriture/mrl-lmr-eng.php
PMRLs – http://www.hc-sc.gc.ca/cps-spc/pest/part/consultations/index-eng.php

The analytical results from targeted survey samples were compared to the MRL or PMRL. The CFIA recognizes that there is no difference between an MRL and a PMRL in terms of scientific validity, therefore both MRLs and PMRLs are used to assess compliance. Levels at or below were in compliance with Canadian Regulations and did not require further action. All violations were assessed and appropriate follow-up actions reflecting the magnitude of the health risk were taken.

3. Pesticide Survey

3.1. Chemical Hazards in Fresh Fruits and Vegetables

Several types of hazards are present in fresh fruits and vegetables, including physical, microbiological and chemical hazards. Chemical hazards can include mycotoxins, environmental contaminants and pesticide residues. Pesticides are an important tool used in food production because pests such as insects, bacteria, fungi and other organisms can

have devastating effects on the quantity and quality of the food. Although pesticides play an important role in agriculture by protecting food and crops from pests, inappropriate use of pesticides may pose a health risk.

Health Canada's Pest Management Regulatory Agency (PMRA) is responsible for confirming that pesticide residues in the Canadian food supply do not pose a human health concern to any segment of the Canadian population, including infants, children, and pregnant women.

3.2. Rationale

Canadians are increasingly aware of the health benefits of fruit and vegetable consumption prompting them to increase their intake of fresh fruits and vegetables as per the Canadian Food Guide for daily portions of fruits and vegetables. Apples, small berries, tomatoes and lettuce are widely consumed domestic produce in Canada. Each of these commodities is subject to various pest pressures and is commonly grown and sold within provincial boundaries.

The NCRMP is the monitoring program for chemical residues in foods traditionally under the CFIA's mandate. While this program tests for pesticide residues in various commodities, its scope is limited to imported and domestic products that are sold across provincial borders. Food safety surveillance for intra-provincial sale of products generally falls under provincial jurisdiction. The present targeted survey was designed by the CFIA in consultation with provincial partners to gain an appreciation of the pesticide residues in fresh fruits and vegetables harvested and sold within a given province that are not traditionally included in CFIA's monitoring program.

3.3. Sample Distribution

The 2009-2010 Targeted Pesticide Survey in fresh fruits and vegetables sampled fresh local produce, harvested and sold intra-provincially. A total of 3078 samples of leafy greens, tomatoes, apples, and berries were collected in cities[1] within CFIA's operational areas: Atlantic, Quebec, Ontario, and the West. The number of samples distributed by commodity type is listed in Table 3.1.

In the targeted survey, 1000 apple products (includes fresh apples and juice), 525 leafy greens, 610 tomatoes and 943 small berries were sampled at a mixture of U-picks, roadside farm stands, farmers markets and grocery stores. The small berries sampled in this survey consisted of strawberries, blueberries, raspberries/blackberries, Saskatoon berries and cranberries. The category of leafy greens is comprised of different varieties of lettuce such as romaine, chicory and Boston which were either field or greenhouse

[1] The following cities and their surrounding areas that were sampled included Halifax, Saint John, Quebec City, Montreal, Ottawa, Toronto, Calgary and Vancouver.

grown. Tomatoes also consisted of different varieties such as roma, field and vine which were either field or greenhouse grown.

Table 3.1. Detailed list of commodity sample numbers.

Commodity	Total	Product	Subtotal
Apple product	1000	Apple	990
		Apple Juice	10
Leafy greens	525	Arugula	2
		Chard	4
		Kale	6
		Lettuce	479
		Spinach	12
		Chicory	22
Small berries	943	Blackberry	52
		Blueberry	298
		Cranberry	200
		Raspberry	48
		Saskatoon Berry	42
		Strawberry	303
Tomatoes	610	Tomato	610
		Grand Total	**3078**

3.4. Method Details

Samples from the fresh fruit and vegetable pesticide residue targeted survey were analysed by an accredited third party laboratory or the Calgary CFIA Laboratory depending on the analytical method used. Third party laboratories are accredited to ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories* (or its replacement by the Standards Council of Canada (SCC)).

All of the samples collected were sent to either the CFIA Calgary laboratory for liquid chromatography–mass spectrometry (LC-MS) analysis or to private laboratories for gas chromatography–mass spectrometry (GC-MS). When used simultaneously the two multi-residue methods can analyse for over 400 different pesticides per sample. Consult Appendix A and B for a detailed list of pesticide residues analysed by the two multi-residue methods.

One of the objectives of this targeted survey was to compare the targeted survey results from food sold locally to the NCRMP results from food traded across provincial and national borders. The NCRMP analysis consisted of only the aforementioned GC-MS method. At the time the current targeted survey was being completed, the LC-MS methodology had not been validated for use under the NCRMP, therefore the direct comparison between the targeted survey results and the NCRMP results will be for the GC-MS results only.

3.4.1. Gas Chromatography Analysis (GC – MS)

The GC-MS method used can measure up to 304 pesticide analytes (Appendix A). This GC-MS method met or exceeded the requirements of the CFIA reference method entitled 'Determination of Pesticides in Fruits and Vegetables (with Solid Phase Extraction Clean-Up and GC/MSD and HPLC Fluorescence Detection) (PMR-001-V1.8)'. The limit of detection for the carbamates was 0.01 ppm and 0.017 ppm for all other measured pesticides.

3.4.2. Liquid Chromatography Analysis (LC – MS)

A new LC-MS method entitled "Determination of Pesticides in Infant Foods using Liquid Chromatography Electrospray Ionization Mass Spectrometry (LC/ESI-MS/MS) (PMR-006-V1.0)" was recently validated by CFIA laboratories. This method enables the screening of approximately 130 additional pesticide residues which are not detected by GC-MS. The complete list of analytes can be found in Appendix B. The limit of detection for all measured pesticides was 0.001 ppm except for aclonifen (0.005 ppm). The reporting limit for all pesticides was 0.010 ppm with the exception of the following pesticides which are at the higher reporting level of 100 ppb (0.10 ppm): aclonifen, chlorthiamid, chlorbromuron, cycloxydim, pyridalyl and quizalofop.

3.5. Limitations

A total of 3078 samples were collected and analysed in the 2009-2010 fresh fruit and vegetable pesticide survey. In comparison to the total number of fresh fruit and vegetables products available, 3078 total samples represent a small fraction of fresh fruits and vegetables available to consumers regionally. Therefore, no definite conclusions regarding these parameters can be drawn from the data herein. This data is meant to provide a snapshot of the targeted commodities. The survey only covers one growing season and therefore represents limited pest pressures. This survey does not examine year-to-year trends, impact of product shelf-life or cost of the commodity on the open market. It does not account for the relative consumption pattern nor does it represent the relative risk. As well, it does not consider trade and contractual relationships.

4. Results

4.1. Apple Products

A total of 1000 samples of fresh apples (n[2]=990) and apple juice (n=10) were collected and analysed. Five hundred (50%) of the samples had no detected pesticide residues. When the samples were broken down by region, the West (n=184) had the least number of samples with detectable pesticide residues at 23.4%. The percentages of detectable pesticides residues in the remaining regions were 59.4%, 52.7% and 57.2% from Atlantic (n=106), Quebec (n=264) and Ontario (n=446), respectively (Figure 4.1). Sixteen of the 1000 apple samples collected were labelled as organic. No detectable pesticide residues were found on any of the organically labelled apple samples. Also, no detectable pesticide residues were found in any of the apple juice samples collected.

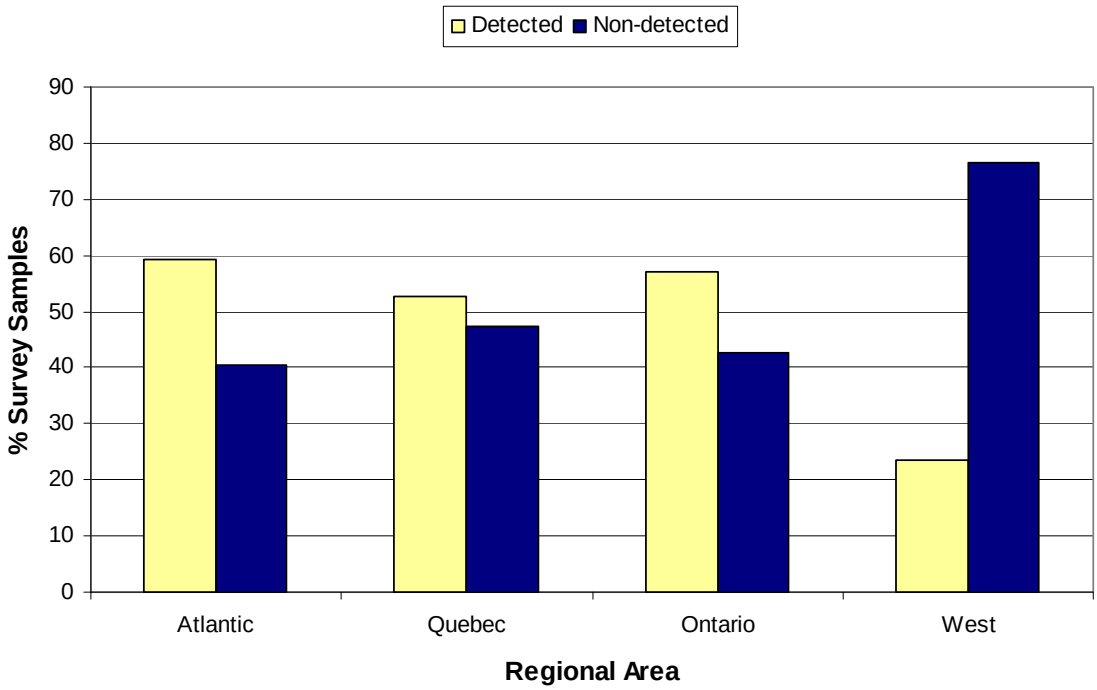


Figure 4.1. Regional distribution of samples containing detected and non-detected pesticide residues.

The frequency at which specific detectable pesticide residues were found in each sample is illustrated in Figure 4.2. Eighty-seven percent of apple samples with detectable pesticide residues contained one and two pesticide residues (n=256 and 178, respectively). Thirteen percent of the apple samples containing detected pesticide residues contained three to a maximum of five residues per sample. Five pesticide residues per sample were found on only two fresh apple samples. None of the residues

[2] n = Represents the number samples

detected in apple products were in violation of established MRLs, therefore the compliance rate was 100%.

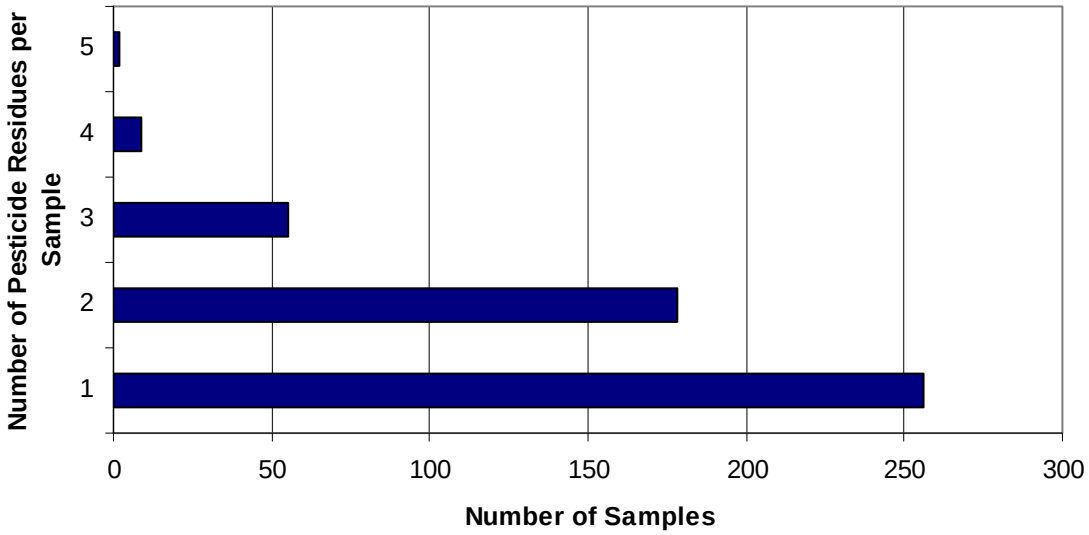


Figure 4.2. Frequency of pesticide residues per apple sample.

There were 24 different pesticide residues found on apples through the GC-MS method and 10 found from the LC-MS method. A detailed list of the detected pesticide residues can be found in Appendix C. Captan, carbaryl, diphenylamine, endosulfan (total), phosalone and phosmet were the predominant (>10 residue counts) pesticide residues detected in apples with GC-MS (Table C.1). Pyrimethanil, spirodiclofen, thiabendazole and thiacloprid were the predominant pesticide residues within the LC-MS analysis.

The distribution of the number of pesticide residues per 2008-2009 NCRMP sample is similar to the current targeted survey (Figure 4.3). As previously mentioned the NCRMP data consists of GC-MS analysis only and results from food traded across provincial and national borders. NCRMP apple samples did have approximately 15% more detected pesticide residues than the targeted survey apple samples. The predominant GC-MS pesticide residues found in the NCRMP data were also found on apple samples from the targeted survey. The NCRMP did have three apple samples in violation of the 0.1 ppm General MRL, resulting in an overall compliance rate of 99%.

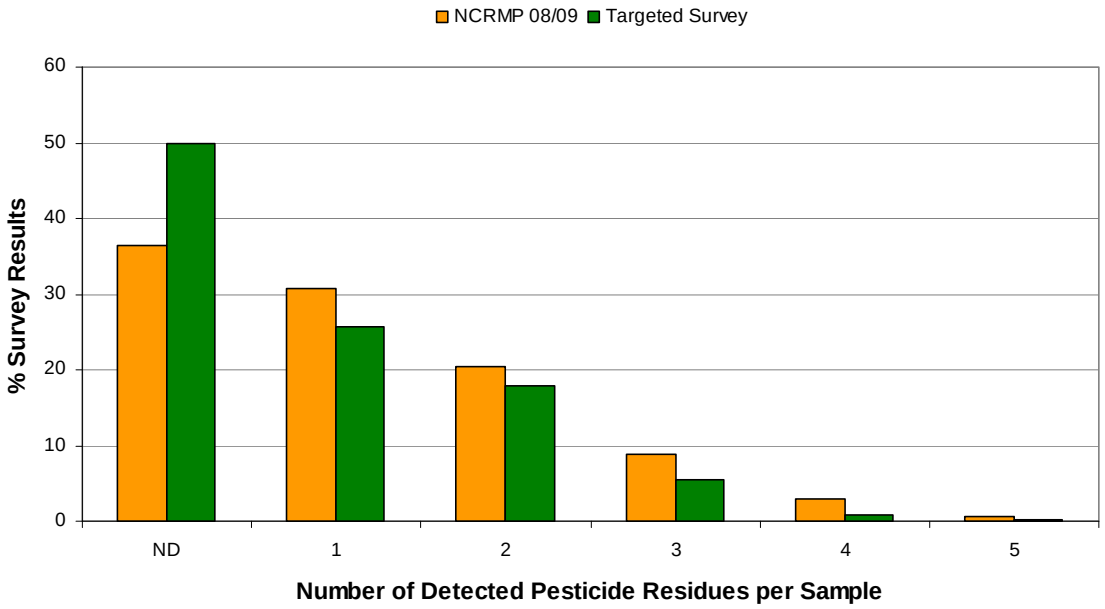


Figure 4.3. Distribution of apple targeted survey samples and 2008-2009 NCRMP apple samples according to the number of pesticide residues found.

4.2. Small Berries

A total of 943 small berry samples (strawberries, blueberries, raspberries/blackberries, Saskatoon berries and cranberries) were collected and analysed for this targeted survey. Of the total number of samples, 476 (50.5%) contained no detectable pesticide residues. When the samples were broken down by region, the Atlantic region (n=150) had the least number of samples with detectable pesticide residues at 30.7% (Figure 4.4). The percentages of detectable pesticide residues in the remaining regions were 44.5%, 53.8% and 62.5% from Quebec (n=344), Ontario (n=145) and the West (n=304), respectively. Two of the 943 small berry samples collected were labelled as organic. No detectable pesticide residues were found on the organically labelled small berry samples.

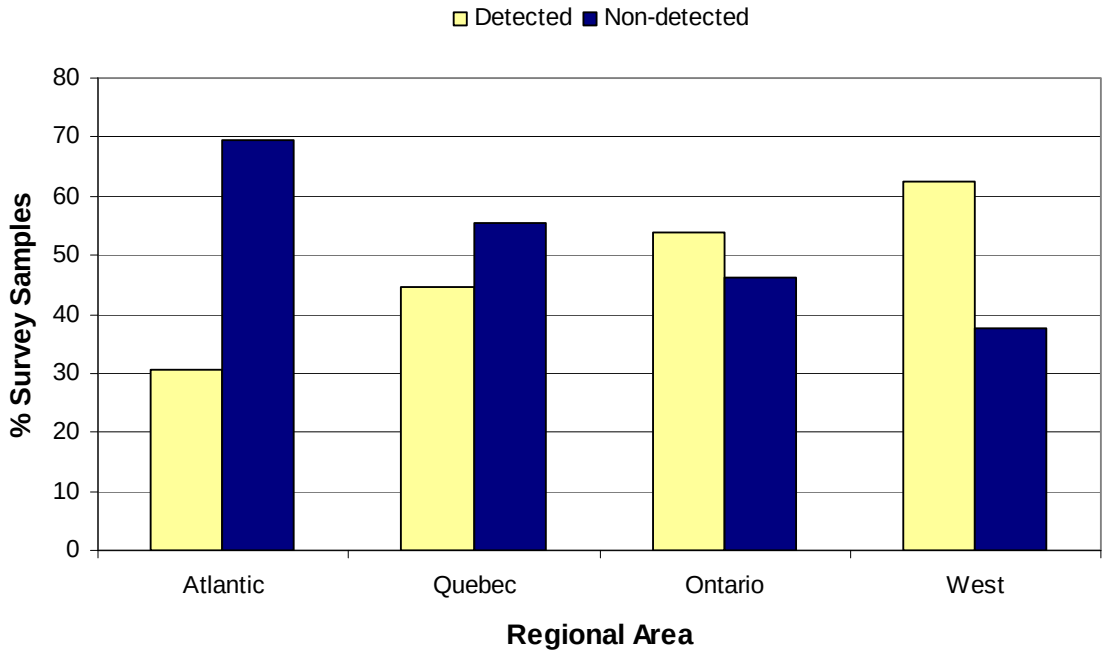


Figure 4.4. Regional distribution of small berry detected and non-detected pesticide residue samples.

The frequency at which specific detectable pesticide residues were found on each berry sample is illustrated in Figure 4.5. Approximately 79% of the samples with detectable pesticide residues contained one and two pesticide residues (n=228 and 143, respectively). Twenty-one percent of the small berry samples contained three to a maximum of nine pesticide residues per sample. Only one sample contained the maximum of nine pesticide residues. Berry types in which the highest percentage of the samples contained pesticide residues were strawberries (71%) followed by blackberries/raspberries (58%), cranberries (40%), blueberries (37%) and Saskatoon berries (12%).

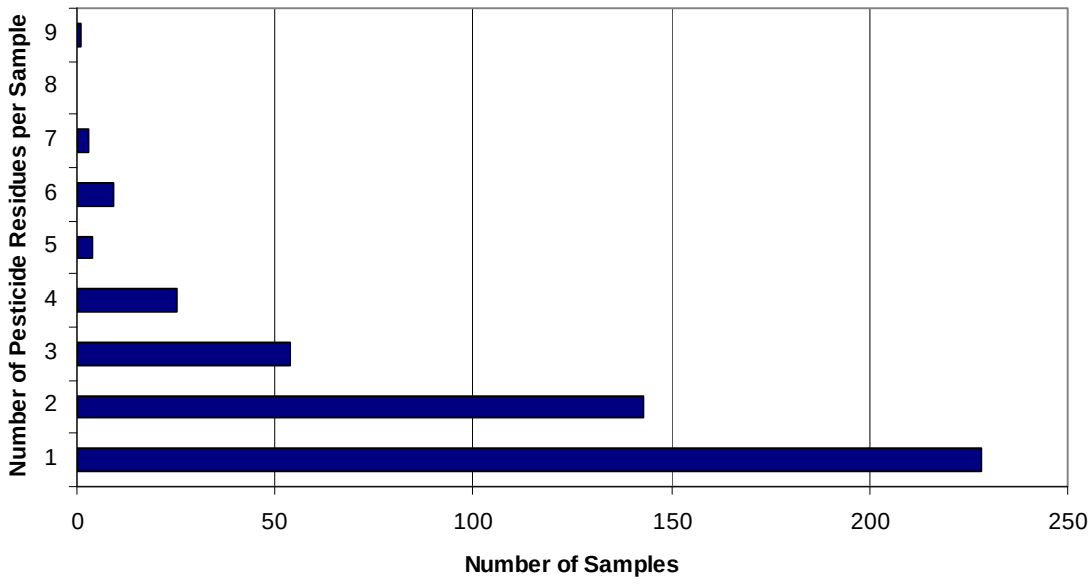


Figure 4.5. Frequency of pesticide residues per small berry sample.

In small berries, there were 34 different pesticide residues found through the GC-MS method and 13 found from the LC-MS method. A detailed list of the detected pesticide residues can be found in Appendix C. Captan, carbaryl, chlorothalonil, cyprodinil, endosulfan (total), and fludioxonil were some of the predominant (>20 residue counts) pesticide residues detected in small berries with GC-MS (Table C.1). Carbaryl, carbendazim, fenhexamid, pyraclostrobin and pyrimethanil were the predominant pesticide residues within the LC-MS analysis.

There were three samples, one strawberry and two blackberries in which the pesticide residue detected exceeded the General MRL of 0.1 ppm (as stated in B.15.002 of the FDR) and were considered a violation (Table 4.1). The information pertaining to the sample violations was referred to the appropriate program for follow-up action. The compliance rate in small berries was approximately 99%.

Table 4.1. Type and level of pesticide residue found in the small berry sample violations.

Sample Type	Pesticide	Amount (ppm)	Reason for Violation	Province
Strawberry	Trifloxystrobin	0.131	>0.1 ppm in violation of paragraph B.15.002 of the *Food and Drug Regulations*.	Quebec
Blackberry	Total Permethrins	0.644		Quebec
Blackberry	Total Permethrins	0.414		Quebec

The distribution of the number of pesticide residues per 2008-2009 NCRMP berry samples, are similar to the current targeted survey (Figure 4.6). NCRMP small berry samples did have approximately 20% more detected pesticide residues than the targeted survey berry samples. Some of the predominant pesticide residues found in the NCRMP were common to the targeted survey. There were 20 berry samples that exceeded the

established MRLs, 19 of which were imports. The overall compliance rate was 92% for the 2008-2009 NCRMP small berry samples.

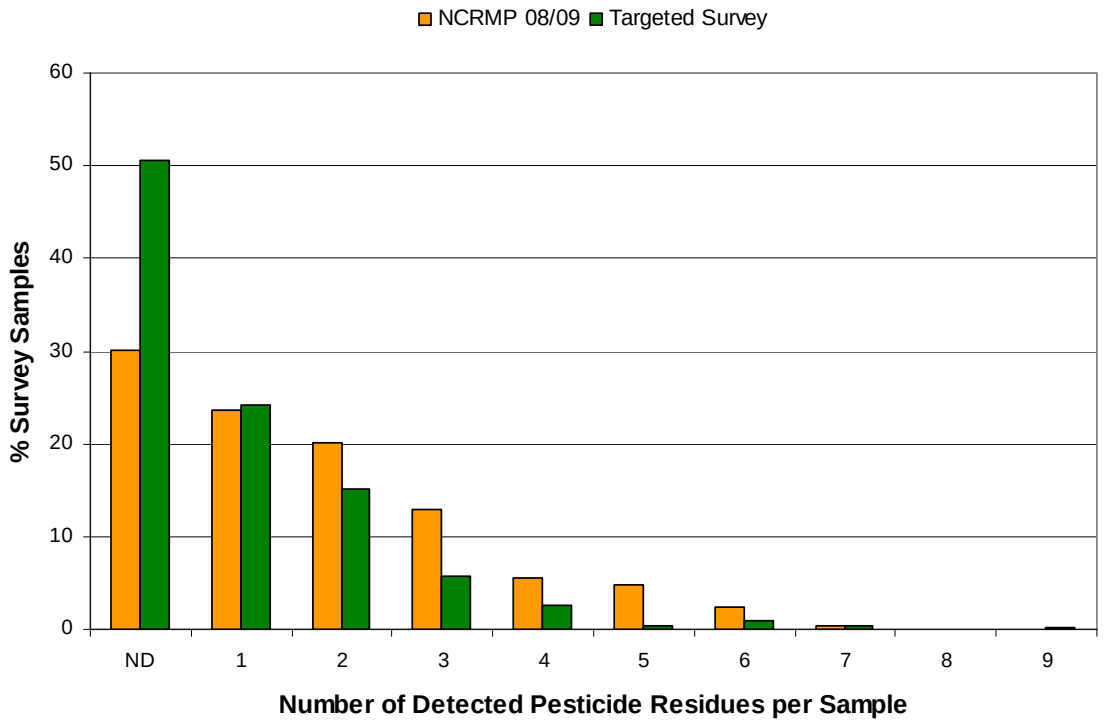
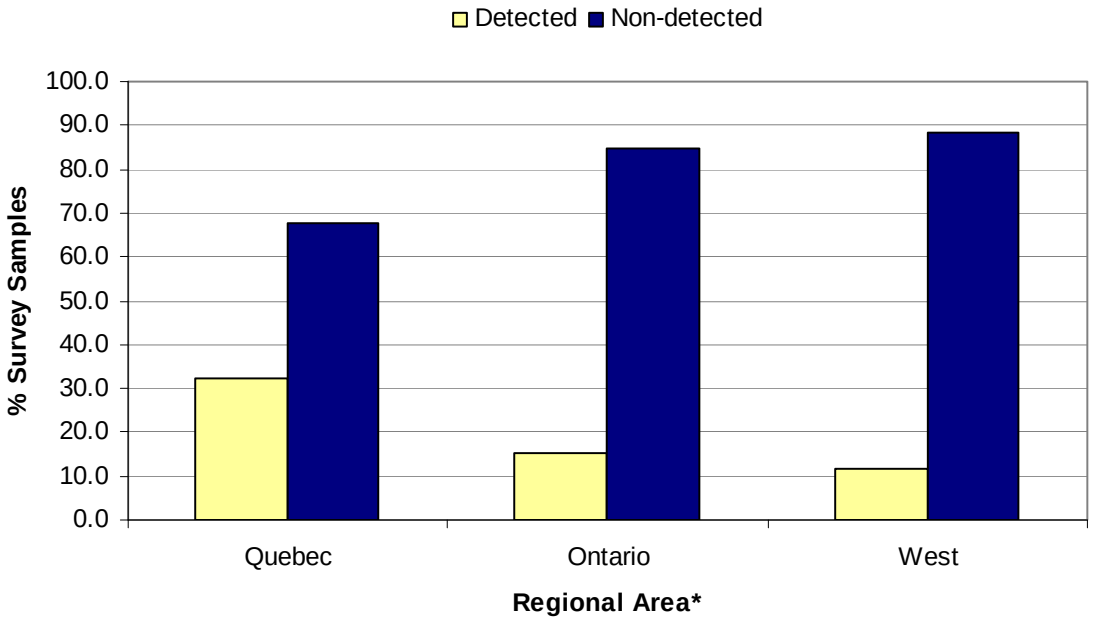


Figure 4.6. Distribution of small berry targeted survey samples and 2008-2009 NCRMP small berry samples according to the number of pesticide residues found.

4.3. Leafy Greens

A total of 525 leafy green samples (both greenhouse and field) were collected and analysed for this targeted survey. Of the total number of samples, 377 (71.8%) contained no detectable pesticide residues. No samples were collected from the Atlantic region as it is not a large producer of fresh leafy greens based on production statistics[1]. When samples were broken down by region, the West (n=26) had the lowest percentage of detectable pesticide residues at 11.5%, followed by Ontario (n=99) at 15.2% (Figure 4.7). Approximately 32.5% of the samples from Quebec (n=400) had detectable pesticide residues.

Of the leafy green samples collected, 126 (24%) were labelled as greenhouse grown. Both greenhouse and field leafy greens contained approximately 30% detectable pesticide residues. Ten of the 525 samples collected were labelled as organic. No detectable pesticide residues were found on any of the organically labelled leafy green samples.



*No samples were collected from the Atlantic region due to the fact that it is not a large producer of field or greenhouse lettuce according to Statistics Canada[1].

Figure 4.7. Regional distribution of detected and non-detected pesticide residues on leafy greens.

The frequency at which specific detectable pesticide residues were found on each leafy green sample is illustrated in Figure 4.8. Approximately 74% of the samples with detectable pesticide residues contained one and two pesticide residues per sample (n=67 and 43, respectively). Twenty-six percent of the samples contain three to a maximum of 11 pesticide residues per sample. Only one sample contained the maximum of 11 pesticide residues.

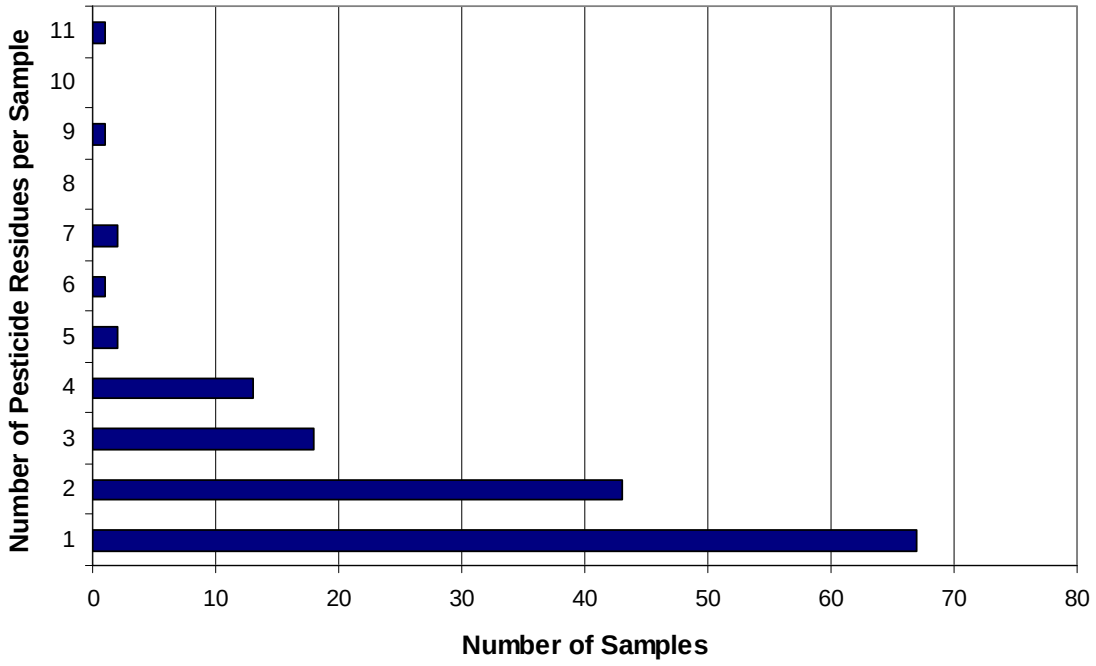


Figure 4.8. Distribution of the number of pesticide residues detected per leafy green sample.

There were 38 different pesticide residues found through the GC-MS method and eight found from the LC-MS method. A detailed list of the detected pesticide residues can be found in Appendix C. Dimethoate, endosulfan (total), and metalaxyl were some of the predominant (>20 residue counts) pesticide residues detected in leafy greens with GC-MS (Table C.1). Fenamidone and imidacloprid were the predominant pesticide residues within the LC-MS analysis.

There were seven leafy greens samples (i.e., Boston, romaine and leaf lettuce) where the pesticide residues found exceeded the General MRL of 0.1 ppm (as stated in B.15.002 of the FDR) and were considered a violation (Table 4.2). The information pertaining to the sample violations was referred to the appropriate program for follow-up actions. Overall, the compliance rate in leafy greens was 98.5%.

Table 4.2. Type and level of pesticide residue found in the leafy green sample violations.

Sample Type	Pesticide	Amount (ppm)	Reason for Violation	Province
Greenhouse Leaf Lettuce	Pirimicarb	1.2628	>0.1 ppm in violation of paragraph B.15.002 of the *Food and Drug Regulations*.	Quebec
Field Boston Lettuce	Chlorothalonil	0.2218		Quebec
Field Romaine Lettuce	Chlorothalonil	0.3206		Quebec
Field Romaine Lettuce	Chlorothalonil	0.5684		Quebec
Field Romaine Lettuce	Cypermethrin	0.2651		Quebec
Field Leaf Lettuce	Cypermethrin	0.2971		Quebec
Field Red Romaine Lettuce	Cypermethrin	0.2944		Quebec

The distribution of the number of pesticide residues per 2008-2009 NCRMP leafy green samples, are similar to the current targeted survey (Figure 4.9). NCRMP leafy samples did have approximately 20% more detected pesticide residues than the targeted survey leafy green samples. Some of the predominant pesticide residues found in the NCRMP were common to the targeted survey. There were 9 leafy green samples that exceeded the established MRLs, all of which were imports. The overall compliance rate was 96% for the 2008-2009 NCRMP leafy green samples.

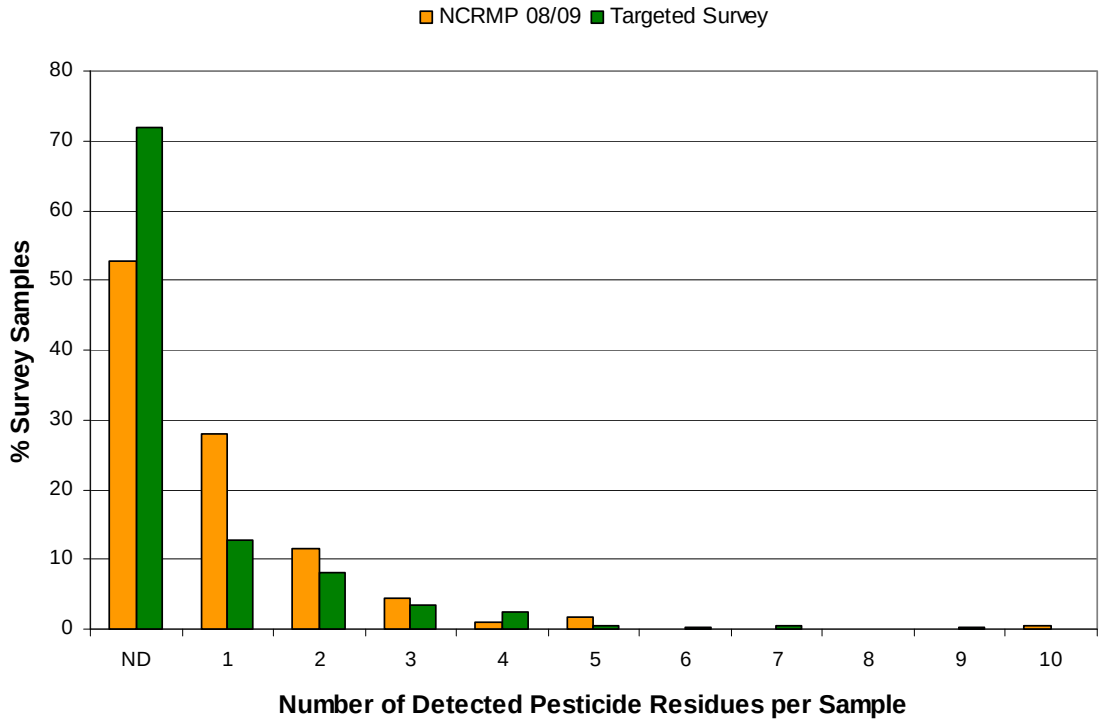


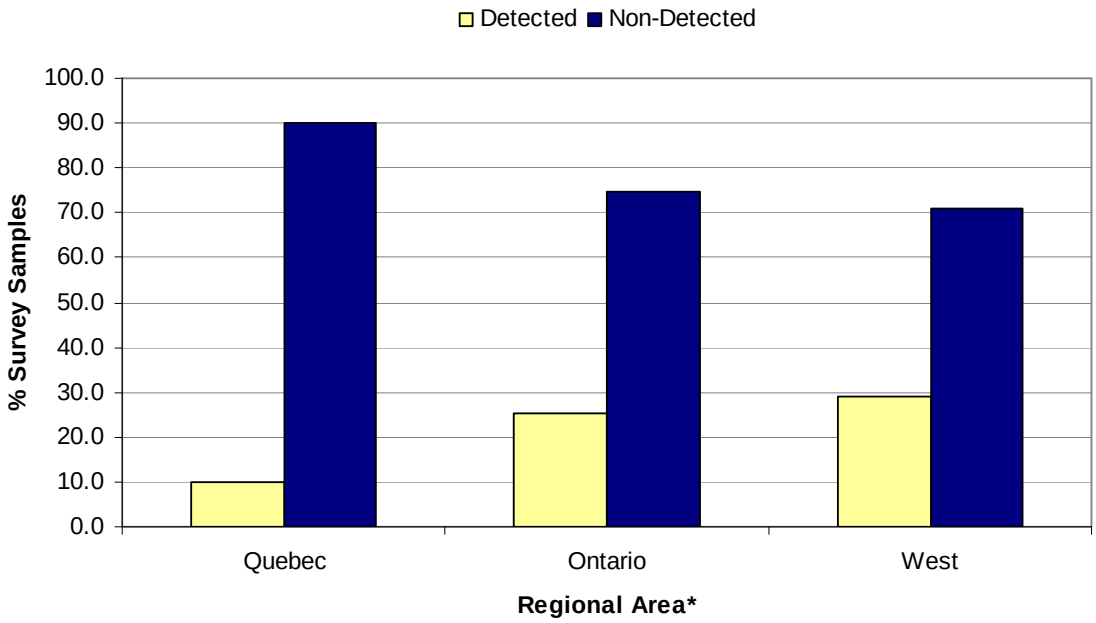
Figure 4.9. Distribution of leafy green targeted survey samples and 2008-2009 NCRMP leafy green samples according to the number of pesticide residues found.

4.4. Tomatoes

A total of 610 tomato samples (both greenhouse and field) were collected and analysed for this targeted survey. Of the total number of samples, 468 (76.7%) of the samples contained no detectable pesticide residues. No samples were collected from the Atlantic region as it is not a large producer of either field or greenhouse tomatoes according to production statistics[1]. When samples were broken down by region, Quebec (n=110) had the lowest percentage of detectable residues at 10.0%, followed by Ontario (n=400) at 25.5% (Figure 4.10). Approximately 29.0% of the samples from the West (n=100) had detectable residues.

Of the tomato samples collected 183 (30%) of them were labelled as greenhouse tomatoes. Approximately 27% of the greenhouse tomatoes contained detectable pesticide

residues whereas 22% of the field tomatoes were found to contain pesticide residues. Many of the same pesticide residues detected in the greenhouse were also detected on field tomatoes. Thirty of the 610 tomato samples collected were labelled as organic, none of which contained detectable pesticide residues.



*No samples were collected from the Atlantic region due to the fact that it is not a large producer of field or greenhouse tomatoes according to Statistics Canada[1].

Figure 4.10. Regional distribution of detected and non-detected pesticide residues on tomato samples.

The frequency at which specific detectable pesticide residues were found on each sample is illustrated in Figure 4.11. Ninety-four percent of samples with detectable pesticide residues contained one and two pesticide residues (n=108 and 26, respectively). Six percent of samples contained three to a maximum of six pesticide residues per sample. Only one sample contained the maximum of six pesticide residues.

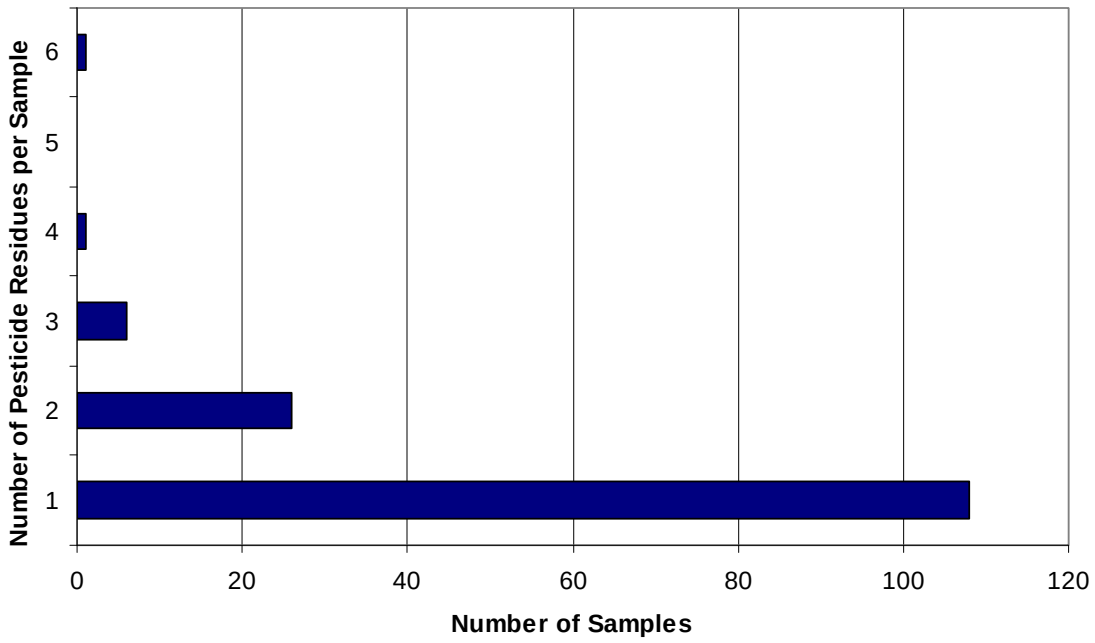


Figure 4.11. Frequency of pesticide residues found per tomato sample.

There were 15 different pesticide residues found through the GC-MS method and 12 found from the LC-MS method. A detailed list of the detected pesticide residues can be found in Appendix C. Myclobutanil and permethrin (Total) were the predominant (>10 residue counts) pesticide residues detected in tomatoes with GC-MS (Table C.1). Fenhexamid, imidacloprid, pyraclostrobin, spiromesifen and tebufenozide were the predominant pesticide residues within the LC-MS analysis.

There was one tomato sample in which the pesticide residue detected was in violation of the established MRL of 0.01 ppm in/on tomatoes (Table 4.3). The information pertaining to the sample violations was referred to the appropriate program for follow-up actions. Overall, the compliance rate in tomatoes was 99.6%.

Table 4.3. Type and level of pesticide residue found in the tomato sample violation.

Sample Type	Pesticide	Amount (ppm)	Reason for Violation	Province
Tomato	Fludioxonil	0.0249	Exceeds established MRL of 0.01 ppm	Ontario

The distribution of the number of pesticide residues per 2008-2009 NCRMP tomato samples, are similar to the current targeted survey (Figure 4.12). The tomato samples from the targeted survey did have approximately 15% fewer detected pesticide residues. The predominant pesticide residues found in the NCRMP were common to those detected in the targeted survey. There was one imported tomato sample that exceeded the established MRL. The overall compliance rate was 99.7% for the 2008-2009 NCRMP tomato samples.

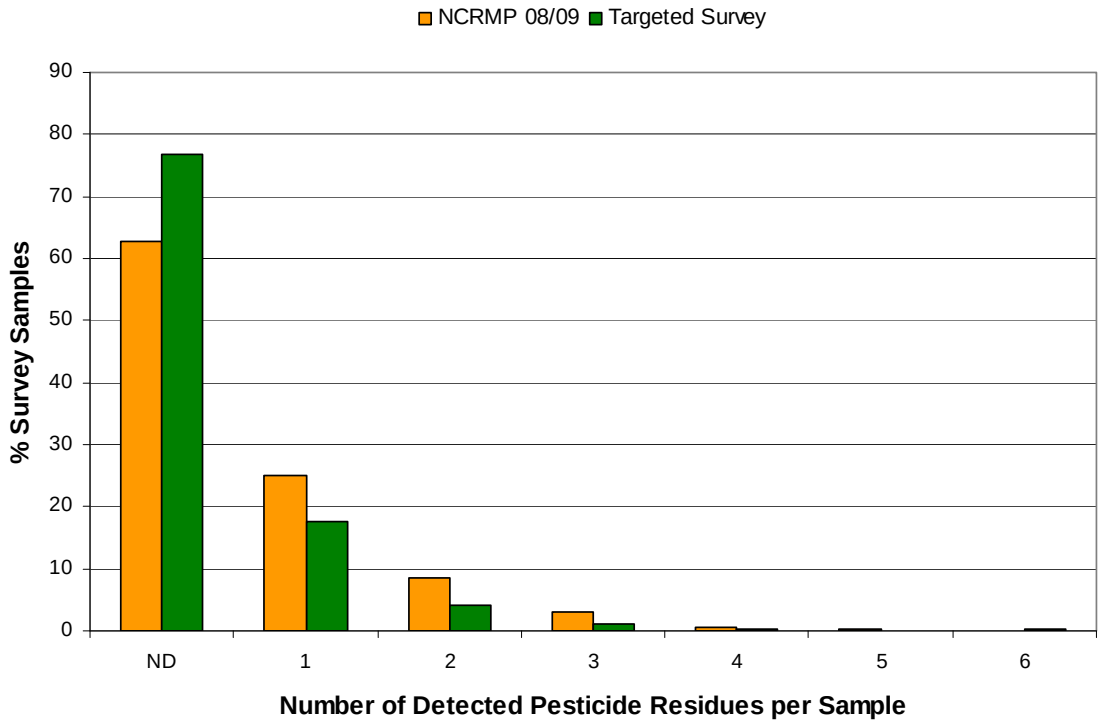


Figure 4.12. Distribution of tomato targeted survey samples and 2008-2009 NCRMP tomato samples according to the number of pesticide residues found.

5. Discussion

Generally, a high level of compliance was observed in the fresh fruits and vegetables sold locally. This is consistent with the high level of compliance observed in the NCRMP from fresh fruits and vegetables sold and imported nationally. In total, there were 3078 samples collected across the country in this targeted survey. Less than one percent (11 samples) of the total samples collected were in violation of established Canadian MRLs resulting in an overall compliance rate of 99.6%. Most of the violations occurred in leafy green samples from the Quebec region (seven out of 11 samples in violation), followed by three violations in small berries from the Quebec region (blackberries and strawberries), and one violation in field tomatoes from the Ontario region. All violations were assessed and appropriate follow-up actions reflecting the magnitude of the health risk were taken.

Within this targeted survey 84 different pesticide residues were detected. There were 13 pesticide residues that were considered predominant (i.e., >50 residue counts) and were assessed for regional trends (i.e., does one region use more pesticides than another). Appendix C contains a detailed list of pesticide residues found in this targeted survey with the predominant residues highlighted in bold. It was observed that certain regions used more of a specific pesticide than others. However, this was not a consistent observation in a particular region for all pesticide residues found. It is not unusual for a

certain region to use more of a specific pesticide than another, since pesticide applications are often related to climatic conditions and/or regionally specific pest pressures. As such, it was determined that there was no region that consistently used more pesticides than another.

6. Conclusions

The 2009-2010 fresh fruit and vegetable targeted survey was completed in order to elucidate the levels of pesticide residues in those foods sold intra-provincially. Apples, small berries, leafy greens and tomato samples were purchased at retail. Detectable pesticide residues were found in all sampled commodities. The percentage of samples that contained detectable pesticide residues was the highest in apple products (50%) and small berries (49.5%) followed by leafy greens (28%) and tomatoes (23%). Leafy greens and small berries contained samples with the highest number of pesticide residues per sample, 11 and nine, respectively. Of the 3078 samples analysed, 11 of them were in violation of established MRLs. Seven of the violations occurred in leafy greens, three in small berries and one in tomatoes. All violations were assessed and appropriate follow-up actions reflecting the magnitude of the health risk were taken. The overall compliance rate for this targeted survey was 99.6%.

Data collected in this targeted survey on locally sold apples, small berries, leafy greens and tomatoes were compared to 2008-2009 NCRMP data for the same nationally sold and imported fresh fruits and vegetables. The compliance rates, number and type of pesticide residues found in fresh fruits and vegetables sampled within provincial boundaries are reflective of the same foods nationally sold and imported.

7. References

[1] Statistics Canada. “Fruit and Vegetable Production.” June 2009. Catalogue no. 22-003-X.

8. Appendix A

Table 1A. Combined list of analytes (304) detected by the GC-MS pesticide multi-residue method (PMR-001-V1.8) from the three accredited laboratories used in this targeted survey.

2-phenylphenol (ortho-phenylphenol)	Cyfluthrin (I,II,III,IV)	Fludioxonil	Pebulate
3-OH Carbofuran	Cyhalothrin-lambda	Flumetralin	Penconazole
Acephate	Cypermethrin	Fluorochloridone	Pendimethalin
Acibenzolar-s-methyl	Cyprazine	Fluorodifen	Pentachloroaniline
Alachlor	Cyproconazole	Flusilazole	Permethrin (Total)
Aldicarb	Cyprodinil	Fluvalinate	Permethrin cis
Aldicarb Sulfone	Cyromazine	Folpet	Permethrin trans
Aldicarb sulfoxide	Dacthal (chlorthal-dimethyl)	Fonofos	Phenthoate
Aldrin	delta-HCH (delta-lindane)	Heptachlor	Phorate
Allidochlor	Deltamethrin	Heptachlor epoxide endo	Phorate sulfone
Ametryn	delta-trans-allethrin	Heptanophos	Phosalone
Aminocarb	Demeton-O	Hexachlorobenzene	Phosmet
Aramite	Demeton-S	Hexaconazole	Phosphamidon
Aspon	Demeton-S-methyl	Hexazinone	Piperonyl butoxide
Atrazine	Des-ethyl Atrazine	Imazalil	Pirimicarb
Azinphos-ethyl	Desmetryn	Iodofenphos	Pirimiphos-ethyl
Azinphos-methyl	Di-allate	Iprobenfos	Pirimiphos-methyl
Azoxystrobin	Dialofos	Iprodione	Prochloraz
Benalaxyl	Diazinon	Iprodione metabolite	Procymidone
Bendiocarb	Diazinon o analogue	Isazophos	**Prodiamine**
Benfluralin	Dichlobenil	Isofenphos	Profenofos
Benodanil	Dichlofluanid	**Isoprocarb**	Profluralin
Benzoylprop-ethyl	Dichloran	Isopropalin	Promecarb
BHC Alpha	Dichlormid	Isoprothiolane	Prometon
BHC beta	Dichlorvos	Kresoxim-methyl	Prometryne
Bifenox	Diclobutrazole	Leptophos	Pronamide
Bifenthrin	Diclofenthion	Lindane (gamma-BHC)	Propachlor
Biphenyl	Diclofop-methyl	Linuron	Propanil
Bromacil	Dicofol	Malaoxon	Propargite
Bromophos	Dicrotophos	Malathion	Propazine
Bromophos-ethyl	Dieldrin	Mecarbam	Propetamphos
Bromopropylate	Diethatyl-ethyl	Metalaxyl	Propham
Bufencarb	Dimethachlor	Metazachlor	Propiconazole
Bupirimate	Dimethoate	Methamidophos	Propoxur
Buprofezin	Dinitramine	Methidathion	Propyzamide
Butachlor	**Dioxacarb**	**Methiocarb**	Prothiophos
Butralin	Dioxathion	**Methiocarb sulfoxide**	Pyracarbolid
Butylate	Diphenamid	**Methomyl**	Pyrazophos
Captafol	Diphenylamine	Methoprotryne	Pyridaben
Captan	Disulfoton	Methoxychlor	Quinalphos
Captan metabolite	Disulfoton sulfone	Methyl - trithion	Quinomethionate
Carbaryl	Edifenphos	Methyl Pentachlorophenyl sulphide	Quintozene
Carbetamide	Endosulfan alpha	Metobromuron	**Schradan**
Carbofenthion	Endosulfan beta	Metolachlor	Secbumeton
Carbofuran	Endosulfan sulfate	Metribuzin	Simazine
Carbosulfan	Endrin	Mevinphos-cis	Simetryn

Carboxin	EPN	Mevinphos-trans	Sulfallate
Chlorbenside	EPTC	Mexacarbate	Sulfotep
Chlorbenzilate	Erbon	Mirex	Sulprophos
Chlorbromuron	Esfenvalerate	Monocrotophos	TCMTB
Chlorbufam	Etaconazole	Monolinuron	Tebuconazole
Chlordane cis	Ethalfluralin	Myclobutanil	Tecnazene
Chlordane trans	Ethion	Naled	Terbacil
Chlordimeform	Ethofumsate	Nitralin	Terbufos
Chlorfenson	Ethoprophos	Nitrapyrin	Terbumeton
Chlorfenvinphos (e+z)	Ethylan	Nitrofen	Terbutryne
Chlorflurenol-methyl	Etridiazole	Nitrothal-isopropyl	Terbutylazine
Chloridazon	Etrimfos	Norflurazon	Tetrachlorvinphos
Chlormephos	Fenamiphos	Nuarimol	Tetradifon
Chloroneb	Fenamiphos sulfone	o,p'-DDD (o,p'-TDE)	Tetraiodoethylene
Chloropropylate	Fenamiphos sulfoxide	o,p'-DDE	Tetramethrin
Chlorothalonil	Fenarimol	o,p'-DDT	Tetrasul
Chlorpropham	Fenbuconazole	Octhilinone	Thiobencarb
Chlorpyrifos	Fenchlorophos (Ronnel)	Omethoate	Tolclofos-methyl
Chlorpyriphos-methyl	Fenfuram	Oxadiazon	Tolyfluanid
Chlorthiamid	Fenitrothion	Oxadixyl	Triadimefon
Chlorthion	Fenpropathrin	**Oxamyl**	Triadimenol
Chlorthiophos	**Fenpropimorph**	Oxycarboxin	Tri-allate
Chlozolinate	Fenson	Oxychlordane	Triazophos
Clomazone	Fensulfothion	Oxyflurofen	Tribufos
Coumaphos	Fenthion	p,p'-DDD (p,p'-TDE)	Tricyclazole
Crotoxyphos	Fenvalerate	p,p'-DDE	Trifloxystrobin
Crufomate	Flamprop-isopropyl	p,p'-DDT	Triflumizole
Cyanazine	Flamprop-methyl	Paraoxon	Trifluralin
Cyanophos	Fluchloralin	Parathion	Vernolate
Cycloate	Flucythrinate	Parathion-methyl	Vinclozolin

Note: Pesticides highlighted in bold are detected in both the GC-MS and LC-MS analytical methods.

9. Appendix B

Table B1. List of analytes (146) detected by the LC-MS pesticide multi-residue method (PMR-006-V1.0) at the CFIA Calgary laboratory.

Acetochlor	Epoxiconazole	Molinate	Thiamethoxam
Aclonifen	Ethiofencarb	Napropamide	Thiazopyr
Aldicarb	Ethiofencarb sulfone	Naptalam	Thiodicarb
Aldicarb sulfone	Ethiofencarb sulfoxide	Neburon	Thiofanox
Aldicarb sulfoxide	Ethirimol	Ofurace	Thiofanox sulfone
Azaconazole	Ethoprop	**Oxamyl**	Thiofanox sulfoxide
Benomyl[b]	Etofenprox	Oxamyl-oxime	Thiophanate-methyl[b]
Benoxacor	Etoxazole	Paclobutrazol	Tralkoxydim
Bitertanol	Fenamidone	Pencycuron	Trichlorfon
Bromuconazole	Fenazaquin	Penoxsulam	Trietazine
Butafenacil	Fenhexamid	Picolinafen	Trifloxysulfuron
Butocarboxim	Fenoxanil	Picoxystrobin	Triforine
Carbaryl	Fenpropidine	Piperophos	Trimethacarb
Carbendazim	**Fenpropimorph**	Pretilachlor	Zinophos
Carbendazim d_3	Fenpyroximate	Primisulfuron-methyl	Zoxamide
Carbendazim d_4	Fentrazamide	**Prodiamine**	
Carbofuran	Fluazifop-butyl	Propoxur	
Carbofuran d_3	Flucarbazone-sodium[a]	Pymetrozine	
Carbosulfan[c]	Flutolanil	Pyraclostrobin	
Carfentrazone-ethyl	Flutriafol	Pyraflufen-ethyl	
Cadusafos	Forchlorfenuron	Pyridalyl	
Chlorimuron ethyl	Formetanate[a]	Pyridaphenthion	
Chloroxuron	Fosthiazate	Pyridate	
Chlortoluron	Fuberidazole	Pyrifenox	
Clodinafop-propargyl	Furathiocarb	Pyrimethanil	
Cloquintocet-mexyl	Haloxyfop	Pyriproxyfen	
Clothianidin	3-Hydroxycarbofuran	Quinoxyfen	
Cyanofenphos	Imazamethabenz-methyl	Quizalofop	
Cycloxydim	Imidacloprid	Quizalofop ethyl[f]	
Cycluron	Indoxacarb	**Schradan**	
Demeton-s-methyl sulfone	Iprovalicarb	Spinosad A[d]	
Demeton-s-methyl sulfoxide	Isocarbamide	Spinosad B[d]	
Desmedipham	**Isoprocarb**	Spirodiclofen	
Diclocymet[a]	Isoxathion	Spiromesifen	
Diethofencarb	Mepanipyrim	Spiroxamine[e]	
Difenoconazole	Mephosfolan	Sulfentrazone	
Dimethametryn	Methabenzthiazuron	Tebufenozide	
Dimethomorph	**Methiocarb**	Tebufenpyrad	
Diniconazole	Methiocarb sulfone	Tebupirimfos	
Dioxacarb	**Methiocarb sulfoxide**	Tepraloxydim	
Dipropetryn	**Methomyl**	Tetraconazole	
Diuron	Methoxyfenozide	Thiabendazole	
Dodemorph	Metolcarb	Thiabendazole	
Emamectin	Metoxuron	Thiacloprid	

Notes:

Pesticides highlighted in bold are detected in both the GC-MS and LC-MS analytical methods.

[a] Formetanate, flucarbazone sodium and diclocymet are screened only. Positive findings need to be confirmed by preparing

fresh standard solutions. To quantify diclocymet, standard mix and samples should not contain tralkoxydim.
[b] Any detected benomyl and/or thiophanate-methyl will be reported as carbendazim.
[c] Any detected carbosulfan will be reported as carbofuran.
[d] Spinosad is a mixture of spinosad A and spinosad B; quantitation can be based on either one.
[e] Retention time may change over time.
[f] There is a small interference peak but its intensity is less than that of quizalofop ethyl at 1 µg/kg

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10. Appendix C

Table C.1. Detailed list of detected pesticide residues.

Analytical Method	Analyte	Pesticide Residue Count									Total
		Apple (n=1000)	Small Berries (n=943)						Leafy Green (n=525)	Tomato (n=610)	
			Blueberry (n=298)	Blackberry (n=52)	Cranberry (n=200)	Raspberry (n=48)	Saskatoon (n=42)	Strawberry (n=303)			
GC-MS	2-phenylphenol (ortho-phenylphenol)		3		5				2		**10**
	3-OH Carbofuran							1			**1**
	Acephate								11		**11**
	Aldicarb								1		**1**
	Aldicarb sulfoxide							1			**1**
	Atrazine							1	2		**3**
	Azinphos-methyl	6	1					1			**8**
	Azoxystrobin	1								1	**2**
	Bifenthrin								1	1	**2**
	Biphenyl					1					**1**
	Boscalid		1								**1**
	Captan	366	22	6		1		74	1	2	**472**
	Carbaryl	19	2		26	1		1	5		**54**
	Carbofuran					1		1	1		**3**
	Chlorothalonil	1			40			3	7	4	**55**
	Chlorpyrifos						2	2	5		**9**
	Cyfluthrin (I,II,III,IV)								1		**1**
	Cyhalothrin-lambda						1		13		**14**
	Cypermethrin			3				15	6	1	**25**
	Cyprodinil		36	11		9	1	39		5	**101**
	Dacthal (chlorthal-dimethyl)							1	11		**12**
	Demeton-S-methyl	2									**2**
	Diazinon	1							5		**6**
	Dichloran								2		**2**

Table C.1. Detailed list of detected pesticide residues.

Analytical Method	Analyte	Pesticide Residue Count									Total
		Apple (n=1000)	Small Berries (n=943)						Leafy Green (n=525)	Tomato (n=610)	
			Blueberry (n=298)	Blackberry (n=52)	Cranberry (n=200)	Raspberry (n=48)	Saskatoon (n=42)	Strawberry (n=303)			
GC-MS	Dicofol	1									**1**
	Dieldrin								1		**1**
	Dimethoate		9					2	25		**36**
	Diphenylamine	77									**77**
	Endosulfan (Total)	11						64	65	1	**141**
	Fenbuconazole	1									**1**
	Fenpropathrin							1			**1**
	Fludioxonil		32	12		10	1	20		3	**78**
	Flusilazole	2							1		**3**
	Folpet	1	8					34	1		**44**
	Imazalil								1		**1**
	Iprodione					1		33	16	6	**56**
	Linuron								1		**1**
	Malathion	1			13	1		8	4		**27**
	Metalaxyl							2	30	4	**36**
	Methamidophos								12		**12**
	Methiocarb Sulfoxide	1									**1**
	Methomyl	1						1	1	1	**4**
	Myclobutanil	7						31		31	**69**
	o,p'-DDT								2		**2**
	Omethoate		9						15		**24**
	Oxamyl				1			2			**3**
	p,p'-DDD (p,p'-TDE)								2		**2**
	p,p'-DDE								10		**10**
	p,p'-DDT								4		**4**
	Pendimethalin								1		**1**
	Permethrin (Total)		1	2				1	5	14	**23**
	Phosalone	113									**113**
	Phosmet	71	9					3			**83**
	Piperonyl butoxide	3							1		**4**

Table C.1. Detailed list of detected pesticide residues.

Analytical Method	Analyte	Pesticide Residue Count									Total
		Apple (n=1000)	Small Berries (n=943)						Leafy Green (n=525)	Tomato (n=610)	
			Blueberry (n=298)	Blackberry (n=52)	Cranberry (n=200)	Raspberry (n=48)	Saskatoon (n=42)	Strawberry (n=303)			
	Pirimicarb	4							2		**6**
	Prometryne								5		**5**
	Propetamphos	9									**9**
	Propiconazole		2				2	6			**10**
	Propoxur							1			**1**
	Pyridaben	5								5	**10**
	Triadimenol									1	**1**
	Trifloxystrobin	4						1			**5**
	Vinclozolin							3			**3**
LC-MS	3-OH Carbofuran			1							**1**
	Carbaryl	9			21			1	2		**33**
	Carbendazim	6		2		2		18	1	1	**30**
	Dimethomorph								1		**1**
	Fenamidone								11	1	**12**
	Fenhexamid		2	6		4		28		13	**53**
	Imidacloprid		18	1				1	10	19	**49**
	Indoxacarb									1	**1**
	Linuron								2		**2**
	Methoxyfenozide	6									**6**
	Oxamyl-oxime	1									**1**
	Pyraclostrobin		22	9		8		51	2	20	**112**
	Pyrimethanil	10						26		3	**39**
	Pyriproxyfen									6	**6**
	Quinoxyfen							2			**2**
	Spinosad									7	**7**
	Spirodiclofen	25									**25**
	Spiromesifen							4		12	**16**
	Tebufenozide	7			5				1	23	**36**
	Thiabendazole	32								1	**33**
	Thiacloprid	18									**18**

Table C.1. Detailed list of detected pesticide residues.

Analytical Method	Analyte	Pesticide Residue Count									Total
		Apple (n=1000)	Small Berries (n=943)						Leafy Green (n=525)	Tomato (n=610)	
			Blueberry (n=298)	Blackberry (n=52)	Cranberry (n=200)	Raspberry (n=48)	Saskatoon (n=42)	Strawberry (n=303)			
	Thiophanate-methyl	1						6			**7**
	Tolyfluanid							1			**1**
	Triforine							2			**2**
Total		**823**	**177**	**53**	**111**	**39**	**7**	**493**	**309**	**188**	**2200**

Note: Those pesticide residues highlighted in bold are considered to predominant residues (i.e., >50 counts).