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

FOOD SAFETY ACTION PLAN

REPORT

2008-2009
TARGETED SURVEYS – CHEMISTRY
TS-CHEM-08/09-05

PESTICIDE RESIDUES
IN
PICKLED VEGETABLES

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Executive Summary

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

The main objectives of the pickled vegetables survey were:

- To provide baseline surveillance data for pesticide residues in pickled vegetables
- To obtain a snapshot of the domestic and imported pickled vegetables

There were 659 (203 domestic, 456 imported) pickled vegetable samples collected and analyzed in the targeted survey. The samples included 43 different types of pickled vegetables from 32 countries. Most of the samples (59%) were pickled cucumbers, gherkins, and olives. The top import countries of pickled vegetables were targeted, which include the United States, India and Greece. The samples were analyzed for pesticide residues using a multi-residue method which can detect 286 distinct carbamate, organochlorine and organophosphate compounds. In total, 659 multi-residue tests (188 474 pesticide analyses) were conducted on the 659 samples.

Of the 659 samples tested, 607 (92.11%) contained no detected pesticide residues. The remaining 52 samples had detected levels of pesticide residues, of which only one had two detected pesticide residues. All 53 detected pesticide residues were in compliance with existing Canadian Maximum Residue Limits (MRLs).

The study also showed that there was no significant difference between domestic and imported pickled vegetable compliance rates. There was no relationship between residue type or commodity or country and the proportion of detected residues.

1 Introduction

1.1 Food Safety Action Plan

The Food Safety Action Plan (FSAP) aims to modernize and enhance Canada's food safety system. The FSAP includes multiple partners and processes that work collectively towards providing safe foods for Canadians.

The Canadian Food Inspection Agency (CFIA) has been given the lead in the area of enhanced surveillance, an important initiative of the FSAP. The CFIA works on this initiative with input from 1) Federal partners, including Agriculture and Agri-Food Canada and Health Canada, 2) Provincial and Territorial (P/T) representatives and 3) Industry and other non-government organisations (NGOs).

As part of the FSAP enhanced surveillance initiative, targeted surveys are used to test various foods for specific hazards. Targeted surveys are a complementary approach to the CFIA's regular monitoring activities and will allow the Agency to ask specific questions regarding the level and presence of various chemical and microbiological hazards in targeted foods.

1.2 Targeted Surveys

Targeted surveys can be considered special or pilot surveys that are used to gather preliminary information about the occurrence of chemical hazards in food. They are designed to answer a specific question. Therefore the testing activity is targeted to a sample population (such as commodity types and/or geographical areas). Due to the large number of chemicals and food types that exist in the world today, it is not possible to use targeted surveys to identify and quantify all chemical hazards in foods. The CFIA uses a prioritisation approach to identify food-hazard combinations of greatest potential health risk. Risk prioritisation is performed by 1) consulting the results of a risk-based model, 2) consulting the scientific opinion of Federal, Provincial and Territorial (F/P/T) partners and non-government organizations (NGOs), and 3) using existing survey/monitoring data.

The risk-based model was developed by a multi-disciplinary Food Safety Science Committee (FSSC). Publicly available hazard and food exposure information is entered into a model that generates a relative risk score. The hazards are further evaluated by FSSC members and a consensus is reached on their overall priorities.

The current targeted survey reports on the level of pesticides in pickled vegetables.

1.3 Pickled vegetables

1.3.1 Definition of Pickled Vegetables

The pickling of vegetables is an ancient means of preservation. According to the *Food and Drug Regulations*[1], pickles and relishes are prepared from vegetables or fruits with salt and vinegar, and may contain spices, seasonings, sugars, food colourings; as well as a variety of other food additives meant to extend the shelf life or improve the appearance of the finished product. In Asian countries, vegetables are also pickled in oil or in brine[3].

1.3.2 Consumption

Most pickled vegetables are used as garnishes, or snacks. The pickled cucumber is the most widely consumed pickled vegetable in Canada and the U.S., with the U.S. having a daily consumption of 5 million pounds of cucumbers[2]. A great variety of pickled vegetables are produced and imported to Canada from Europe and Asia.

1.3.3 Pickled Vegetable Processing

The commercial processing of fresh vegetables into pickled vegetables is similar for all pickled vegetables. The manufacturing process can be broken down into four steps: harvesting, preservation, processing/packaging and pasteurisation/sealing. The commercial production of pickled cucumbers is presented as an example in Appendix A

1.4 Potential Hazards in Pickled Vegetables

There are several types of hazards that can exist in pickled vegetables. These include physical, microbiological and chemical hazards.

Pre-processing steps are meant to minimize the physical hazards via washing of field grown produce and eliminating extraneous matter such as grit, sand and debris.

Microbiological hazards can also exist in pickled vegetables. Blemishes and cuts that occur on the surface of pickled vegetables as a result of a physical injury is an ideal location for bacterial growth, insects, mould and mildew. Mould and mildew can also form during transportation and storage. There are multiple processing steps that can aid in reducing microbiological hazards from pickled vegetables. The addition of acids, sugars, salts and other preservatives can retard bacterial/fungal growth; whereas heating (or high pressure) steps can destroy moulds and bacteria that may have contaminated the vegetables prior to pickling.

Chemical hazards that can originate from the vegetables include pesticides, mycotoxins and environmental contaminants. Pesticides are an important tool in crop management practices and are widely used all over the world. Although pesticides are deliberately added to enhance growth conditions for vegetables, inappropriate uses of these chemical

compounds may pose a health hazard. Pesticides are to be applied according to label instructions as the pesticide 1) may only be effective when applied at the appropriate time and 2) may require sufficient time to degrade and be removed from the surface of the produce before it is harvested and consumed.

This report will focus on pesticide residues in pickled vegetables.

1.5 Pesticides

Many of the vegetable ingredients used to make pickled vegetables are susceptible to pests, including mildew, insects and worms. There are many widely known pest management programs used to control pests in vegetable crops in a variety of different countries.

Some of the pickled vegetables consumed by Canadians and tested in this survey are not domestically produced or may be sourced from foreign countries. Regardless of where the vegetables are grown or pickled, the CFIA is responsible for enforcing the maximum residue limits (MRLs) established by Health Canada's Pesticide Management Regulatory Agency (PMRA). All Canadian MRLs for pesticides are established under the Pest Control Products Act (PCPA). Although many pesticides used in foreign countries have no applicable uses in Canada, the PMRA may establish import MRLs for regulatory purposes. When no specific pesticide MRL exists, a general level of 0.1 part per million (ppm) applies.

1.6 Targeted Survey Objective

CFIA's regular monitoring program for chemical residues in foods is the National Chemical Residue Monitoring Program (NCRMP). This program tests for multiple hazards in various commodities including processed vegetables. Pickled vegetables have been monitored to a very limited extent under the NCRMP.

Since most pickled vegetables are not regularly monitored under the NCRMP, there was a need to collect baseline surveillance data for pesticide residue levels in pickled vegetables. A total of 659 samples (203 domestic and 456 imported) were analysed for pesticide residues. Forty-three different commodities from 32 different countries (including Canada) were tested for pesticide residues. The types of pickled vegetables selected for the survey were based on collaborative discussions with the Processed Products Section of the CFIA.

2 Survey Samples & Analytical Methods

2.1 Targeted Survey Sample Overview

A full description of all pickled vegetable samples, including commodity, sample number, origin and sample description can be found in Appendix B.

There were a total of 659 samples collected for the pickled vegetables survey from 32 countries. Most of the samples were picked up by CFIA inspectors at manufacturers or importer warehouses and distributors. Generally, the samples consisted of a small amount of pickled vegetables from larger holding tanks or an appropriate number of jars/tins of finished product.

The distribution of samples with respect to country of origin is depicted in Table 2-1. The country of origin is as stated on the import documents or on the jar label. It is not possible to determine if the vegetables were grown and processed in the stated country of origin nor is it possible to ascertain if all the vegetables in a given sample were sourced from a single country**.** This uncertainty exists for all samples.

Table 2-1 Distribution of Samples by Country of Origin

Sample Origin	# of Samples	% Total Samples
Canada	203	30.8
United States of America	150	22.8
India	143	21.7
Greece	29	4.4
Turkey	19	2.9
Poland	18	2.7
China	14	2.1
Taiwan	9	1.4
Iran	7	1.1
Vietnam	6	0.9
Spain	5	0.8
France	5	0.8
Lebanon	5	0.8
Mexico	5	0.8
Peru	5	0.8
Germany	5	0.8
Bulgaria	4	0.6
Bosnia & Herzegovina	3	0.5
Morocco	3	0.5
Macedonia	3	0.5
Slovenia	3	0.5
United Arab Emirates	2	0.3
Croatia	2	0.3
Netherlands	2	0.3
Thailand	2	0.3
Egypt	1	0.2
Guatemala	1	0.2
Israel	1	0.2
Italy	1	0.2
Pakistan	1	0.2
Unknown	1	0.2
South Africa	1	0.2
Grand Total	**659**	**100.0**

There were a total of 43 different pickled vegetable commodity types collected. More emphasis was put on pickled cucumbers, gherkins, olives, mixed vegetables and peppers (sweet or hot) as they are the most commonly imported pickled vegetables in Canada. The number of samples for each commodity type was determined based on input from the Processed Products section of the CFIA. Figure 2-1 is a graphical depiction of sample distribution by commodity type.

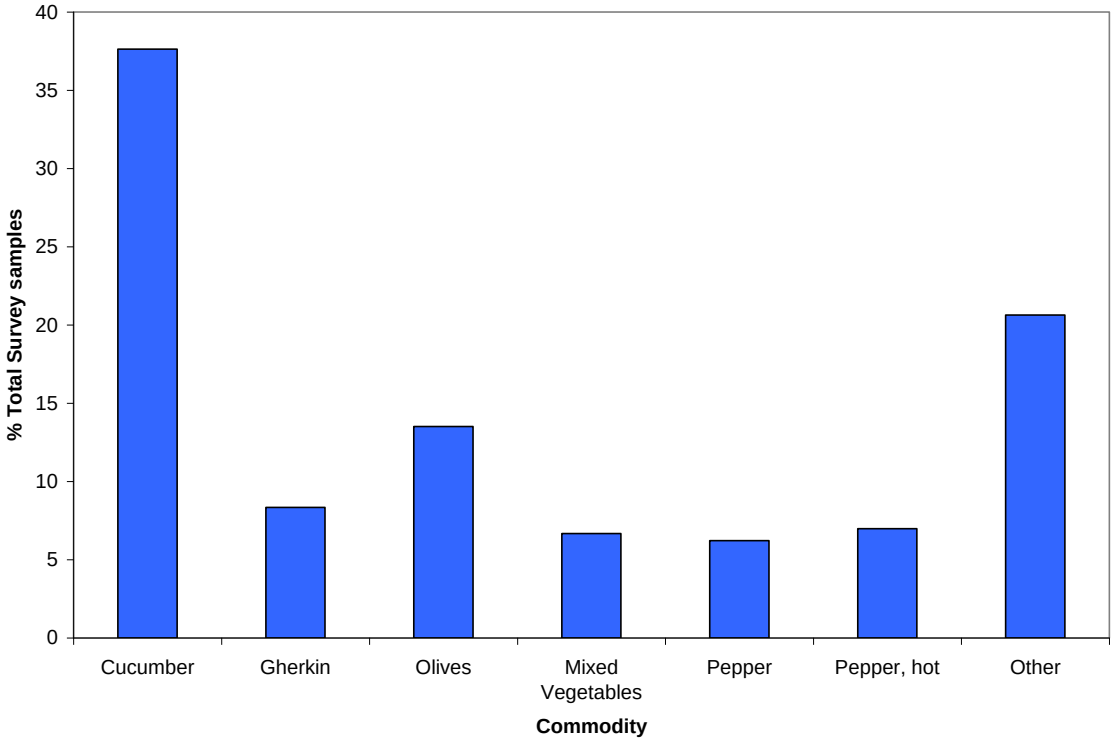

Figure 2-1 Distribution of Samples by Commodity Type

A breakdown of the ‘other’ pickled vegetable commodity types is illustrated in Table 2-2.

Table 2-2 Distribution of 'Other' Pickled Vegetable Commodities

"Other" Pickled Vegetables	Number of Samples	% of Samples
Antipasto	2	0.30
Artichoke Hearts	2	0.30
Milkweed	1	0.15
Asparagus	11	1.67
Bean	5	0.76
Beet	10	1.52
Cabbage	1	0.15
Cactus	3	0.46
Capers	2	0.30
Carrots	7	1.06
Cauliflower	2	0.30
Celery salad	1	0.15
Crispy snappers	1	0.15
Dill chips	1	0.15
Eggplant	4	0.61
Garlic	13	1.97
Ginger	3	0.46
Horseradish, Extra Hot	1	0.15
Kerda in brine	1	0.15
Leeks	2	0.30
Lettuce	1	0.15
Lime	2	0.30
Lime chilli	1	0.15
Mango	2	0.30
Manzanilla	1	0.15
Mushroom	8	1.21
Mustard greens	3	0.46
Nopalitos	1	0.15
Onions	18	2.73
Pepperoncinis	1	0.15
Radish in soy sauce	1	0.15
Relish	4	0.61
Sauerkraut	10	1.52
Tomato	4	0.61
Turmeric in brine	2	0.30
Turnips	3	0.46
Vine Leaves	1	0.15

2.2 Survey Limitations

The pickled vegetables survey was designed to give a snapshot of the pickled vegetable industry. There were a limited number of samples (659 in total) that were used to collect information on pickled vegetables. Conclusions regarding sample country of origin cannot be made as it is impossible to establish where the vegetable ingredients used to manufacture the product were grown. The term 'sample origin' refers to the country of manufacture, as indicated on the product label. The survey does not examine seasonality, year-to-year trends and impact of product shelf-life.

2.3 Analytical Methods

To analyze the survey samples whose pesticide treatment history is generally unknown, the contracted third party laboratories use analytical methods capable of simultaneously determining a large number of pesticide residues. The CFIA has established requirements for the acceptance of analytical results from third party laboratories. Such laboratories must be 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). Acceptance of results is contingent on those routine tests and analytical matrices being included in the laboratory's current scope of accreditation[3].

To become accredited, an analytical method must: a) be relevant for its intended purpose and b) meet certain validation parameters. Typical validation characteristics considered include:

- recovery
- selectivity
- specificity
- accuracy
- linearity/range
- precision
- repeatability/reproducibility
- limit of quantitation (LOQ)
- limit of detection (LOD)

The 659 pickled vegetable samples were analysed by a contract laboratory using a pesticide multi-residue method (286 residues, consult Appendix C for the full list of pesticides included in the method). The method includes banned pesticides (in Canada), pesticides that have established Canadian MRLs, and pesticides that lack MRLs. The analytical method is based on the CFIA reference method PMR-002-V1.1, entitled 'Determination of Pesticides in Honey, Fruit Juice and Wine (With Solid Phase Extraction Clean-Up and GC-MSD and HPLC Fluorescence Detection)'.

3 Results and Discussion

3.1 Overview

The results from this targeted survey are presented graphically below. The supporting information is presented in tabular form in the appendices.

The results of analyses obtained are compared to the applicable standards established by Health Canada at the time of sampling. For pesticides, MRLs are established and regulated under the Pest Control Products Act (PCPA) and can be found on Health Canada's Consumer Product Safety website:
http://www.hc-sc.gc.ca/cps-spc/pest/protect-proteger/food-nourriture/mrl-lmr-eng.php

Unless otherwise stated, the results presented in this report are presented in mg/kg (ppm).

3.2 Results for Pesticide Residues

3.2.1 Samples for Pesticide Analysis

The 659 samples (456 imported and 203 domestic) collected in this study were analysed with the multi-residue pesticide protocol described in Section 2.3.

Six hundred seven samples (92.11%) had no detected (ND) residues. Fifty-one samples had one detected residues and one sample had two detectable residues. All of the pesticide residues detected were compliant with MRLs.

3.2.2 Distribution of Residues by Pesticide Residue Type

The 659 pickled vegetable samples were tested for 286 pesticide residues. In total, 186 474 analyses were conducted. There were 53 positive results. All 53 positive results were below the established MRLs or below the general MRL of 0.1 ppm. A total of 14 different pesticide residues were detected. Figure 3-1 below illustrates the distribution of positives by residue type.

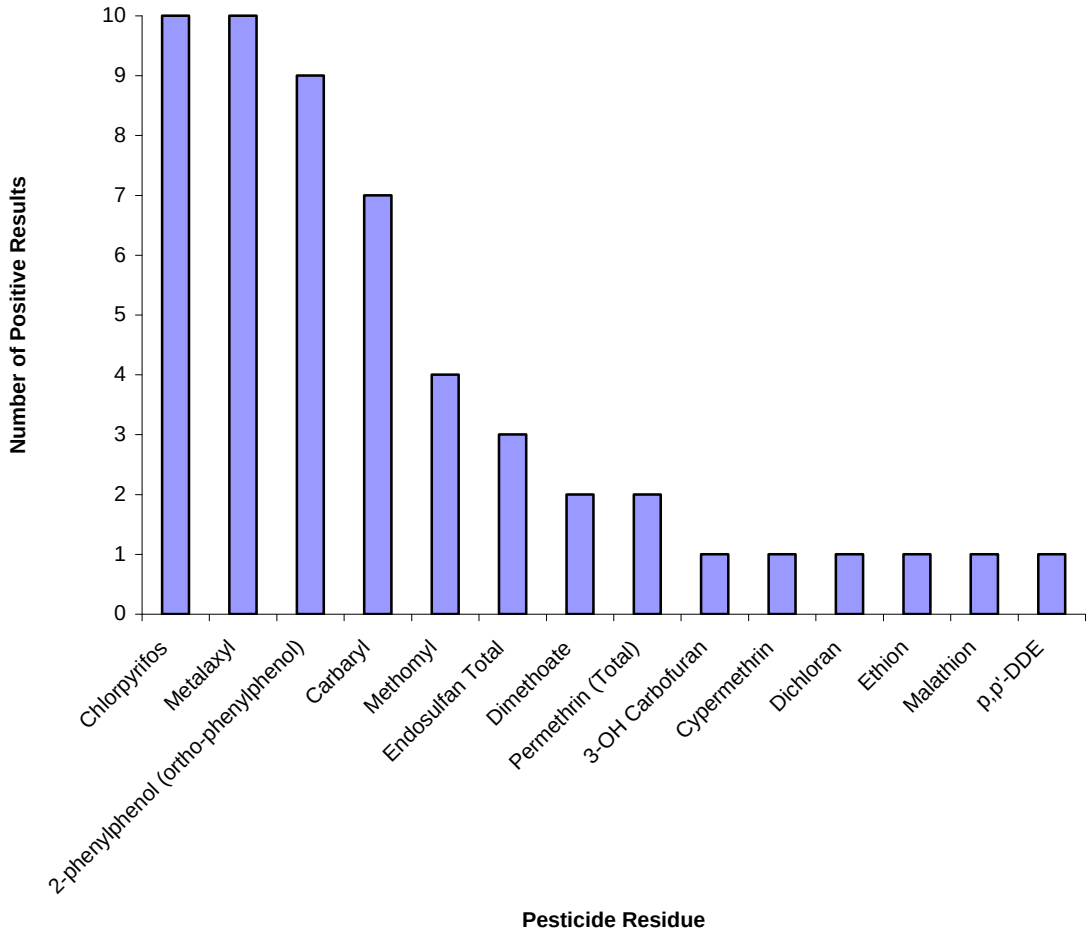

Figure 3-1 Number of Positive Results by Pesticide Residue

3.2.3 Distribution of Residues by Country

The pickled vegetables targeted survey included samples from 32 countries. Three countries (Canada, India and the United States) were identified in the planning of the targeted survey as being the principal sources of pickled vegetables in Canada. Therefore, a large number of samples (75.3%) originate from these countries. A complete list of the detected residues by sample origin is represented in Table 3-1. There were no detected residues for products originating from 19 of the 32 countries surveyed (sample numbers varied from 1 to 5 samples per country).

Table 3-1 Residue Distribution by Sample Origin

Origin	Total Number of Samples	Total Number of Positive Samples	Total Number of Negative Samples	% Negative samples	Analyte	Number of Positives
Bosnia and Herzegovina	3	1	2	66.67	Metalaxyl	1
Canada	203	10	193	95.07	Carbaryl	3
					Chlorpyrifos	3
					Methomyl	1
					p,p'-DDE	1
					Permethrin (Total)	2
China	14	3	11	78.57	Dichloran	1
					Dimethoate	1
					Methomyl	1
France	5	1	4	80.00	Methomyl	1
Greece	29	2	27	93.10	Carbaryl	1
					Methomyl	1
Croatia	2	1	1	50.00	Metalaxyl	1
India	143	13	130	90.91	2-phenylphenol (ortho-phenylphenol)	1
					Carbaryl	1
					Chlorpyrifos	2
					Endosulfan Total	1
					Metalaxyl	8
Iran	7	1	6	85.71	Chlorpyrifos	1
Poland	18	2	16	88.89	Chlorpyrifos	1
					Ethion	1
Thailand	2	1	1	50.00	3-OH Carbofuran	1
Turkey	19	2	17	89.47	Chlorpyrifos	2
USA	150	14	136	93.30	2-phenylphenol (ortho-phenylphenol)	7
					Carbaryl	2
					Chlorpyrifos	1
					Cypermethrin	1
					Dimethoate	1
					Endosulfan Total	2
					Malathion	1
Vietnam	6	1	5	83.33	2-phenylphenol (ortho-phenylphenol)	1

Table 3-2 Nature of Pesticide Residues in Different Pickled Vegetables

Commodity	Total Number of Samples	Number of Positive Samples	Total Number of Negative Samples	% Negative Samples	Analyte	Number of Positives
Asparagus	11	1	10	90.91	Carbaryl	1
Cucumber	248	19	229	92.34	Carbaryl	2
					Chlorpyrifos	3
					Endosulfan Total	3
					Ethion	1
					Metalaxyl	8
					Methomyl	1
					Permethrin (Total)	1
Garlic	13	1	12	92.31	Methomyl	1
Gherkin	55	6	49	89.09	2-phenylphenol (ortho-phenylphenol)	1
					Carbaryl	1
					Metalaxyl	2
					Chlorpyrifos	2
Mustard Greens	3	3	0	0	2-phenylphenol (ortho-phenylphenol)	1
					3-OH Carbofuran	1
					Chlorpyrifos	1
					Cypermethrin	1
Horseradish, Extra Hot	1	1	0	0.00	p,p'-DDE	1
Olives	89	9	80	89.89	2-phenylphenol (ortho-phenylphenol)	6
					Dimethoate	1
					Methomyl	2
Onions	18	1	17	94.44	Chlorpyrifos	1
Pepper	41	1	40	97.56	Permethrin (Total)	1
Pepper, hot	46	2	44	95.65	2-phenylphenol (ortho-phenylphenol)	1
					Malathion	1
Pepperonicinis	1	1	0	0.00	Carbaryl	1
Vegetable, mixed	44	7	37	84.09	Carbaryl	2
					Chlorpyrifos	3
					Dichloran	1
					Dimethoate	1

3.2.4 Distribution of Pesticide Residues by Commodity Type

There were 43 types of pickled vegetables obtained in the survey. Of the 43 different commodities tested in the survey, 13 (21.31%) contained at least one detectable pesticide residue. One sample of mustard greens from the USA tested positive for two pesticide residues, namely chlorpyrifos and cypermethrin. Table 3- lists the residues found in the various types of pickled vegetables.

3.2.5 Discussion of Specific Pesticide Residue Results

The results of the survey indicate that the overall compliance rate with Canadian pesticide MRLs in pickled vegetables was 100% for domestic and 100% for imported pickled vegetables. This is similar to the compliance rates seen in most fresh and processed vegetable products sampled in the NCRMP.

There were 14 different pesticide residues detected in the survey. The most commonly detected pesticide residues were chlorpyrifos (10 samples), five of which were detected in pickled cucumbers and gherkins for which there is no MRL. Metalaxyl was found in 10 samples, all in pickled cucumbers and gherkins. There is an MRL for metalaxyl in cucumbers. 2-phenylphenol was found in nine samples, six of which were detected in olives. There is no MRL for 2-phenylphenol in olives. Chlorpyrifos and cypermethrin were both detected in one sample of mustard greens from the USA. Metalaxyl, 2-phenylphenol, chlorpyrifos and cypermethrin residues are often detected in fresh vegetables sampled in the NCRMP.

Out of a total of 659 samples, 607 samples (92.1%) had no detected pesticide residues. Fifty-two samples had one or more detected residues. There were a total of 53 positive results; 23 (43.4%) results were lower than their specific MRLs and 30 (56.4%) were lower than the general 0.1 ppm MRL. All of the results are compliant with established regulations.

4 Conclusions

The pickled vegetables targeted survey analysed 659 samples corresponding to 61 different pickled vegetables from 32 countries. The design of the survey does not provide a statistically robust data set. However, the results obtained can provide a snapshot of the pickled vegetable industry as a whole.

The majority of the samples (92.11%) were found to contain no measurable pesticide residues. All samples were in compliance with Canadian pesticide residue MRLs. There was no difference in compliance rate of domestic and import commodities. There was no relationship found between commodity, residue type, or country of origin and the number of samples with detected pesticide residues.

5 Future Considerations

Although all samples were compliant with Canadian pesticide residue MRLs, survey results do not represent a statistically relevant data set but rather provide a snapshot of the industry.

A potential future pesticide survey on pickled vegetables may aim to:

- Increase the number of samples to obtain a statistically-relevant data set;
- Identify trends (by commodity, by country of origin, by nature of residues, year-to-year climatic variations)
- Increase the scope of analysis by incorporating a second pesticide multi-residue screen (developed by the CFIA laboratories in 2009 and is now fully validated and available).

6 References

[1] Canada**.** Justice Canada**.** *Food and Drugs Regulations. Part B. Division 11. Fruits, Vegetables, Their Products and Substitutes.* 2009. Web. 6 August 2009. http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-b:l_11//en#anchorbo-ga:l_B-gb:l_11.

[2] Romanowski, P. "Pickle". How *Products Are Made, Volume 4*. 1996. Web. 6 August 2009. http://findarticles.com/p/articles/mi_gx5205/is_1996/ai_n19124778/?tag=content:col.

[3] Canada. Canadian Food Inspection Agency. *Chemistry Testing for Enhanced QMP Importers.* 2005. Web. 7 August 2009 http://www.inspection.gc.ca/english/fssa/fispoi/commun/20050919e.shtml.

Appendix A

The commercial processing of fresh vegetables into pickled vegetables is similar for all pickled vegetables. The commercial production of pickled cucumbers is presented as an example. Most of the information, unless otherwise indicated, was provided by Romanowski[2].

Manufacture of Pickled Cucumbers

Cucumbers used for pickling must be sound and free from major damage that can promote the growth of bacteria or moulds. The cucumbers are either selected over time or have been bred specifically for pickling. The cucumbers for pickling are straight, thin-skinned cucumbers of a uniform size and with a tolerable number of defects.[4, 5] Pesticides may be applied to the cucumbers to prevent loss of crops in the fields or in storage facilities.[6]

Harvesting

Harvesting can be done by hand or mechanically. The cucumbers are stored in large bins and are then transported by truck (refrigerated if necessary to preserve freshness and flavour) to a receiving station. Upon arrival at the site of manufacture, cucumbers are washed and inspected for damage, after which they are sorted by sized and chilled until processing.

Preservation

There are three different methods of preservation. These include fermentation, pasteurisation and refrigeration.

Fermentation is the oldest and most common pickling process. In this process, cucumbers are placed in large, air-tight, fiber-glass or stainless steel tanks filled with brine (water and 10%salt). Fermentation is carried out by salt-resistant bacteria (naturally occurring or inoculated strains). The fermentation process requires five weeks during which time

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4 CODEX. *CODEX Standard for Pickled Cucumbers (Cucumber Pickles). CODEX STAN 115-1981*.

5 United States. North Carolina State University, College of Agriculture and Life Sciences. *Commercial production of Pickling & Slicing Cucumbers in North Carolina.* Web. 9 August 2009. http://www.ces.ncsu.edu/depts/hort/hil/ag552.html.

6 Canada. Canadian Food Inspection Agency. *Chemistry Testing for Enhanced QMP Importers.* 2005. Web. 7 August 2009. http://www.inspection.gc.ca/english/fssa/fispoi/commun/20050919e.shtml.

the bacteria break down the sugars in the cucumber, releasing carbon dioixde in the process. This method results in pickles with the longest shelf life

Pasteurisation does not require a fermentation step. It involves the application of high temperatures for set times to bottled cucumbers in order to kill naturally occurring bacteria. This method results in pickles with an intermediate shelf life.

The refrigeration and acidification method also does not require fermentation. In this method, the pickles are placed in a brine solution containing vinegar and are kept at a low temperature. This is the fastest pickling method but results in pickles with the shortest shelf life.

Processing and Packaging

All subsequent steps are carried out quickly and/or under aseptic conditions to prevent microbial growth and product spoilage. Where fermentation was used, the salt solution is drained from the tank and the pickles are washed with water to remove the salt. The pickles are then cut under aseptic conditions to the appropriate size and shape. The pickles are then placed into glass jars or other containers. These jars or containers may contain spices. The pickling liquor is then added and the jars/containers are capped. Vinegar (most commonly acetic acid), salt and water make up the most significant portions of the pickling liquid. Both vinegar and salts are preservatives and add flavour to the finished product. The vinegar imparts sourness to the pickle and the source of the vinegar may impact the taste of the final product.

The flavourings added to the pickle liquor are responsible for the unique taste of each pickle type or brand. The most commonly used flavourings include sugar, dill weed, onions and garlic. Other commonly used spices include allspice, cassia, cinnamon, cloves, fennel, fenugreek, and nutmeg, capsicum, black pepper, ginger, and mustard.

The food colours most commonly used in pickles are turmeric caramel (brown to yellow colour) and cholorphyll (green). Sulfur dioxide may also be added to prevent the pickles from changing colour.

Other ingredients that may be added to the liquor include firming agents and surfactants. Firming agents like sugar, lime and alum help the pickle to retain its plumpness and crispiness. Polyoxyethylene (20) sorbitan monooleate is a surfactant used to bind ingredients in the liquor solution.

Pasteurisation/sealing

The pickles are pasteurised by exposing the jarred product to a high temperature for a sufficently long time to kill off salt- and vinegar-tolerant bacteria or to inactivate the cucumber's enzymes. The pickles are then vacuum sealed.

Appendix B

The following table is a description of all the samples included in the survey.

Table B-0-1 Pickled vegetables samples included in targeted survey

Commodity Type	Total Number of Samples	Country of Origin	Number of samples per country
Antipasto	2	Canada	2
Artichoke	2	Peru USA	1 1
Milkweed	1	Canada	1
Asparagus	11	USA Canada China Peru	5 4 1 1
Bean	5	Canada USA	3 2
Beet	10	Canada Poland India	8 1 1
Cabbage	1	Guatemala	1
Cactus	3	Mexico	3
Capers	2	Canada Turkey	1 1
Carrots	7	USA Canada India	3 3 1
Cauliflower	2	Poland Iran	1 1
Celery Salad	1	Poland	1
Crispy snappers	1	USA	1
Cucumber	248	Canada India USA Taiwan Poland Iran Turkey Germany China Bosnia & Hercegovina Bulgaria Egypt Greece Pakistan	95 80 44 7 6 3 3 2 2 1 1 1 1 1

Commodity Type	Total Number of Samples	Country of Origin	Number of samples per country
		South Africa	1
Dill Chips	1	India	1
Eggplant	4	Canada Thailand Vietnam	2 1 1
Garlic	13	India Canada China Iran Vietnam	5 4 2 1 1
Gherkin	55	India Canada France Germany USA Poland Croatia Iran Lebanon Netherlands Turkey	27 12 4 3 2 2 1 1 1 1 1
Ginger	3	China Canada	2 1
Horseradish	1	Canada	1
Kerda in brine	1	India	1
Leeks	2	Vietnam unknown	1 1
Lettuce	1	China	1
Lime	2	India	2
Lime Chili	1	India	1
Mango	2	India	2
Manzanilla	1	Spain	1
Mixed Vegetables	44	Canada India Turkey USA China Greece Vietnam Slovenia Macedonia Poland	13 10 5 5 3 2 2 2 1 1
Mushroom	8	Canada	3

Commodity Type	Total Number of Samples	Country of Origin	Number of samples per country
		Poland	3
		India	1
		Bulgaria	1
Mustard Greens	3	USA	1
		Thailand	1
		Vietnam	1
Nopalitos	1	Mexico	1
Onions	18	Canada	12
		USA	2
		India	1
		India	1
		Netherlands	1
		Taiwan	1
Olives	89	USA	52
		Greece	19
		Canada	4
		Spain	4
		Morocco	3
		Peru	2
		France	1
		Israel	1
		Italy	1
		Lebanon	1
		Turkey	1
Peppers	41	Canada	12
		USA	9
		Greece	4
		India	4
		Turkey	3
		Bosnia & Hercegovina	2
		Croatia	1
		Lebanon	1
		Macedonia	1
		Mexico	1
		Peru	1
		Poland	1
		Slovenia	1
Peppers, Hot	46	Canada	18
		USA	14
		Turkey	5
		Greece	2
		India	2
		United Arab Emirates	2

Commodity Type	Total Number of Samples	Country of Origin	Number of samples per country
		Bulgaria China Macedonia	1 1 1
Pepperoncinis	1	Greece	1
Radish in soy sauce	1	Taiwan	1
Relish	4	Canada India	3 1
Sauerkraut	10	USA Canada Poland China	6 2 1 1
Tomato	4	Bulgaria India Poland USA	1 1 1 1
Turmeric in brine	2	India	2
Turnips	3	Lebanon China	2 1
Vine Leaves	1	USA	1

Appendix C

The following is a list of pesticides (286) included in third party method

Analytes included in third party method			
2-phenylphenol (ortho-phenylphenol)	Cyfluthrin (I,II,III,IV)	Fluchloralin	Pebulate
3-OH Carbofuran	Cyhalothrin-lambda	Fludioxonil	Penconazole
Acephate	Cypermethrin	Flumetralin	Pendimethalin
Acibenzolar-s-methyl	Cyprazine	Fluorochloridone	Permethrin cis
Alachlor	Cyproconazole	Fluorodifen	Permethrin trans
Aldicarb	Cyprodinil	Flusilazole	Phenthoate
Aldicarb Sulfone	Cyromazine	Fluvalinate	Phorate
Aldicarb sulfoxide	Dacthal (chlorthal-dimethyl)	Folpet	Phorate sulfone
Aldrin	delta-HCH (delta-lindane)	Fonofos	Phosalone
Allidochlor	Deltamethrin	Heptachlor	Phosmet
Ametryn	delta-trans-allethrin	Heptachlor epoxide endo	Phosphamidon
Aminocarb	Demeton-O	Heptanophos	Piperonyl butoxide
Aramite	Demeton-S	Hexachlorobenzene	Pirimicarb
Aspon	Demeton-S-methyl	Hexaconazole	Pirimiphos-ethyl
Atrazine	Des-ethyl Atrazine	Hexazinone	Pirimiphos-methyl
Azinphos-ethyl	Desmetryn	Imazalil	Prochloraz
Azinphos-methyl	Di-allate	Iodofenphos	Procymidone
Azoxystrobin	Diazinon	Iprobenfos	Prodiamine
Benalaxyl	Diazinon o analogue	Iprodione	Profenofos
Bendiocarb	Dichlobenil	Isazophos	Profluralin
Benfluralin	Dichlofluanid	Isofenphos	Prometon
Benodanil	Dichloran	Isoprocarb	Prometryne
Benzoylprop-ethyl	Dichlormid	Isopropalin	Pronamide
BHC Alpha	Dichlorvos	Isoprothiolane	Propachlor
BHC beta	Diclobutrazole	Kresoxim-methyl	Propanil
Bifenox	Diclofenthion	Leptophos	Propargite
Bifenthrin	Diclofop-methyl	Lindane (gamma-BHC)	Propazine
Biphenyl	Dicofol	Linuron	Propetamphos
Bromacil	Dicrotophos	Malaoxon	Propham
Bromophos	Dieldrin	Malathion	Propiconazole
Bromophos-ethyl	Diethatyl-ethyl	Mecarbam	Propoxur
Bromopropylate	Dimethachlor	Metalaxyl	Prothiophos
Bupirimate	Dimethoate	Metazachlor	Pyracarbolid

Butachlor	Dinitramine	Methamidophos	Pyrazophos
Analytes included in third party method			
Butralin	Dioxathion	Methidathion	Pyridaben
Butylate	Diphenamid	Methiocarb	Quinalphos
Captafol	Diphenylamine	Methiocarb Sulfoxide	Quintozene
Captan	Disulfoton	Methomyl	Secbumeton
Carbaryl	Disulfoton sulfone	Methoprotryne	Simazine
Carbetamide	Edifenphos	Methoxychlor	Simetryn
Carbofenthion	Endosulfan alpha	Methyl - trithion	Sulfallate
Carbofuran	Endosulfan beta	Metobromuron	Sulfotep
Carboxin	Endosulfan sulfate	Metolachlor	Sulprophos
Chlorbenside	Endrin	Metribuzin	TCMTB
Chlorbenzilate	EPN	Mevinphos-cis	Tebuconazole
Chlorbromuron	EPTC	Mevinphos-trans	Tecnazene
Chlorbufam	Erbon	Mexacarbate	Terbacil
Chlordane cis	Esfenvalerate	Mirex	Terbufos
Chlordane trans	Etaconazole	Monocrotophos	Terbumeton
Chlordimeform	Ethalfluralin	Monolinuron	Terbutryne
Chlorfenson	Ethion	Myclobutanil	Terbutylazine
Chlorfenvinphos (e+z)	Ethofumsate	Naled	Tetrachlorvinphos
Chlorflurenol-methyl	Ethoprophos	Nitrapyrin	Tetradifon
Chloridazon	Ethylan	Nitrothal-isopropyl	Tetraiodoethylene
Chlormephos	Etridiazole	Norflurazon	Tetramethrin
Chloroneb	Etrimfos	Nuarimol	Tetrasul
Chloropropylate	Fenamiphos	o,p'-DDD (o,p'-TDE)	Thiobencarb
Chlorothalonil	Fenamiphos sulfone	o,p'-DDT	Tolclofos-methyl
Chlorpropham	Fenamiphos sulfoxide	Octhilinone	Tolyfluanid
Chlorpyrifos	Fenarimol	Omethoate	Triadimefon
Chlorpyriphos-methyl	Fenbuconazole	Oxadiazon	Triadimenol
Chlorthiamid	Fenchlorophos (Ronnel)	Oxadixyl	Tri-allate
Chlorthion	Fenfuram	Oxamyl	Triazophos
Chlorthiophos	Fenitrothion	Oxycarboxin	Tribufos
Chlozolinate	Fenpropathrin	Oxychlordane	Tricyclazole
Clomazone	Fenpropimorph	Oxyflurofen	Trifloxystrobin
Coumaphos	Fenson	p,p'-DDD (p,p'-TDE)	Triflumizole
Crotoxyphos	Fensulfothion	p,p'-DDE	Trifluralin
Crufomate	Fenthion	p,p'-DDT	Vernolate
Cyanazine	Fenvalerate	Paraoxon	Vinclozolin
Cyanophos	Flamprop-isopropyl	Parathion	
Cycloate	Flamprop-methyl	Parathion-methyl	