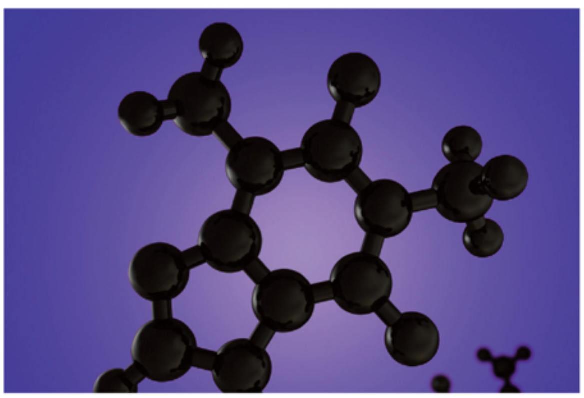
Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2010-2011 Targeted Surveys

Chemistry



Pesticides in Coffee, Fruit Juice and Tea

TS-CHEM-10/11

Canada

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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 objectives of the pesticides in coffee, fruit juice and tea targeted survey were to:

- generate baseline surveillance data on the levels of pesticide residues in coffee, fruit juice and tea available on the Canadian retail market; and
- enable comparison of pesticide residue levels in tea with data from the 2009-2010 FSAP targeted survey on pesticides in tea and in juices with data from the 2008-2009 FSAP targeted survey on pesticides in fruit juice concentrates and previous National Chemical Residue Monitoring Program (NCRMP) and Children's Food Project results.

All data generated may be used by Health Canada in performing human health risk assessments.

In total, 297 coffee, 510 juice and 267 tea samples were collected from Canadian retail stores and were analysed for over 430 different pesticide residues. It should be noted that brewed tea and coffee were not analyzed in this survey[a]. The Canadian Food Inspection Agency (CFIA) monitors food as sold rather than as consumed, maximum residue limits (MRLs) for pesticides are established for dried tea leaves and coffee beans and there are analytical method considerations when analyzing brewed drinks. As such, the results presented should only be interpreted as tea and coffee available as sold and not brewed tea and coffee as consumed.

All coffee samples in this survey were compliant with existing MRLs for the pesticides analyzed. Only two of the 297 coffee samples were found to contain detectable pesticide residues and both were compliant with the Canadian General 0.1 parts per million (ppm) MRL.

For the juice samples analyzed in this survey, 99.6% were compliant with existing MRLs for pesticides. Only one lemon and one pineapple juice were found to contain one pesticide residue each in violation of the General 0.1 ppm MRL. Juice not from concentrate also had the highest percentage of samples with detected pesticide residues (67%) compared to juice from concentrate (48%) and juice concentrates (0%). Seventy-five percent of orange, apple, grapefruit and pear juices analyzed contained one or more

[a] Coffee samples analyzed in this survey include ground, instant or whole, roasted coffee beans as sold at Canadian retail and not brewed coffee as consumed.

Tea samples analyzed in this survey include dried loose leaf, bagged and instant tea as sold at Canadian retail and not brewed tea as consumed.

detectable pesticide residues, all of which were in compliance with established MRLs. The overall compliance of juices analyzed in the present survey is similar to that of the 2008-09 FSAP juice survey on fruit juice concentrates (100% for 186 samples), and to juice samples analyzed for pesticides under the NCRMP (98.9% for 88 samples) and under the Children's Food Project (100% for 170 samples) from 2009 to February 2012.

The overall compliance rate for pesticide residues in the 267 tea samples in this targeted survey was 75%, compared to 59% in the 2009-10 FSAP targeted survey on tea. In total, there were 66 tea samples containing at least one pesticide violation of the General 0.1 ppm or an established MRL, with 138 pesticide residue violations in total. Oolong tea contained the highest percentage of samples with pesticide residue violations at 75% followed by white tea at 50%, green tea at 32%, herbal and black tea at 20% each, and other tea at 12%. Detectable pesticide residues were found in all types of tea sampled.

All juice and tea violations were assessed and appropriate follow-up action was pursued. Exposure to these pesticide residues in coffee, juice and tea is not expected to pose a human health concern to consumers.

1 Introduction

1.1 Food Safety Action Plan

In 2007, the Canadian government launched a five year initiative in response to a growing number of product recalls and concerns about food safety. This initiative, called the Food and Consumer Safety Action Plan (FCSAP), aims to modernize and strengthen the food safety regulatory system. The FCSAP initiative unites multiple partners in ensuring safe food for Canadians.

The Canadian Food Inspection Agency's (CFIA) Food Safety Action Plan (FSAP) is one element of the government's broader FCSAP initiative. The goal of FSAP is to identify risks in the food supply, limit the possibility that these risks occur, improve import and domestic food controls and identify food importers and manufacturers.

Within FSAP there are twelve main areas of activity, one of which is risk mapping and baseline surveillance. The main objective of this area is to better identify, assess, and prioritize potential food safety hazards through risk mapping, information gathering, and testing of foods from the Canadian marketplace. Targeted surveys are one tool used to test for the presence and level of a particular hazard in specific foods. Targeted surveys are largely directed towards the 70% of domestic and imported foods that are regulated solely by the *Food and Drugs Act and Regulations*, and are generally referred to as non-federally registered commodities.

1.2 Targeted Surveys

Targeted surveys are pilot surveys used to gather information regarding the potential occurrence of chemical residues in defined 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 chemical 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 scientific literature, media reports, and/or a risk-based model developed by the Food Safety Science Committee (FSSC), a group of federal, provincial and territorial subject matter experts in the area of food safety.

As part of the 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. Due to regulatory considerations, targeted surveys focus mainly on those products not sampled under the NCRMP. Routine monitoring of coffee, juice and tea products at the federal level is limited. The purpose of this targeted survey was to establish baseline data on pesticide residue levels in coffee, juice and tea available in the Canadian marketplace. The pesticide residue levels observed in tea in this survey were compared with data from the 2009-10 FSAP targeted survey on tea. The pesticide residue levels in juice were compared with previous NCRMP and Children's Food Project juice data, as well as the 2008-09 FSAP targeted survey on fruit juice concentrates.

1.3 Acts and Regulations

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 and Regulations*.

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*. The MRL is the maximum amount of residues that is expected to remain in or on food products when a pesticide is used according to label directions. At the time this survey was conducted and the results evaluated, there were no specific MRLs for pesticide residues in tea or coffee* and a limited number of established MRLs for juice listed on Health Canada's website. However, specific MRLs for raw agricultural food commodities (e.g., orange, apple) apply to any processed food product containing these ingredients (e.g., juice). In the absence of a specific MRL for a particular commodity, pesticide residues must comply with the Canadian General MRL of 0.1 ppm as stated in section B.15.002(1) of the *Food and Drug Regulations*.

The analytical results from targeted survey samples were compared to applicable MRLs. Levels detected at or below these MRLs were considered in compliance with Canadian regulations and did not require follow-up. All violations were assessed and appropriate follow-up action was pursued.

**Note: Since this survey was conducted and the results evaluated, Health Canada has established MRLs of 2 ppm for lambda-cyhalothrin (November 30, 2011) and fenpropathrin (December 2, 2011) in tea (dried leaves), and 0.1 ppm for phsosphine (March 18, 2011) and 0.05 ppm for thiamethoxam (May 18, 2011) in coffee:* http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_decisions/index-eng.php#mrl-lmr.

2 Survey Details

2.1 Pesticides in Coffee, Fruit Juice and Tea

Similar to other crops, coffee, fruit and tea plants are subject to various pest and disease pressures which impact their production. 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 tea leaves, coffee grains/beans and fruit. Different pest pressures and climatic conditions in coffee-, fruit- and tea-producing areas may result in the potential for use of pesticides that are not approved or have been banned for use in Canada. Although pesticides play an important role in agriculture by protecting food and crops from pests, inappropriate use of pesticides may pose a health risk.

China, Turkey, India, Kenya and Sri Lanka are some of the world's top tea-producing countries while South and Central America and Indonesia produce much of the world's coffee[1]. As these agricultural commodities are high value cash crops and are susceptible to pest pressures, pesticides can be applied pre-harvest during production and/or post-harvest on dried tea leaves and green coffee beans during manufacturing.

Many of the fruit juices consumed by Canadians and analyzed in this survey are made from fruits not grown in Canada. The pesticides used in these countries are not subject to Canadian regulatory oversight for their use; however, the resulting pesticide residues must meet established Canadian MRLs to be legally sold in Canada. It is important to note that much of the fruit utilized in the production of fruit juice is grown specifically for this purpose and pesticides used for aesthetic purposes are normally not necessary.

2.2 Rationale

According to Statistics Canada data from 2009, coffee and tea are among the beverages most available for consumption by Canadians with approximately 106.4 L of coffee and 77.1 L of tea consumed per person per year. There is also significant consumption of fruit juice at 23.5 L per person per year[2]. Fruit juices are also highly consumed by children at 168-200 grams fruit juice per day[3].

Given the high consumption of these beverages by Canadians, this targeted survey was designed to establish baseline data on pesticide levels in coffee, juice and tea available to Canadians. It will also enable comparison of pesticide levels in tea and juice between survey years. All data may be used by Health Canada in performing health risk assessments.

2.3 Sample Distribution

In this survey, a total of 1074 samples were collected from grocery and specialty stores in 11 Canadian cities between October 2010 and March 2011. The samples included 297 coffee, 267 tea and 510 juice products in various types of packaging.

2.4 Method Details

Coffee, juice and tea samples were analyzed using multi-residue pesticide methods by three laboratories under contract with the Government of Canada. The laboratories are accredited to ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories* (or its equivalent by the Standards Council of Canada (SCC)).

These laboratories were required to use analytical methods that met or exceeded the requirements and limits of detection of the equivalent CFIA reference method.

Sufficient quantities of coffee, juice and tea samples were collected to allow for two different analytical methodologies to be conducted on each sample. When used simultaneously, the two multi-residue methods can analyze for over 430 different pesticide residues with minimal overlap. Please refer to Appendix A and B for detailed lists of pesticide residues analyzed by the two multi-residue methods.

Depending on the laboratory, the gas chromatography–mass spectrometry (GC-MS) method used can measure up to 304 pesticide residues (Appendix A). For coffee and tea, the GC-MS method was based on the CFIA reference method entitled “Determination of Pesticides in Tea (by Modified QuEChERS Extraction and GC-MSD Detection (PMR-010-V1.0)”. For juice, the CFIA reference method was “Determination of Pesticides in Honey, Fruit Juice and Wine (With Solid Phase Extraction Clean-Up and GC/MSD and HPLC Fluorescence Detection)”. The GC-MS methods used in this survey had limits of detections with an analytical range of 0.0005 ppm to 0.025 ppm.

The liquid chromatography–mass spectrometry (LC-MS) method used can measure up to 154 pesticide residues (Appendix B). For coffee and tea, the LC-MS method was based on the CFIA reference method entitled “Determination of Pesticides in Tea Matrices (Homogenized Leaves and Herbal) using Liquid Chromatography Electrospray Ionization Mass Spectrometry (LC/ESI-MS/MS) (PMR-011-V1.0)”. For juice, the CFIA reference method was “Determination of Pesticides in Infant Foods using Liquid Chromatography Electrospray Ionization Mass Spectrometry (LC/ESI-MS/MS)”. The LC-MS methods used in this survey had limits of detections with an analytical range of 0.00014 ppm to 0.005 ppm.

2.5 Limitations

This survey was designed to provide a snapshot of the levels of pesticide residues in coffee, juice and tea available for sale in Canada and has the potential to highlight commodities that warrant further investigation. The limited sample sizes analyzed represent a small fraction of the products available to consumers. Therefore, care must be taken when interpreting and extrapolating these results.

Results were not analyzed according to country of origin as this information could not be verified for many of the products sampled. Although coffee, tea and many fruits intended for juice are not grown in Canada, Canadian companies import raw or intermediate materials for blending, roasting and further processing for resale into Canadian and export markets. In some of these cases, products may be considered to be of Canadian origin. Determination of country of origin is further complicated by the fact that ingredients are often sourced from different countries. As a result, no inferences or conclusions were made regarding the data with respect to country of origin. Regional differences, impact of product shelf-life, packaging and storage conditions, or cost of the commodity on the open market were also not examined in this survey.

Distribution of juice samples by country of origin (as recorded by the sampler or indicated on the label) is presented to provide a general sense of the origin of juice samples. It is important to note, however, that some of the samples considered as originating in Canada or imported with unknown origin may include, for example, products prepared for a Canadian company without further clarification of the country of origin.

Analysis was completed on tea and coffee as available on the Canadian retail market. Brewing of coffee and tea was not carried out. Therefore, the results should only be interpreted as tea and coffee available as sold and not brewed tea and coffee as consumed. The level of transfer of a pesticide residue from tea or coffee to the brewed product can be dependent on the chemical and physical properties of the individual compounds (e.g., solubility). As such, it was difficult to estimate the level of a pesticide that may occur in the brewed tea or coffee based on the levels detected in the tea or coffee available at retail.

3 Results and Discussion

Please refer to Appendix C for a summary of pesticide residue violations detected in all samples in this survey.

3.1 Pesticides in Coffee

A total of 297 coffee samples were collected and analyzed, including caffeinated and/or decaffeinated whole beans, ground, and instant. The distribution of coffee samples by type is shown in Figure 1.

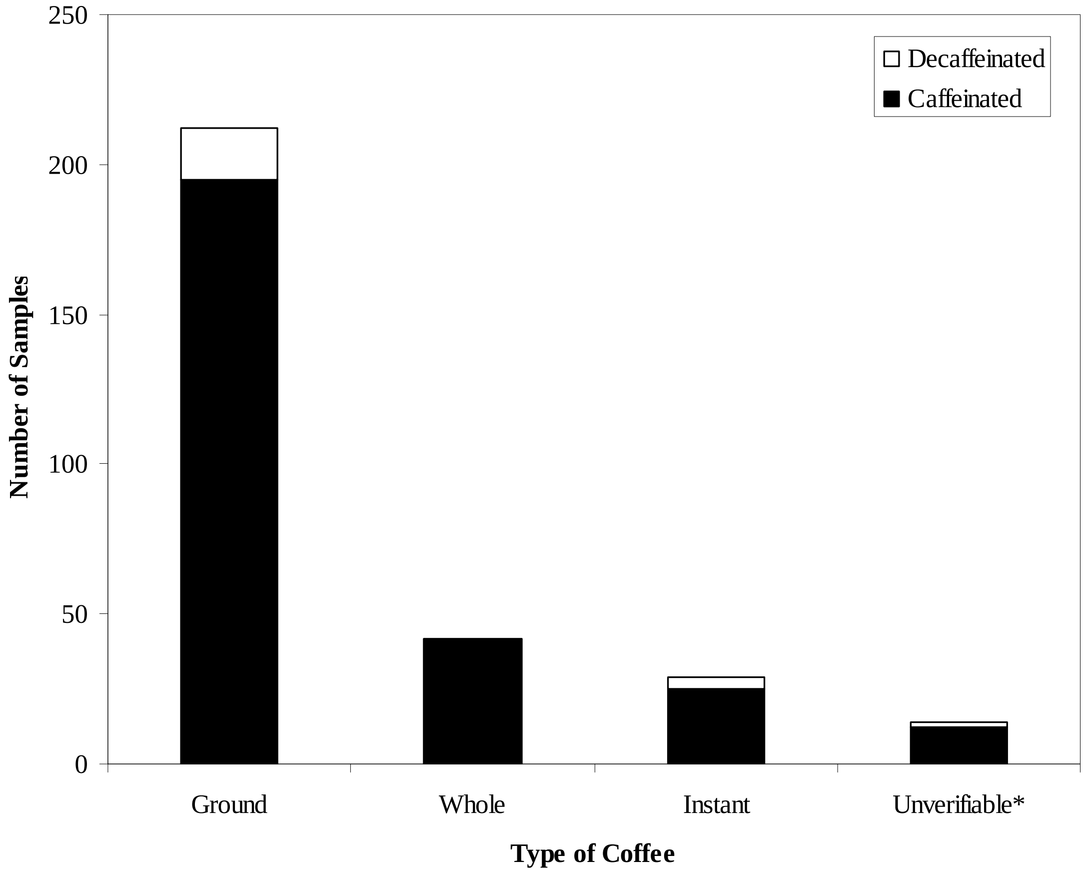

Figure 1. Distribution of coffee samples by type.

* Unverifiable refers to samples for which type could not be determined based on the label or sample description.

Only two (0.7%) of the 297 coffee samples contained detectable levels of pesticide residues (Table 1). Both samples were instant coffee. Twenty-seven other instant coffee samples were analyzed and did not have detectable pesticide residues. In both positive samples, flutriafol was the only pesticide residue detected. As there is no specific MRL for this pesticide in coffee, the General MRL of 0.1 ppm for all commodities applies. The levels of flutriafol detected were below this General MRL and so were in compliance with Canadian regulations. No detectable pesticide residues were found in any of the ground or whole bean coffee samples (Table 1).

This was the first FSAP survey that targeted pesticides in coffee available to Canadian consumers. The absence or low level of pesticide residues in roasted coffee is consistent with results of pesticide residue surveillance data on coffee by Food Standards Australia New Zealand[4]. The results are also consistent with the reported extensive degradation of pesticides during the coffee bean roasting process observed in other studies[5,6].

Table 1. Summary of pesticide residue detections and violations distributed by type of coffee.

Type of Coffee	Number of Samples	Number of Samples with Detected Pesticide Residues (Number of Detected Residues)	Number of Sample Violations (Number of Detected Residues in Violation)
Ground	212	0 (0)	0 (0)
Whole	42	0 (0)	0 (0)
Instant	29	2 (2)	0 (0)
Unverifiable	14	0 (0)	0 (0)
Total	**297**	**2 (2)**	**0 (0)**

*Unverifiable refers to samples for which type could not be determined based on the label or sample description.

3.2 Pesticides in Juice

A total of 510 juice samples were analyzed, including ready to drink juices made from concentrate, juices not from concentrate, and two concentrate samples. The distribution of juice samples by fruit type is shown in Figure 2.

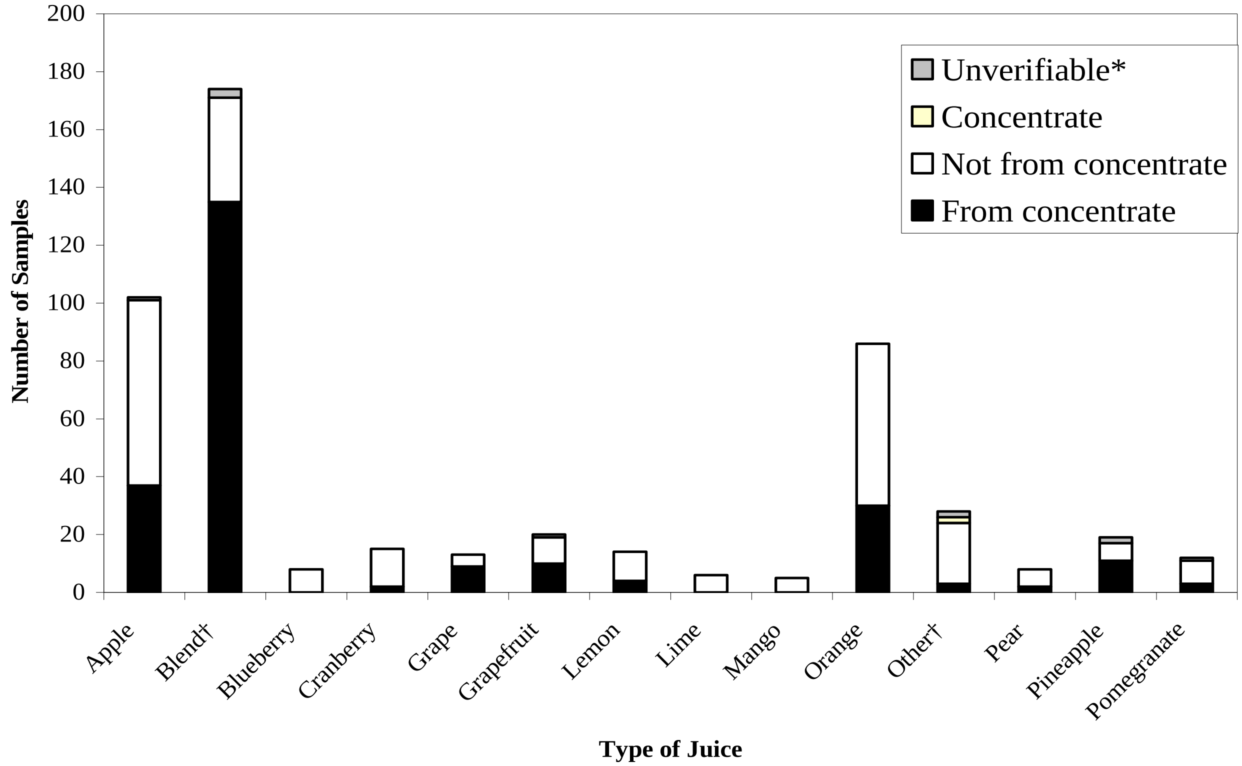

Figure 2. Distribution of juice samples by fruit type.

*Unverifiable includes those samples for which type of concentrate could not be determined from the label or sample description.

†Blend refers to juice derived from a mixture of fruits. Other refers to other single fruit juices (e.g., peach, guava).

The distribution of juice samples by country of origin (as recorded by the sampler or indicated on the label) is presented in Figure 3 to provide a general sense of the origin of juices sampled. It is important to note, however, that some of the samples considered as originating in Canada or imported with unknown origin may include, for example, products prepared for a Canadian company without further clarification of the country of origin. Determination of country of origin is further complicated by the fact that ingredients are often sourced from different countries.

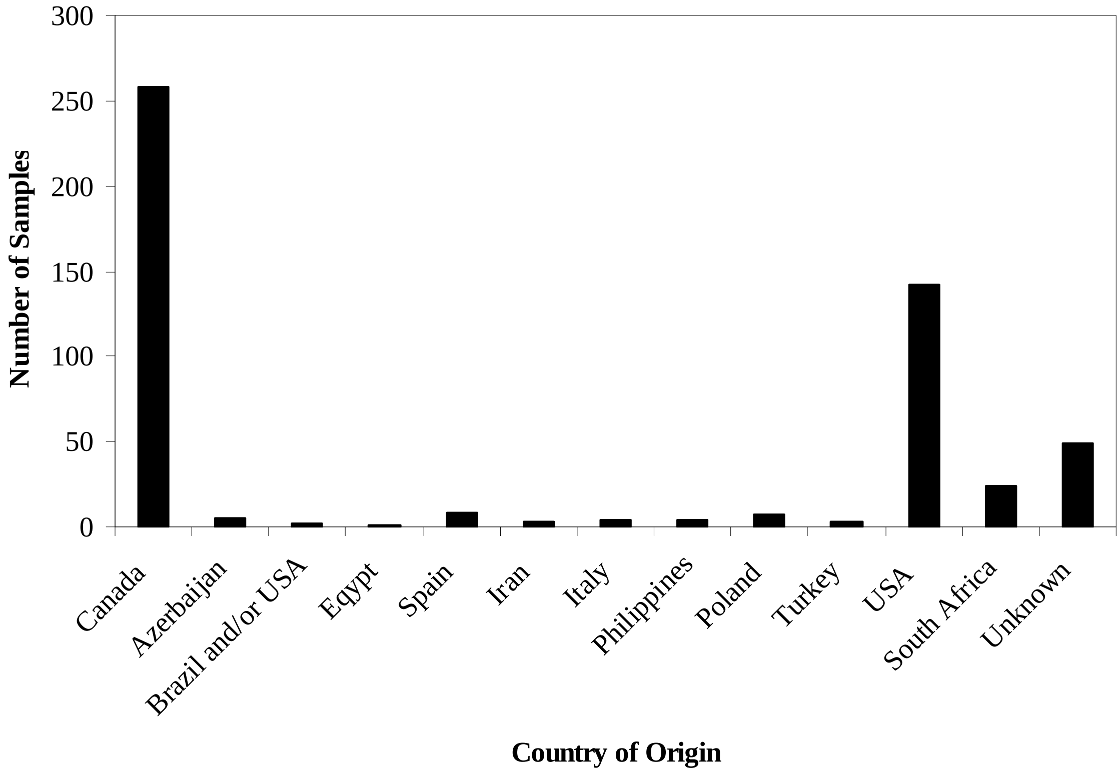

Figure 3. Distribution of juice samples by country of origin.

Two hundred nineteen (42.9%) of the 510 juice samples had no detectable pesticide residues, 289 samples (56.7%) had detectable compliant pesticide residues and two samples (0.4%) each contained a single residue in violation of the General MRL of 0.1 ppm (Figure 4). The two samples with pesticide residues in violation (in both cases, phosmet) were lemon and pineapple juice, both not from concentrate.

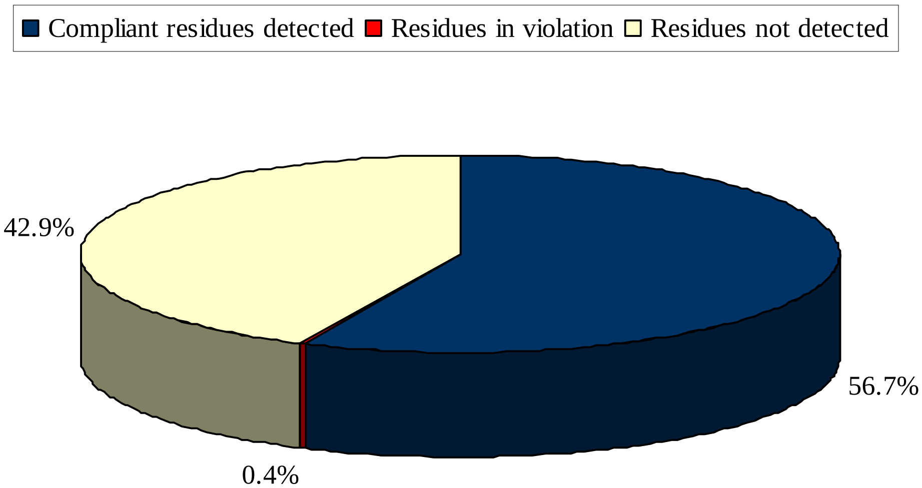

Figure 4. Distribution of juice samples with compliant pesticide residues detected, residues in violation, and residues not detected.

One hundred eighty-nine juice samples contained one detectable pesticide residue, 65 samples contained two detectable residues, 25 samples contained three detectable residues, nine samples contained four detectable residues, one sample contained five detectable residues and two samples contained seven detectable residues (Figure 5). The pineapple and lemon juice samples in violation were both single pesticide residue violations in samples with one and two detectable pesticide residues, respectively (Figure 5).

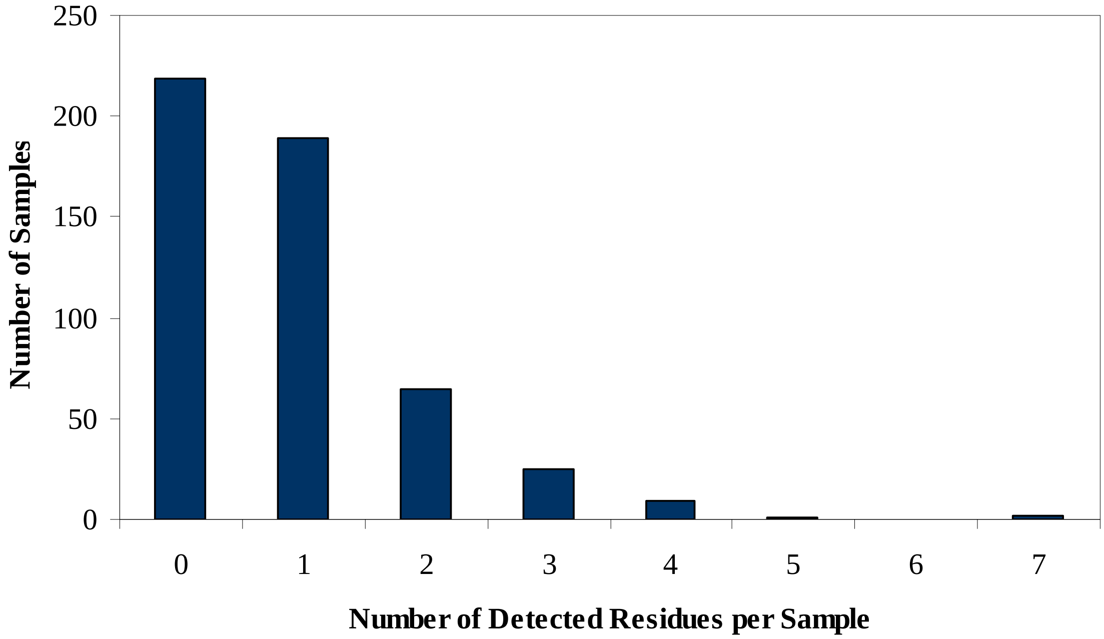

Figure 5. Distribution of juice samples by number of detected pesticide residues per sample.

When juice samples were divided according to concentrate type, juices not from concentrate contained the only two pesticide residue violations (Figure 6). Juice not from concentrate also had the highest percentage of samples with detected pesticide residues (67%, n=246) compared to juice from concentrate (48%, n=252) and juice concentrates (0%, n=2). Collectively, juices not from concentrate also had the greatest number of pesticide residue detections (285) compared to 157 pesticide residue detections in juices made from concentrate, zero detections in the two juice concentrate samples and seven detections in juice samples for which concentrate type could not be determined (Figure 6).

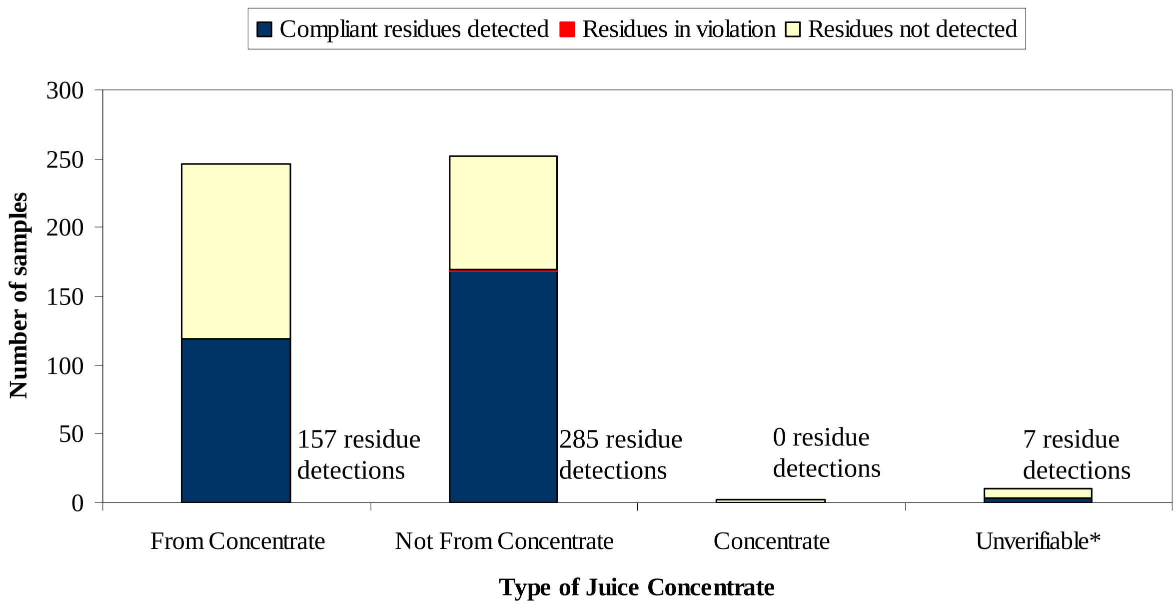

Figure 6. Number of samples with compliant residues detected, residues in violation and residues not detected according to type of juice concentrate.
*Unverifiable refers to samples for which concentrate type could not be determined from the label or sample description.

A summary of sample and pesticide residue detections and violations according to fruit type is presented in Table 2. Although sample size (n) must be taken into consideration when interpreting these results, 75% or more of the orange (n=86), apple (n=102), grapefruit (n=20) and pear (n=8) juices analyzed had one or more detectable pesticide residues, all of which were in compliance with established MRLs. Cranberry (n=15) and pineapple juices (n=19) had the lowest percentage of samples with detectable pesticide residues at 27% and 11%, respectively (Table 2). However, one of the two pineapple juice samples with a detected pesticide residue contained a residue in violation of the General MRL of 0.1 ppm.

Based on the samples collected in this targeted survey, other (single fruit), pear and apple juices had the highest average number of compliant pesticide residue detections at 2.2, 2.2 and 1.7, respectively (Table 2). In total, there were 449 detections of pesticide residues in the 291 juice samples with detected residues (Table 2).

Table 2. Summary of pesticide residue detections and violations by type of fruit juice.

Juice Type	Number of Samples	Number of Samples with Detected Residues (Number of Detected Residues)	Number of Samples in Violation (Number of Pesticide Residue Violations)
Apple	102	78 (135)	0 (0)
Blend	174	75 (120)	0 (0)
Blueberry	8	4 (12)	0 (0)
Cranberry	15	4 (4)	0 (0)
Grape	13	5 (6)	0 (0)
Grapefruit	20	15 (19)	0 (0)
Lemon	14	7 (10)	1 (1)
Lime	6	4 (6)	0 (0)
Mango	5	3 (4)	0 (0)
Orange	86	68 (79)	0 (0)
Other	28	15 (33)	0 (0)
Pear	8	6 (13)	0 (0)
Pineapple	19	2 (2)	1 (1)
Pomegranate	12	5 (6)	0 (0)
Total	**510**	**291 (449)**	**2 (2)**

Results of the present survey were compared with those of the 2008-09 FSAP targeted survey on pesticides in fruit juice concentrates. The high overall compliance of fruit juice concentrates analyzed in the 2008-09 survey (100%) was similar to that of the present survey (99.6%), which looked at a greater number of juice samples primarily made from concentrate and not from concentrate. Results obtained are also comparable to residue concentration in juice samples analyzed for pesticides under NCRMP from 2009 to February 2012 (98.9% compliance for 88 samples) and under the Children's Food Project over the same time period (100% compliance for 170 samples). The low levels of detected pesticide residues observed in juice samples in this survey are expected as processing (washing, pasteurization, etc.) may remove or further degrade any pesticide residues present on the harvested fruit.

Except for one pineapple and one lemon juice sample, 99.6% (508 samples) of juice samples were compliant with existing MRLs. Both pesticide residue violations identified in this juice survey were assessed and appropriate follow-up action was pursued. Exposure to this pesticide residue is not expected to pose a human health concern to consumers.

3.3 Pesticides in Tea

A total of 267 dried loose leaf, bagged and instant tea samples were collected from Canadian retail outlets. The distribution of tea samples by type of tea is shown in Figure 7.

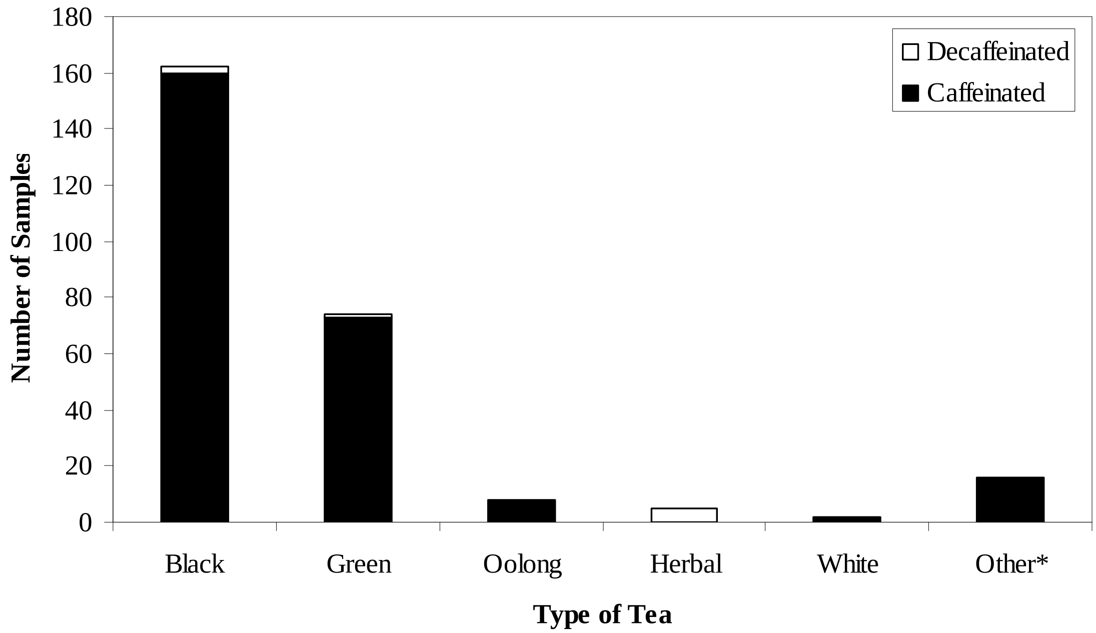

Figure 7. Distribution of tea samples by type of tea.

*Other includes semi-fermented, instant and other teas, as well as samples for which type could not be determined based on the label or sample description.

Ninety-five (35.6%) of the 267 tea samples had no detectable pesticide residues, 106 samples (39.7%) had compliant detectable pesticide residues and 66 samples (24.7%) were in violation of established MRLs (Figure 8).

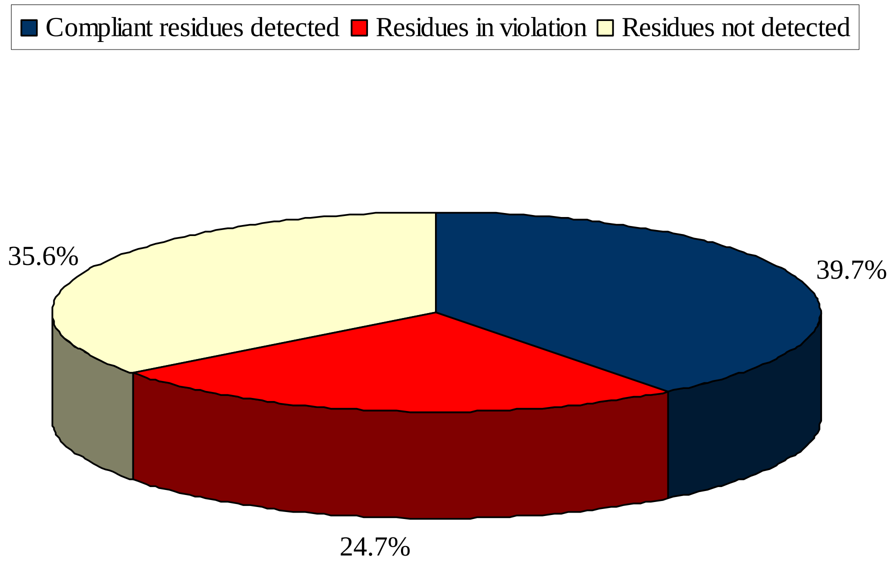

Figure 8. Distribution of tea samples with compliant pesticide residues detected, residues in violation and residues not detected.

The distribution of samples with the number of detected residues per sample is shown in Figure 9. Samples frequently contained more than one pesticide residue per sample, with numerous individual tea samples containing both compliant pesticide residues and residues in violation of applicable MRLs. Fifty-one samples contained one pesticide residue per sample, 38 samples contained two pesticide residues, 28 samples contained three pesticide residues, 48 samples contained four to nine pesticide residues per sample and 7 samples contained 10 to a maximum of 15 pesticide residues per sample (Figure 9).

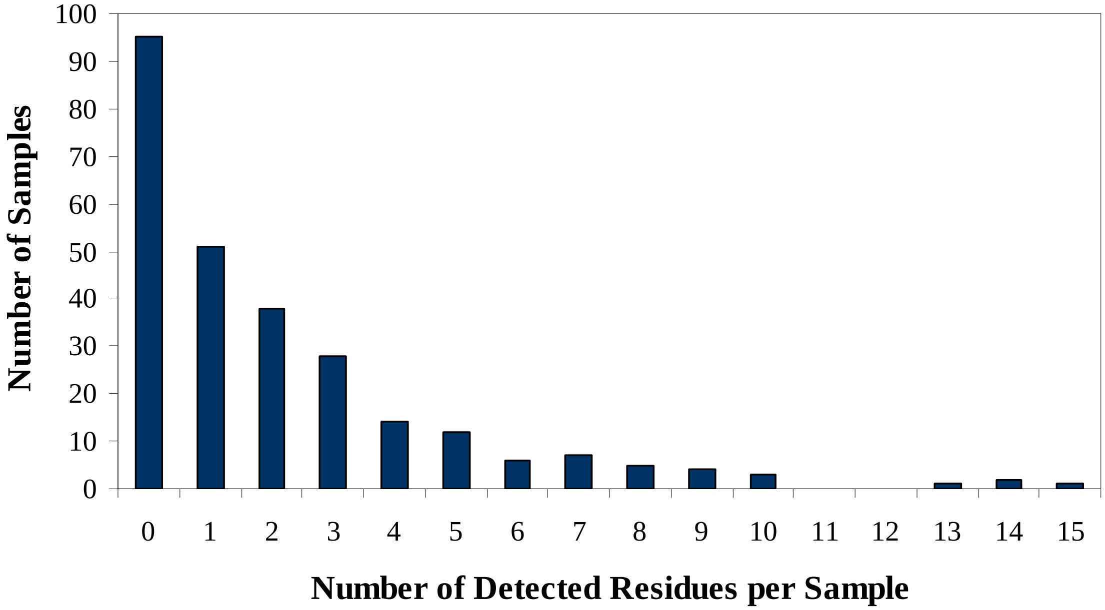

Figure 9. Distribution of samples by number of detected residues per sample.

The number of pesticide residue violations found per sample is shown in Figure 10. Forty of the 66 samples (61%) with pesticide residue violations had only a single residue in violation of applicable MRLs. Twenty percent (13 samples) had two pesticide residue violations per sample, 9% (6 samples) had three to five violations per sample, and 10% (7 samples) had six to nine pesticide residue violations per sample (Figure 10).

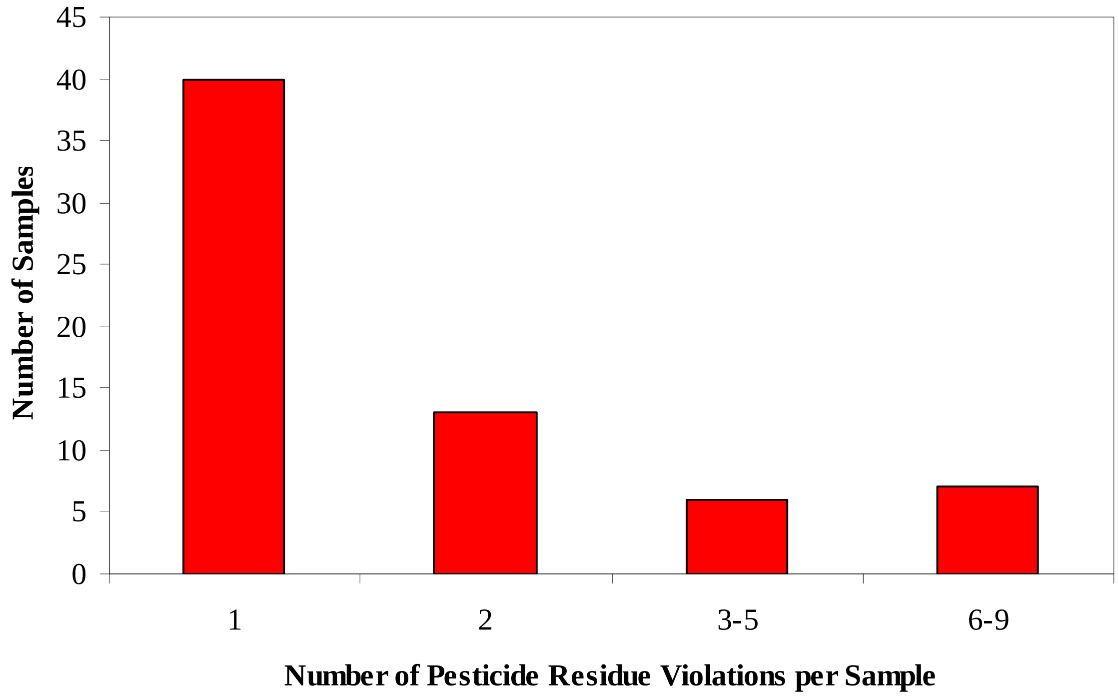

Figure 10. Number of pesticide residue violations per violative sample.

A summary of sample and pesticide residue detections and violations according to tea type is presented in Table 3. When samples with pesticide residue violations were considered according to tea type, oolong tea contained the highest number of violations at 75% (n=8). This was followed by white tea at 50% (n=2), green tea at 32% (n=74), herbal tea at 20% (n=5), black tea at 20% (n=162) and other tea at 12% (n=16) (Table 3). Based on the samples in this survey, green tea samples in violation had the highest average number of pesticide residue violations per sample at 3.2, followed by oolong with an average of 2.8 residue violations per sample.

Based on the samples collected in this targeted survey, green tea had the highest average number of total pesticide residue detections (those in violation of, or compliant with, applicable MRLs) at 4.8 detected residues per sample, followed by white and oolong teas at 4.5 and 4.4 residue detections per sample. In total, there were 573 detections of pesticide residues in the 172 tea samples with detected residues (Table 3).

Table 3. Summary of pesticide residue detections and violations by tea type.

Tea Type	Number of Samples	Number of Samples with Detected Residues (Number of Detected Residues)	Number of Sample Violations (Number of Pesticide Residue Violations)
Black	162	90 (214)	32 (37)
Green	74	58 (278)	24 (76)
Oolong	8	8 (35)	6 (17)
Herbal	5	3 (8)	1 (1)
White	2	2 (9)	1 (2)
Other	16	11 (29)	2 (5)
Total	**267**	**172 (573)**	**66 (138)**

Results of the present survey were compared with those of the 2009-10 FSAP targeted survey on pesticides in tea. The overall compliance rate of teas in the present survey at 75% was higher than the 59% compliance rate observed previously. Although the survey sample sizes were small, oolong tea was the type with the highest percentage of pesticide residue violations in both the present FSAP targeted survey (75%) and in the 2009-10 FSAP survey (92%). Oolong tea samples in both surveys had a relatively high average number of residue violations per sample in violation (current – 2.8, 2009-10 – 3.6), although, in the present survey, green tea had a slightly higher average number of residue violations per sample in violation at 3.2. In the present survey, a greater percentage of black tea samples (20%) and a smaller percentage of green tea samples (32%) contained pesticide residue violations when compared with the 2009-10 survey results (8% and 44%, respectively). Comparisons were not made for herbal and white teas given the small sample sizes analyzed this year. The levels of pesticide residues in dried tea depend on many factors, including the pesticide and application rate used, climatic conditions and duration between pesticide application and time of harvest, and extent of processing[7].

In summary, 66 tea samples contained a total of 138 violative pesticide residues (Table 3). For the tea samples in this survey, 75% (201 samples) were compliant with existing MRLs for the pesticides analyzed (Figure 8). All violations were assessed and appropriate follow-up action was pursued. Exposure to these pesticide residues in tea is not expected to pose a human health concern to consumers given the consumption of tea relative to other food commodities.

3.4 Specific Pesticide Residues

A total of 20 different pesticide residues detected in the analyzed samples were in violation of established MRLs. Cyhalothrin-lambda* and imidacloprid were the pesticides with the greatest number of residues in violation of applicable MRLs at 22 detections each (Appendix C).

**Note: Since this survey was conducted and the results evaluated, Health Canada has established MRLs of 2 ppm for lambda-cyhalothrin (November 30, 2011) and fenpropathrin (December 2, 2011) in tea (dried leaves), and 0.1 ppm for phosphine (March 18, 2011) and 0.05 ppm for thiamethoxam (May 18, 2011) in coffee:* http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_decisions/index-eng.php#mrl-lmr. *All levels of cyhalothrin-lambda detected in tea samples in this survey would not be considered violations if assessed under this new MRL.*

4 Conclusions

4.1 Coffee

Only two of 297 coffee samples contained detectable levels of pesticide residues. None of the coffee samples contained pesticide residues in violation of applicable MRLs. The compliance rate was 100% for pesticide residues in coffee samples in this survey.

4.2 Juice

The compliance rate for pesticides in juice samples in this survey was 99.6% (508 samples). One lemon juice and one pineapple juice, both not from concentrate, were found to contain one pesticide residue each in violation of applicable MRLs. Juices not from concentrate also had the highest percentage of samples with detected pesticide residues (67%) compared to juice from concentrate (48%) and juice concentrates (0%). Seventy-five percent of orange, apple, grapefruit and pear juices analyzed contained one or more detectable pesticide residues, all of which were compliant with applicable MRLs. Both juice violations were assessed and appropriate follow-up action was pursued. Exposure to this pesticide residue is not expected to pose a human health concern to consumers.

4.3 Tea

The overall compliance rate for pesticide residues in the 267 tea samples in this targeted survey was 75%. Detectable pesticide residues were found in all types of tea sampled. In total there were 66 tea samples containing at least one pesticide violation, with 138 pesticide residue violations in total. Oolong tea contained the highest percentage of samples with pesticide residue violations at 75% followed by white tea at 50%, green tea at 32%, herbal and black tea at 20% each, and other tea at 12%. All tea violations were assessed and appropriate follow-up action was pursued. Exposure to these pesticide residues in tea is not expected to pose a human health concern to consumers given the consumption of tea relative to other food commodities.

5 References

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6 Appendix A

Table A1. Combined list of analytes (304) included in the GC-MS multi-residue pesticide methods used by the laboratories in this survey.

3-hydroxy Carbofuran	Cyprazine	Flamprop-isopropyl	Penconazole
Acephate	Cyproconazole	Flamprop-methyl	Pendimethalin
Acibenzolar-s-methyl	Cyprodinil	Fluchloralin	Pentachloroaniline
Aldicarb	Cyromazine	Flucythrinate	Permethrin
Aldicarb Sulfone	Dacthal (chlorthal-dimethyl)	Fludioxonil	Permethrin cis
Aldicarb sulfoxide	DDD-op	Flumetralin	Permethrin trans
Aldicarb sulfoxide	DDD-pp	Fluorochloridone	Phenthoate
Aldrin	DDE-op	Fluorodifen	Phorate
Allidochlor	DDE-pp	Flusilazole	Phorate sulfone
Ametryn	DDT-op	Folpet	Phosalone
Aminocarb	DDT-pp	Fonofos	Phosmet
Aramite	delta-HCH	Heptachlor	Phosphamidon
Aspon	Deltamethrin	Heptachlor epoxide endo	Piperonyl butoxide
Atrazine	delta-trans-allethrin	Heptenophos	Pirimicarb
Azinphos-ethyl	Demeton-O	Hexachlorobenzene	Pirimiphos-ethyl
Azinphos-methyl	Demeton-S	Hexaconazole	Pirimiphos-methyl
Azoxystrobin	Demeton-S-methyl	Hexazinone	Prochloraz
Benalaxyl	Des-ethyl Atrazine	Imazalil	Procymidone
Bendiocarb	Desmetryn	Iodofenphos	**Prodiamine**
Benfluralin	Di-allate	Iprobenfos	Profenophos
Benodanil	Dialofos	Iprodione	Profluralin
Benzoylprop-ethyl	Diazinon	Iprodione metabolite	Promecarb
BHC alpha	Diazinon o analogue	Isazophos	Prometon
BHC beta	Dichlobenil	Isofenphos	Prometryne
Bifenox	Dichlofluanid	**Isoprocarb**	Pronamide
Bifenthrin	Dichloran	Isopropalin	Propachlor
Biphenyl	Dichlormid	Isoprothiolane	Propanil
Bromacil	Dichlorovos	Kresoxim-methyl	Propargite
Bromophos	Diclobutrazole	lambda-Cyhalothrin	Propazine
Bromophos-ethyl	Diclofenthion	Leptophos	Propetamphos
Bromopropylate	Diclofop-methyl	Lindane	Propham
Bufencarb	Dicofol	**Linuron**	Propiconazole
Bupirimate	Dicrotophos	Malaoxon	**Propoxur**
Buprofezin	Dieldrin	Malathion	Propyzamide
Butachlor	Diethatyl-ethyl	Mecarbam	Prothiophos
Butralin	Dimethachlor	Metalaxyl	Pyracarbolid
Butylate	Dimethoate	Metazachlor	Pyrazophos
Capmet	Dinitramine	Methamidophos	Pyridaben
Captafol	**Dioxacarb**	**Methidathion**	Quinalphos
Captan	Dioxathion	**Methiocarb**	Quinomethionate

Carbaryl	Diphenamid	**Methiocarb Sulfoxide**	Quintozene
Carbetamide	Diphenylamine	**Methomyl**	**Schradan**
Carbofenthion	Disulfoton	Methoprotryne	Secbumeton
Carbofuran	Disulfoton sulfone	Methoxychlor	Simazine
Carboxin	Edifenphos	Methyl - trithion	Simetryn
Chlorbenside	Endosulfan alpha	Methyl Pentachlorophenyl sulphide	Sulfallate
Chlorbenzilate	Endosulfan beta	Metobromuron	Sulfotep
Chlorbromuron	Endosulfan sulfate	Metolachlor	Sulprophos
Chlorbufam	Endosulfan total	Metribuzin	Tau-fluvalinate
Chlordimeform	Endrin	Mevinophos-cis	TCMTB
Chlorfenson	EPN	Mevinophos-trans	Tebuconazole
Chlorfenvinphos	EPTC	**Mexacarbate**	Tecnazene
Chlorflurenol-methyl	Erbon	Mirex	Terbacil
Chlordane cis	Esfenvalerate	**Monocrotophos**	Terbufos
Chlordane trans	Etaconazole	Monolinuron	Terbumeton
Chloridazon	Ethalfluralin	Myclobutanil	Terbutryne
Chlormephos	Ethion	Naled	Terbutylazine
Chloroneb	Ethofumsate	Nitralin	Tetrachlorvinphos
Chloropropylate	Ethoprophos	Nitrapyrin	Tetradifon
Chlorothalonil	Ethylan	Nitrofen	Tetraiodoethylene
Chlorpropham	Etridiazole	Nitrothal-isopropyl	Tetramethrin
Chlorpyrifos	Etrimfos	Norflurazon	Tetrasul
Chlorpyrifos-methyl	Fenamiphos	Nuarimol	Thiobencarb
Chlorthiamid	Fenamiphos sulfone	Octhilinone	Tolclofos-methyl
Chlorthion	Fenamiphos sulfoxide	Omethoate	**Tolyfluanid**
Chlorthiophos	Ferarimol	Ortho-phenylphenol	Triadimefon
Chlozolinate	Fenbuconazole	Oxadiazon	Triadimenol
Clomazone	Fenchlorophos	**Oxadixyl**	Tri-allate
Coumaphos	Fenfuram	**Oxamyl**	Triazophos
Crotoxyphos	Fenitrothion	**Oxycarboxin**	Tribufos
Crufomate	Fenpropathrin	Oxychlordane	**Tricyclazole**
Cyanazine	**Fenpropimorph**	Oxyfluorfen	Trifloxystrobin
Cyanophos	Fenson	Paraoxon	Triflumizole
Cycloate	Fensulfothion	Parathion	Trifluralin
Cyfluthrin	Fenthion	Parathion-methyl	Vernolate
Cypermethrin	Fenvalerate	Pebulate	Vinclozolin

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

7 Appendix B

Table B1. Combined list of analytes (154) included in the LC-MS multi-residue pesticide methods used by the laboratories in this survey.

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

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

8 Appendix C

Table C1. Summary of pesticide residue violations found in juice and tea samples.

Commodity	Pesticide Residue	Number of Samples in Violation	Range of Detected Amount (ppm)
Lemon Juice	Phosmet	**1**	0.126
Pineapple Juice	Phosmet	1	0.408
Tea	Bifenthrin	**11**	0.115 - 0.568
	Clothianidin	**6**	0.122 - 0.146
	Cyhalothrin-lambda	**22**	0.045 - 0.499
	Cypermethrin	**10**	0.114 - 0.288
	Difenoconazole	**6**	0.102 - 0.243
	Diniconazole	1	0.531
	Endosulfan Total	**7**	0.1055 - 0.88
	Fenbuconazole	**5**	0.103 - 0.151
	Fenpropathrin	**3**	0.189 - 0.705
	Fenpyroximate	**3**	0.127 - 0.210
	Imidacloprid	**22**	0.107 - 2.42
	Isoxathion	**2**	0.158 - 0.437
	Methomyl	**7**	0.161 - 0.278
	Methoxyfenozide	**4**	0.107 - 0.225
	Monocrotophos	1	0.124
	Orthophenyl-phenol	2	0.149 - 0.157
	Tebuconazole	**6**	0.111 - 0.930
	Thiacloprid	**2**	0.444 - 0.509
	Thiamethoxam	18	0.025 - 0.086