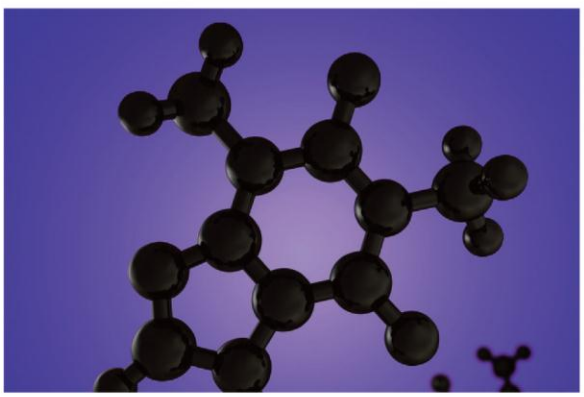
Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2008-2009 Targeted Surveys

Chemistry



Pesticide residues and metals in fruit juice concentrates

TS-CHEM-08/09

Canada

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 fruit juice concentrate survey were:

- To provide baseline surveillance data for pesticide residues and metals in fruit juice concentrates
- To obtain a snapshot of the increasingly-consumed imported fruit juice concentrates where pest control measures are not under the authority of the Canadian Government

There were 186 fruit juice concentrate samples collected and analyzed in the targeted survey. The samples included 22 different types of fruit juice concentrates from 23 countries. The top import countries of fruit juice concentrates were targeted, which include the United States, Brazil and Argentina. The samples were analyzed for pesticide residues and metals using multi-residue and multi-metal methods. In total, 186 multi-residue tests (55 800 pesticide analyses) and 186 multi-metal tests (3 348 metal analyses) were conducted on the 186 samples.

The pesticide multi-residue method can detect about 300 individual carbamate, organochlorine and organophosphate compounds. The multi-metal method can detect 18 metal elements, including aluminum, arsenic, antimony, beryllium, boron, cadmium, chromium, copper, iron, manganese, mercury, molybdenum, nickel, lead, selenium, tin, titanium and zinc.

Of the 186 samples tested, 146 (78.49%) contained no detectable pesticide residues. The remaining 40 samples had detectable levels of pesticide residues, of which 14 had more than one detectable pesticide residue. All survey samples with detected pesticide residues were in compliance with paragraph 4(d) of the *Food and Drugs Act*, specifically, the juice concentrate products are not adulterated. All detected pesticide residues were in compliance with existing Canadian Maximum Residue Limits (MRLs).

All 186 samples were tested for metals. Many of the metals included in the analysis occur naturally in fruit juice concentrates and are essential nutrients for humans. Increased levels of metals (i.e. arsenic, lead) may occur in fruit juice concentrates as a result of 1) pesticide applications (when applied directly (copper) or when included as a component of a pesticide formulation), 2) environmental contamination and 3) food processing/packaging. Although higher than expected levels of manganese were found in some pineapple juice concentrate samples, these levels and all other levels of the detected metals in fruit juice concentrates did not pose a human health risk when consumed as single-strength products.

1 Introduction

1.1 Food Safety Action Plan

Objective
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 Canada and Health Canada, 2) Provincial and Territorial (P/T) representatives and 3) industry and other non-government organizations (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 Agency'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 residues and metals 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 prioritization approach to identify food-hazard combinations of greatest potential health risk. Risk prioritization 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 and heavy metals in fruit juice concentrates. Fruit juice concentrates are widely consumed in Canada. Children consume more fruit juice (per kilogram body weight) than any other age group in Canada. For example, in Canada, 1-3 year old children consume 165-192 grams of fruit juice per day[1] compared to 19 year old adults who consume 136-176 grams of fruit juice per day[2]. Given the difference in body weight between these two age groups, it is evident that children consume more fruit juice per kg body weight.

1.3 Fruit Juice & Fruit Juice Concentrate

1.3.1 Definition of Fruit Juice and Fruit Juice Concentrate

Under the *Food and Drug Regulations*, fruit juice is defined as the 'the unfermented liquid expressed from sound ripe fresh fruit, and includes any such liquid that is heat treated and chilled'. Fruit juice concentrate 'shall be fruit juice that is concentrated to at least one half of its original volume by the removal of water[3].

1.3.2 Canadian Consumption

Fruit juice (derived from either freshly pressed fruit or diluted from concentrate) is consumed by nearly all age groups in Canada. It is becoming more prevalent on the Canadian market, with per capita consumption up 15% since 1981, from 23.26 L/year in 1981 to 26.77 L/year in 2007[4]. Canadians are consuming more exotic fruit juices such as passion fruit. There has also been an increased consumption of lemon and pineapple juices. Pineapple juice reached a new record in 2007 of 0.9 L/person. Among all juices, orange juice remains Canada's juice of choice, at 11.8 L/person in 2007 followed by apple juice at 6.0 L/person[4]. In 2008, other commonly consumed fruit juices in Canada include grape juice (3.99 L/person) and grapefruit juice (0.47 L/person)[5].

1.3.3 Juice Concentrate Processing

Starting Materials

Fruit used for juicing must be sound and free from major damage or contamination that can promote bacterial growth and/or mould/mildew. The fruit juice industry generally utilizes misshapen, skin-blemished and poorly coloured fruit unsuitable for the fresh, frozen or canned fruit market. Fruits for juice have been selected over time or have been bred specifically for juice production. More recently, a wider range of varieties are being utilized as bitterness and other unwanted characteristics can be removed by processing. More 'blends' are now appearing on the market and are perceived as having better flavour over single varietal juice[6].

Brix: A Measure of Sugar Strength

Fruit juice concentrates are normally sold with a measure of degrees Brix (°Bx). °Bx is a measurement of the dissolved sugar-to-water mass ratio of a liquid. It is measured with a saccharimeter that measures specific gravity of a liquid or more easily with a refractometer. A 45 °Bx solution is 45% (sugar/water), with 45 grams of sugar per 100 grams of sugar-water solution. A 45 °Bx solution is equivalent to 10.027 lbs solid/gallon[7]. In general, juice companies will manufacture single-strength juice products based on lbs solids/gallon, most within the range of 0.866 lbs solid/gallon and 1.803 lbs solid/gallon (10°Bx and 20°Bx)[8].

Types of Processing

Fruit juice processing can be broken down into two different processing technologies. The first is soft fruit processing, and includes pome fruits (apples, pears), berries, grapes and stone fruit. The other is citrus fruit processing and it involves all citrus fruits (orange, grapefruit, lemon, lime, etc.). More information can be found in Appendix A.

1.4 Potential Hazards in Fruit Juice Concentrates

There are several types of hazards that can exist in fruit juice concentrates. These include physical, microbiological and chemical hazards.

Much of the fruit used for the fruit juice concentrate industry is grown in fields, either close to the ground or in trees. Therefore, extraneous matter, such as sand, grit and debris from the wind can be present on fruit. The process flow charts, presented in Appendix A for the various types for fruit juice concentrates, demonstrate that physical hazards (extraneous matter) are minimized in the production process as multiple levels of washing and, in some cases, inspection will occur.

Microbiological hazards can also exist in fruit. Blemishes and cuts that occur on the surface of fruits as a result of a physical injury is an ideal location for bacterial growth, insects, mould and mildew. Mould can also form during transportation and storage. There are multiple processing steps that can aid in reducing microbiological hazards from fruit when producing fruit juice concentrates. Washing will physically remove surface hazards whereas heating (or high pressure) steps can destroy moulds and bacteria that may have contaminated the inside fruit matrix.

Chemical hazards that originate from fruits in fruit juice concentrates may consist of pesticides, mycotoxins and environmental contaminants (that may include toxic metal species). Others can be introduced during processing and include chemical preservatives and metals from food additives. The deliberate addition of simple sugars or fortification can be considered adulteration of the product if the practice is not declared. However, this practice does not generally represent a health hazard.

Chemical preservatives are on occasion added to fruit juice concentrates and juices, including sodium and potassium salts of sorbic, benzoic and sulphurous acids as well as dimethyl dicarbonate. Sulphur dioxide is typically added to lime and lemon juice concentrates in Europe.

Mycotoxins are a natural toxin produced by fungi and can be very toxic. For example, patulin appears in apples when fungi causes rot. Although the cumulative effects of patulin exposure are not adequately understood, it is believed to be genotoxic. The CFIA

National Chemical Residue Monitoring Program (NCRMP) has historically found patulin in many apple-based products, including apple juice. The CFIA monitors for patulin in apple-products on an annual basis.

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 the fruit used in fruit juice concentrate processing, 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 rate and time and 2) may require sufficient time for residues to deplete to an acceptable level before it is harvested and consumed. More information on pesticide residues in fruit juice concentrates can be found in Section 1.5.

Metals can be used as tools in crop management practices. Metals can also originate from the environment, and through the use of food additives. Unlike synthetic pesticides, metals can be ubiquitous in nature at low levels and can be essential components of living organisms. High levels of certain metals can represent a health hazard. More information on metals in fruit juice concentrates can be found in Section 1.6.

This report will focus on pesticide residues and metals in fruit juice concentrates.

1.5 Pesticides

All fruits are susceptible to pests, including fungi, insects and worms. There are many known pest management programs used to control pests in fruit crops in a variety of countries.

Many of the fruit juices consumed by Canadians and tested in this survey are from tropical fruits. As these crops do not grow in Canada the pest management tools and techniques used in foreign countries are not under the control of the Canadian Government. The resulting residues from these pesticide practices must meet established Canadian Maximum Residue Limits (MRLs) to be legally sold in Canada.

It is important to note that much of the fruit utilized in the production of fruit juice concentrates is grown specifically for this purpose and pesticides used for aesthetic purposes are normally not necessary. Therefore, as fewer pesticides are used on fruit, the fruit juice would have less pesticide residues.

The CFIA is responsible for enforcing the MRLs established by Health Canada's Pest Management Regulatory Agency (PMRA). All new Canadian pesticide MRLs 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 pesticide residue guidelines exist, the general MRL of 0.1 part per million (ppm) applies.

Health Canada must determine if the consumption of the maximum amount of residues (residues expected to remain on food products when a pesticide is applied according to label directions) will not be a concern to human health. This maximum amount of pesticide residues expected is then legally established as a maximum residue limit. Health Canada sets science-based MRLs to ensure that the food Canadians consume is safe. The MRLs are set at levels well below the amount that could pose a health concern. In general, an MRL applies to a raw agricultural food commodity as well as to any processed food product (i.e., fruit juice concentrate) that contains it[9].

1.6 Metals

Metals are essential components for plant life. Unlike organic chemicals, metals are neither created nor destroyed by biological or chemical processes. Metals such as chromium, copper, iron, manganese, selenium and zinc are essential minerals required for good health in humans. While inadequate amounts of an essential mineral in the diet can be detrimental to health, high levels of certain metals may result in toxic effects. Metals of particular concern to human health include arsenic, cadmium, lead and mercury.

Ongoing lead exposure can lead to anaemia, kidney toxicity and may result in damage to the central nervous system and brain. Young children and the developing foetus are most susceptible to lead toxicity. Health effects of mercury exposure will vary depending on the chemical form. Elemental mercury, when inhaled, can cause damage to the respiratory tract, mouth and lungs. Inorganic mercury may cause gastrointestinal and kidney damage. Ongoing exposures to organic mercury compounds, such as methyl mercury, can be detrimental to a child's developing brain and sensory changes are observed in both children and adults. Arsenic is considered a human cancer-causing agent. Ongoing exposure can lead to cardiovascular and circulatory effects[10]. Cadmium exposure (namely inorganic cadmium) can produce health effects on the kidney, stomach and bones. Cadmium may also play a role in human carcinogenesis[11].

In biological systems, metals can be transformed from one ionic species to another; however, harsh conditions are usually required to convert metals between inorganic and organic forms. As discussed, toxic metals, such as mercury, cadmium and arsenic, exist in a number of physico-chemical forms, some of which are highly toxic to human health while others are less toxic to biological processes. The toxicity, bioavailability, bioactivity, transport and impact of the element in the body are determined by the particular element species present in food[12]. Currently, the CFIA has analytical capabilities limited to the determination of total metal species. However, as new research begins to unveil the effects from toxic species of metal elements, more robust and sensitive methods are needed to determine (both qualitatively and quantitatively) metal speciation in food samples.

Fruit juice concentrates may contain metals originating from a variety of sources. Metals can be deliberately added to fruit crops as components of pesticide formulations or as a pesticide itself (i.e., copper). These agricultural chemicals are regulated and monitored in the same way as pesticides. Metals can also be present in fruit juice concentrates as a result of processing or from the addition of food additives. For example, food colours can contain metal species such as aluminum, arsenic, iron, lead, silver and titanium. Processing equipment can also be a source of metals. Tin may leach into fruit juice concentrates that are stored in plated cans (i.e., pineapple juice).

Metals in fruit juice concentrates can result from environmental contamination. The fruit can become contaminated with toxic metals from fertilizers (i.e., cadmium) or from water and soil sources (such as arsenic, cadmium, lead, mercury, etc). Many of these toxic metal species can result from industrial waste and persist in the environment. As a result of these possible metal sources, the presence of metal analytes in fruit juice concentrates is not unexpected.

1.7 Targeted Survey Objective

CFIA's regular monitoring program for chemical residues in foods is the National Chemical Residue Monitoring Program. This program tests for multiple hazards in various commodities including a limited scope of fruit juices and fruit juice concentrates. The fruit juices and concentrates that fall under the NCRMP include frozen concentrated orange juice, apple and grape juice concentrates (and grape juice from concentrate) and nectars (prune, peach, pear and apricot)).

Since many fruit juice concentrates types are not regularly monitored under the NCRMP, there was a need to collect baseline surveillance data for both pesticide residues and metal levels in fruit juice concentrates. Furthermore, most of Canada's fruit juice concentrates are imported, and consumption data indicate that more Canadians are consuming imported products derived from fruit juice concentrates than ever before. Therefore, there is a need to survey all types of imported fruit juice concentrates. The types of fruit juice concentrate selected for the survey were derived from import statistics from the Canada Border Services Agency (CBSA), consumption statistics (Statistics Canada) and through collaboration with the Processed Products section of the CFIA's Agrifood Division.

2 Survey Samples & Analytical Methods

2.1 Targeted Survey Sample Overview

A full description of all juice concentrate samples, including juice type, sample number, origin and sample description can be found in Appendix B.

There were a total of 186 samples collected for the fruit juice concentrate survey from 23 countries. Most of the samples were picked up by CFIA inspectors at importer warehouses and distributors. Generally, the sample consisted of a small amount of liquid from larger holding tanks of concentrated fruit juice.

The distribution of samples with respect to country of origin is depicted in Figure 2-1. The samples were distributed to exporting countries according to import statistics available from the CBSA and consumption statistics from Statistics Canada. The countries chosen for sampling represent 94% of Canada's imported fruit juice concentrates; the United States accounts for 65%. As the United States is the most important exporter of fruit juices to Canada, most of the survey samples were products from the United States, as indicated by the label. It is not possible to determine if in fact all of the juice concentrate ingredients were grown in the United States. This uncertainty exists for all samples collected in the survey.

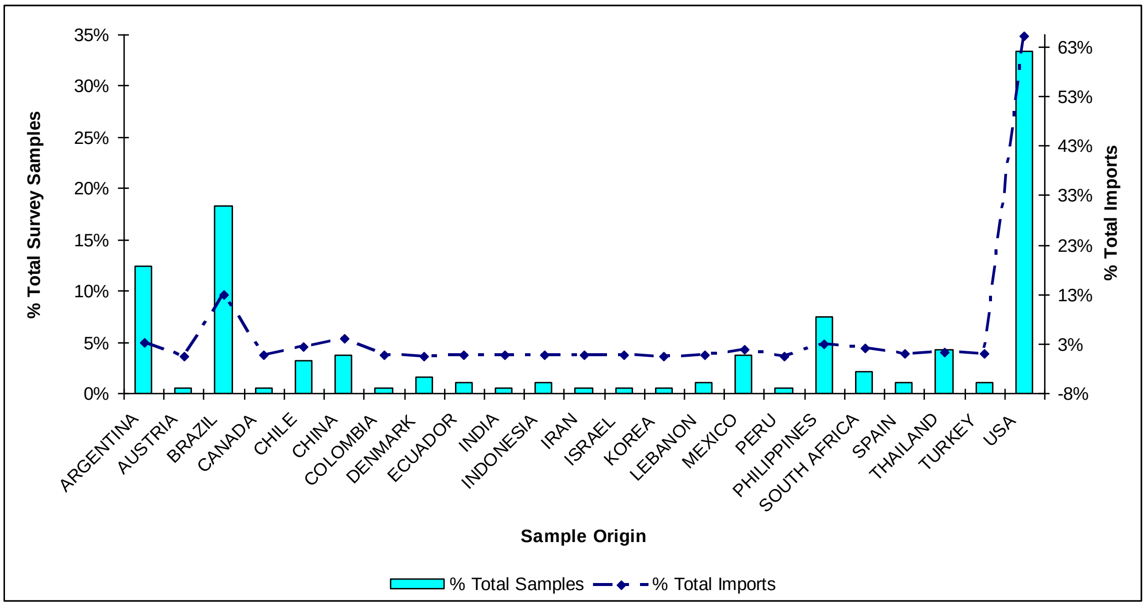


Figure 2-1 Distribution of Samples by Country of Origin

There were a total of 22 different fruit concentrate types collected. More emphasis was put on orange and grape juice concentrates as they are the highest imported fruit juice concentrates in Canada. The number of samples for each fruit juice concentrate type was determined based on import statistics from the CBSA and input from the staff of the Processed Products section of the CFIA. Figure 2-2 is a graphical depiction of sample distribution by concentrate type. The term 'citrus' refers to lime and tangerine. The term 'other' refers to all concentrates from other single fruits.

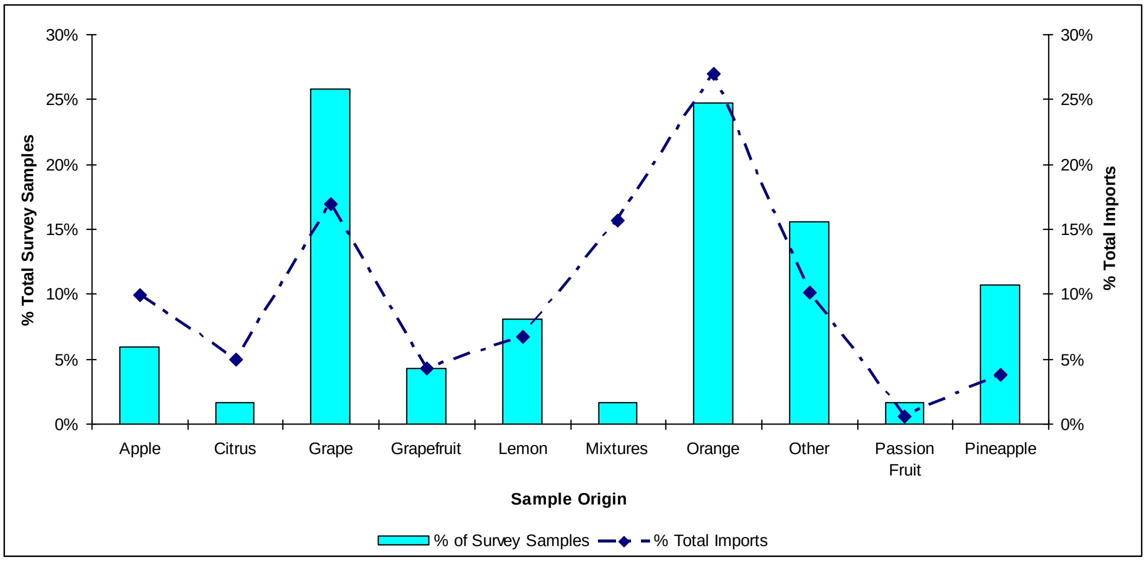


Figure 2-2 Distribution of Samples by Juice Concentrate Types

Although Figure 2-2 illustrates that the 'mixtures' concentrates were under-sampled, the major components of fruit juice concentrates, namely grape, orange, 'other' and pineapple concentrates were either sampled according to the import statistics or were over-sampled. A breakdown of these 'other' fruit concentrate types is illustrated in Figure 2-3.

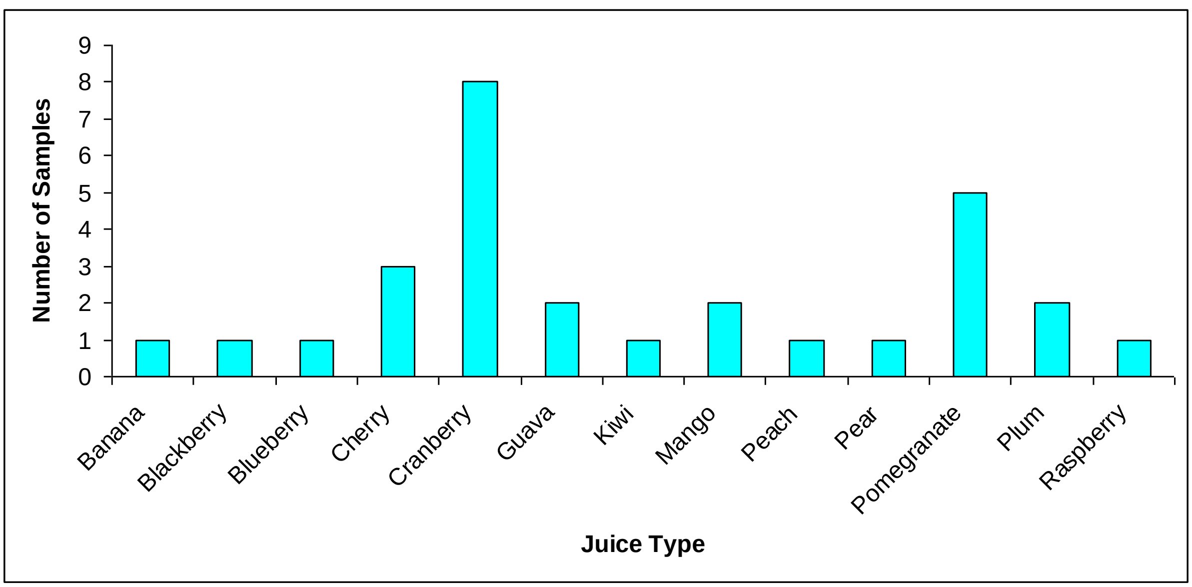


Figure 2-3 Distribution of 'Other' Juice Concentrates

2.2 Survey Limitations

The fruit juice concentrate survey is designed to give a snapshot of the fruit juice concentrate industry. There are a limited number of samples (186 in total) that are used to collect information on fruit juice concentrates as a class of foods. Conclusions regarding sample country of origin cannot be made as it is impossible to establish where the fruit 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. The survey also does not consider the cost of the commodity on the open market.

2.3 Analytical Methods

To analyze the survey samples whose pesticide treatment history is generally unknown, the CFIA laboratories perform analytical methods capable of simultaneously determining a large number of pesticide residues. All of the analyses in the fruit juice concentrate report were analyzed by accredited third party laboratories. 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[13].

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)

There were two analytical tests conducted on all samples in the targeted survey; a method for the determination of pesticides in processed foods by gas chromatography-mass spectrometry (GC-MS) and a method for the analysis of metals in processed foods by inductively-coupled plasma-mass spectrometry (ICP-MS).

2.3.1 Pesticide Residue Analysis

The pesticide method must meet the majority of the requirements of 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)'. The pesticide method can detect for 300 pesticides (consult Appendix C for full list of pesticides included in method). The multi-residue method includes banned pesticides (in Canada), pesticides that have established Canadian MRLs and pesticides that lack MRLs.

2.3.2 Metal Analysis

All samples were analyzed for metals using a third party method that can detect the following 18 metals: aluminum (Al), antimony (Sb), arsenic (As), beryllium (Be), boron (B), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), selenium (Se), tin (Sn), titanium (Ti) and zinc (Zn).

3 Results and Discussion

3.1 Introduction

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

When discussing the results of this study, it is important to remember the origin of the chemical compounds that are being evaluated. The application of pesticides to a food crop is a deliberate action whereas the presence of metals in a food product can be the result of multiple processes such as the direct addition to the food as a food additive or pesticide, from the soil or from other natural exposures (water).

The numerical analytical result values obtained were compared to the applicable standards established by Health Canada at the time of sampling. For the different types of compounds tested, the following documents were used:

- For pesticides, MRLs were 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

- For metals, any applicable entry in the various divisions of the Food and Drug Regulations (FDR)
http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf

Unless otherwise stated, the results in this report are presented in mg/kg (ppm). No distinction was made in the discussion regarding the origin of the chemical tested (i.e., if the food was fortified with minerals and vitamins) as this information was not available for this survey.

3.2 Results for Pesticide Residues

3.2.1 Samples for Pesticide Analysis

The 186 samples (185 imported and one domestic) collected in this study were analyzed with the multi-residue pesticide protocol described in Section 2.2. In total, 55 800 analyses were conducted. There were no Canadian pesticide MRL violations in any of the samples. A non-violative residue is defined as a detectable residue that is at or below the established MRL.

One hundred forty-six samples (78.49%) had no detectable (ND) residues. The following is illustrated in Figure 3-1: 26 samples had one detectable residue, nine samples had two detectable residues, two samples had three detectable residues, one sample had four detectable residues and two samples had five detectable residues.

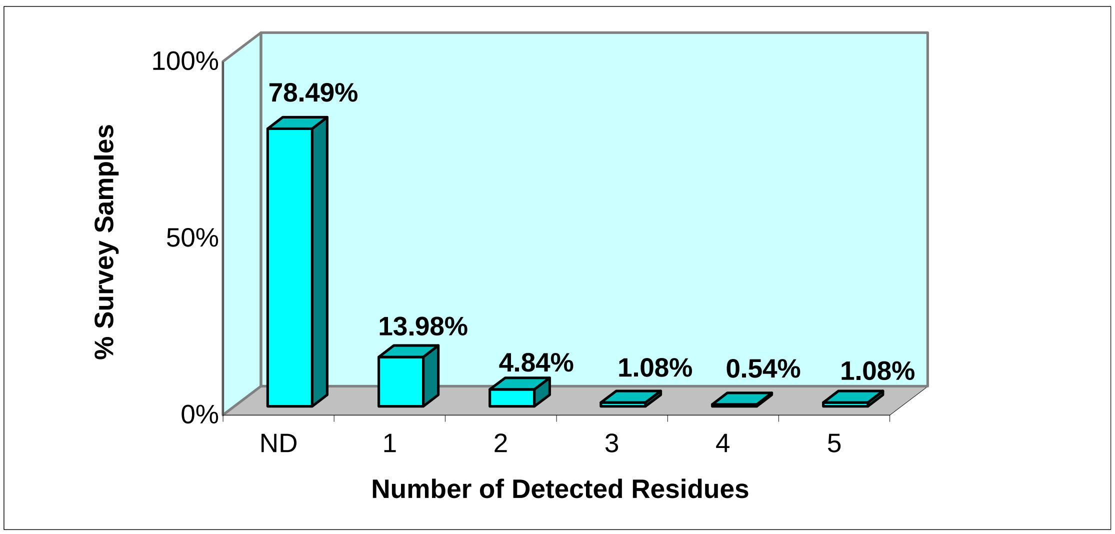


Figure 3-1 Distribution of Samples with Detectable Residues

3.2.2 Residue Distribution by Country of Origin

The fruit juice concentrates targeted survey included samples from 23 countries. Three countries were identified in the planning of the targeted survey as being Canada's top importing countries of fruit juice concentrates: the United States, Brazil and Argentina. Therefore, a large number of samples (64.0%) originate from these countries. A complete list of the detected pesticide residues by sample origin is represented in Table 3-1. The United States, with 62 samples, had 21 (33.9%) samples with detectable residues. There were 10 different pesticide residue species found in these samples. Brazil, with 34 samples, had three (8.8%) samples with detectable residues of dimethoate. Argentina, with 23 samples, had six (26.1%) samples with detectable residues and a total of three different chemical residue species detected. Figure 3-2 illustrates the proportion of samples with detectable residues (positive samples) with respect to samples with no detectable residues (negative samples) by sample origin. Although all samples from Austria, Colombia and Spain had detectable pesticide residues, it should be noted that these findings are based on only one or two samples and should not be considered representative of fruit juice concentrates from these countries.

Table 3-1 Residue Distribution by Sample Origin

Juice Origin	Total Number of Samples	Number of Positive Samples	Number of Negative Samples	% ND	ANALYTE	Number of Detected Analytes
Argentina	23	6	17	73.9%	2-phenylphenol	1
					Captan	2
					Imazalil	4
Austria	1	1	0	0.0%	Captan	1
Brazil	34	3	31	91.2%	Dimethoate	3
Chile	6	3	3	50.0%	Azoxystrobin	1
					Captan	2
					Carbaryl	1
					Cyprodinil	1
					Fludioxonil	1
					Iprodione	2
Colombia	1	1	0	0.0%	Permethrin (Total)	1
					Phosalone	1
					Quintozene	1
					Trifloxystrobin	1
South Africa	4	3	1	25.0%	Bromopropylate	1
					Diphenylamine	1
					Endosulfan Total	1
					Fenbuconazole	1
					Imazalil	1
					Methidathion	1
Spain	2	2	0	0.0%	Carbaryl	1
					Metalaxyl	2
United States	62	21	41	66.1%	2-phenylphenol	3
					Azoxystrobin	2
					Captan	1
					Carbaryl	11
					Chlorpyrifos	2
					Cyprodinil	1
					Iprodione	4
					Myclobutanil	2
					Procymidone	1

3.2.3 Residue Distribution by Juice Concentrate Type

There were 22 types of fruit juice concentrates sampled in the survey. The type entitled 'Mixtures' is considered a fruit juice concentrate mixture of two or more single juice concentrates. Of the 22 different concentrates in the survey, 13 (56.5%) contained at least one detectable pesticide residue. The following fruit juice concentrates had no detectable pesticide residues: guava, kiwi, lime, mango, passion fruit, pear, pineapple, pomegranate and tangerine. The following concentrates had pesticide residues: apple, banana, blueberry, cherry, cranberry, fruit mix, grape, grapefruit, lemon, orange, peach, plum and raspberry. Grape, orange, grapefruit and lemon concentrates had the greatest number of detectable residues; however, these concentrates also represent 69.4% of all the samples in the survey. Figure 3-3 illustrates the proportion of positive samples to negative samples for concentrate types with detected pesticide residues. It should be noted that Figure 3-3 indicates that banana, blueberry, peach and raspberry concentrates have detectable residues in 100% of the samples collected. These results are based on only one sample for each concentrate and should not be considered representative of these fruit juice concentrate types. Table 3-2 lists the residues found in the various types of fruit juice concentrates.

Figure 3-2 Proportion of Positive Samples by Sample Origin

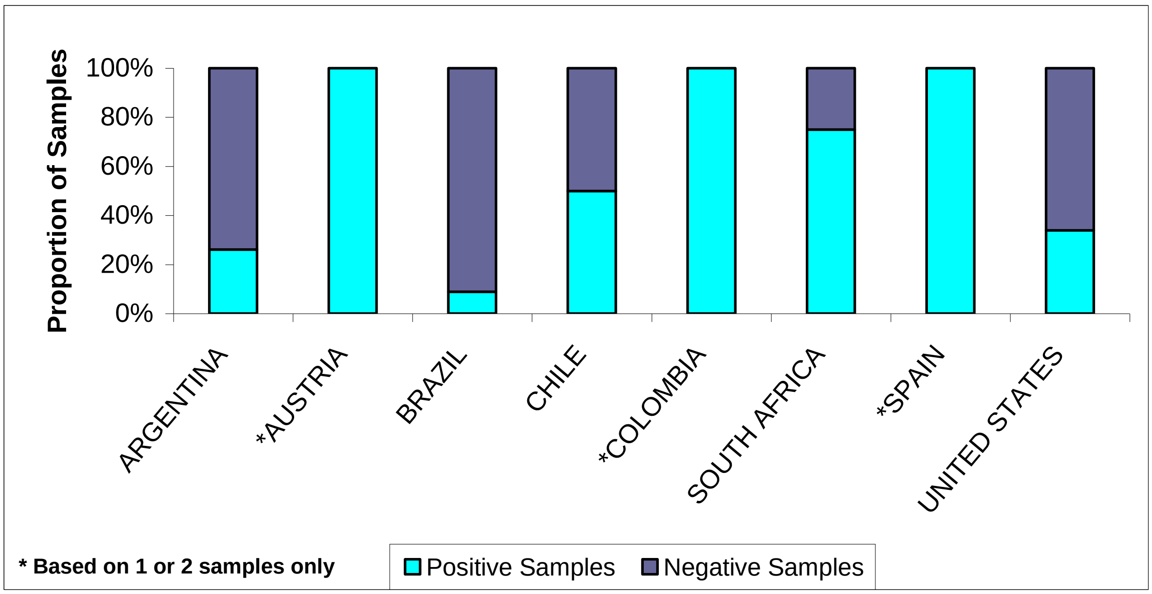


Figure 3-3 Distribution of Positive Samples by Concentrate Type

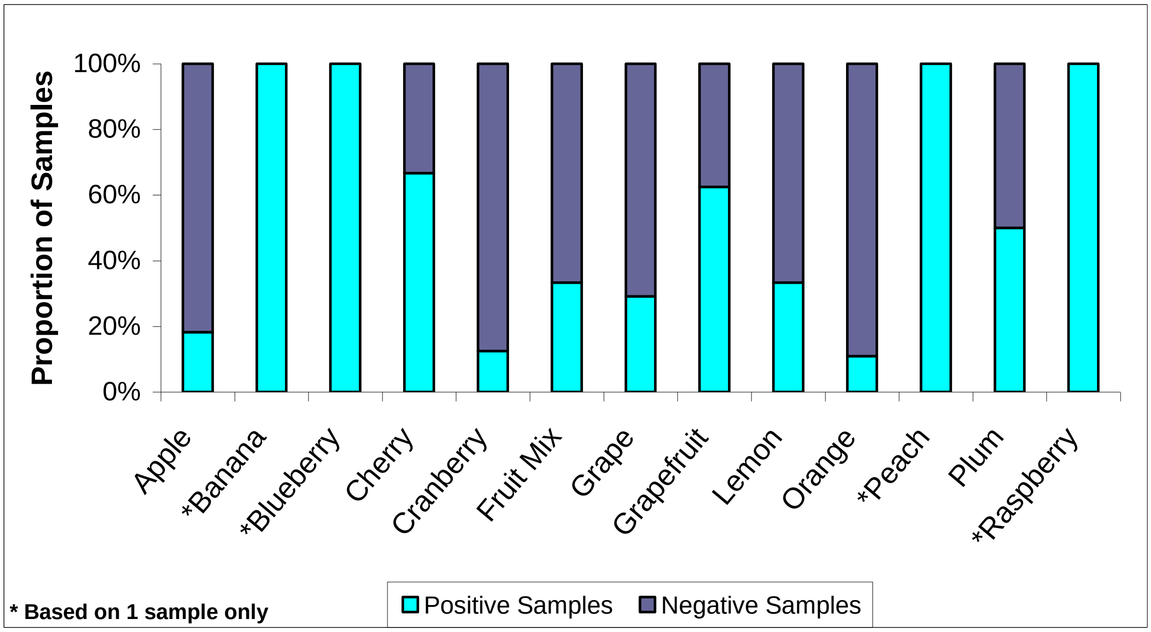


Table 3-2 Nature of Pesticide Residues in Different Fruit Juice Concentrates

Juice Origin	Total Number of Samples	Number of Positive Samples	Number of Negative Samples	% ND	ANALYTE	Number of Detected Analytes
Apple	11	2	9	81.8%	Captan	2
Banana	1	1	0	0.0%	Permethrin (Total)	1
					Phosalone	1
					Quintozene	1
					Trifloxystrobin	1
Blueberry	1	1	0	0.0%	Azoxystrobin	1
					Captan	1
					Carbaryl	1
					Cyprodinil	1
					Iprodione	1
Cherry	3	2	1	33.0%	Azoxystrobin	1
					Carbaryl	1
					Iprodione	1
					Myclobutanil	1
Cranberry	8	1	7	87.5%	Iprodione	1
Mixtures	3	1	2	66.7%	Diphenylamine	1
Grape	48	14	34	70.8%	2-phenylphenol	1
					Azoxystrobin	1
					Captan	2
					Carbaryl	10
					Cyprodinil	1
					Fludioxonil	1
					Imazalil	1
					Iprodione	1
					Metalaxyl	2
					Myclobutanil	1
Grapefruit	8	5	3	37.5%	2-phenylphenol	3
					Imazalil	3
Lemon	15	5	10	66.7%	Bromopropylate	1
					Chlorpyrifos	1
					Imazalil	5
					Methidathion	1
Orange	46	5	41	89.1%	Carbaryl	1
					Chlorpyrifos	1
					Dimethoate	3
					Imazalil	1
Peach	1	1	0	0.0%	Endosulfan Total	1
					Fenbuconazole	1
Plum	2	1	1	50.0%	Captan	1
					Iprodione	1
Raspberry	1	1	0	0.0%	Iprodione	1
					Procymidone	1

3.2.4 Discussion of Specific Pesticide Residue Results

The results of the survey indicate that the overall compliance rate with Canadian pesticide MRLs in fruit juice concentrates was 100%. This is similar to the compliance rates seen in most fresh fruit and processed fruit products sampled in the NCRMP. There were 22 different pesticide residues detected in the survey. Carbaryl was the most commonly detected pesticide residue, found in 13 samples, 10 of which were grape juice concentrates. Imazilil was found in 10 samples, nine of which were citrus fruits (lemon, grapefruit and orange). Captan and iprodione were each found in six samples. These pesticide residues are often detected in fresh fruits sampled in the NCRMP.

Out of a total of 186 samples, 146 samples (78.5%) had no detectable pesticide residues. Forty samples had one or more detectable residue(s). There were a total of 64 positive results; 36 (56.3%) results were lower than their specific MRLs and 28 (43.7%) were lower than the general 0.1 ppm MRL. All of the results are compliant with established regulations.

3.3 Results for Metals

3.3.1 Samples for Metal Analysis

The 186 samples (185 imported and 1 domestic) collected in this study were subjected to the multi-metal laboratory method described in Section 2.2. This method analyzes for 18 metals, including aluminum (Al), antimony (Sb), arsenic (As), beryllium (Be), boron (B), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), selenium (Se), tin (Sn), titanium (Ti) and zinc (Zn).

The results presented below are a measure of the total metal concentration present in the food and do not distinguish between organic and inorganic forms, or ionic species. As such, these results do not provide direct information about the bioavailability or the toxicity of the metal. The metal results do not reveal the potential source (i.e. endogenous versus deliberate addition from pesticide use or food additive, etc). Nevertheless, the results obtained in this case study may be used to estimate metal levels in fruit juice concentrates and to identify any existing patterns.

All the survey samples had detectable levels of metal elements. The following section provides a discussion of the metal results by sample origin and fruit juice concentrate type.

3.3.2 Discussion of Metals by Country and Fruit Juice Concentrate Type

An important calculation was performed on the data before evaluating metal levels in the juice concentrate samples. As most products in this survey are juice concentrates, the metal levels detected represent what is present in the un-diluted form of the product. When metal levels exceeded acceptable levels in the concentrates, appropriate dilution factors were used to determine the expected metal concentration in the single-strength product. In order to estimate the metal levels in the ready-to-serve (single-strength) juices consumed by Canadians, Brix factors were obtained from the juice concentrate importer.

There were samples from 23 countries in the fruit juice concentrate survey. A list of detected metals by sample origin is presented in Appendix D. There were 22 fruit juice concentrate types in the survey. A list of detected metals by concentrate is available in Appendix E. Note that the metal results are reported for the concentrated 'as sold' product, and not on the single-strength basis that may have been used to assess the acceptability of the levels found. A brief discussion of the results follows.

Aluminum

Aluminum is an element that can be present naturally in the foods consumed by Canadians. It is commonly used in food processing as a firming agent, anti-caking agent, stabilizer, food colour, etc. The *Food and Drug Regulations* (FDR) specify the levels of aluminum that are permitted in food when used as a food additive. This survey does not explore the source of the aluminum present (i.e. whether the source is natural, from pesticide use or from food processing). There were 171 (91.9%) samples with detectable amounts of aluminum. The level of aluminum observed in this survey ranged from 0.103 ppm to 33.05 ppm. None of the fruit juice concentrates had levels of aluminum that exceeded levels acceptable in Canada. There were no specific patterns observed for aluminum with respect to country of origin or juice concentrate type.

Antimony

Antimony is a rare and non-essential metal. There are no Canadian tolerances or guidelines established for antimony in foods. However, antimony can be present in titanium dioxide. A 50 ppm tolerance for antimony is established in titanium dioxide when used in food colours. Of the 186 survey samples, nine had detectable levels of antimony. The levels ranged from 0.03 ppm to 0.239 ppm. There were no specific patterns observed for antimony with respect to country of origin or juice concentrate type.

Arsenic

The levels of arsenic allowed in foods are specified in Table I of Division 15 of the FDR. In addition, a 3 ppm arsenic tolerance exists for food colours. Out of 134 samples with detectable levels of arsenic, 24 fruit juice concentrates exceeded the arsenic tolerance for fruit juice (0.1 ppm). Arsenic is a natural element present in certain foods such as apple and pear seeds. It can also be a component of arsenic-containing fungicides. Upon considering the expected single-strength concentration of arsenic of these juice concentrate products, all samples were in compliance with Canadian regulations and are therefore considered safe. The 24 elevated arsenic samples originated from Argentina (n=6), Chile (n=1) and the United States (n=17). Arsenic levels exceeded the tolerance in the following concentrates: grape (n=15), cranberry (n=5), cherry (n=3) and blueberry (n=1).

Beryllium

Beryllium is a relatively rare element and is not known to be necessary for either plant or animal life. There are no Canadian tolerances or guidelines established for beryllium in food. Of the 186 survey samples, one had a detectable level of beryllium (raspberry concentrate from the USA (0.036 ppm)).

Boron

There are no established Canadian tolerances or guidelines for boron in food. Boron is a natural element and ubiquitous in nature. It is found in most commodities and is reportedly being used (as boric acid) on whole fruit as a fungicide[14]. All 186 samples had detectable levels of boron.

Boric acid deposits on fruit resulting from its use as an agricultural compound may degrade to elemental boron. Given the natural levels of boric acid and boron occurring in the plant, elemental boron from agricultural chemical use would be indistinguishable from background levels. It is naturally present in crops such as pome fruit, stone fruit and grapes[14].

The levels of boron in the juice concentrates ranged from 0.137 ppm to 54.94 ppm. A total of 107 concentrate results had higher than expected levels of boron when compared to boron levels from food products in the NCRMP (20 ppm). After calculating the levels of boron for the expected single-strength products, all of the concentrate samples had boron results similar to those observed in the NCRMP. Boron and boric acid are of low toxicity and levels reported after considering the dilution factors would not pose a human health risk.

Cadmium

There are no Canadian tolerances or guidelines established for cadmium in food. There were 74 samples with detectable amounts of cadmium ranging from 0.0021 ppm to 0.0896 ppm. The levels observed are very low and do not represent a health risk to humans. These levels of cadmium likely stem from natural components of fruit juices or environmental sources. There were no specific patterns observed for cadmium with respect to country of origin or juice concentrate type.

Chromium

Chromium is an essential mineral in the human diet. There are no Canadian tolerances or guideline levels for chromium in food. There were 175 samples that had detectable levels of chromium, ranging from 0.01 ppm to 0.426 ppm. The detected levels of chromium in the fruit juice concentrate survey are similar to the levels found in the NCRMP and likely originate from natural components of fruit juices. There were no specific patterns observed for chromium with respect to country of origin or juice concentrate type.

Copper

Most of the samples (183 of 186) had detectable amounts of copper ranging from 0.033 ppm to 14.42 ppm. Copper can be used as a fungicide. A MRL of 50 ppm has been established for copper compounds in all fresh fruits and vegetables. This MRL also applies to processed foods derived from treated crops, such as fruit juice concentrates. All of the products were in compliance with the Canadian MRL. In general, grape fruit juice concentrates had lower amounts of copper than did other concentrates.

Iron

There are no Canadian tolerances or guidelines for iron in food. All 186 samples had detectable amounts of iron, ranging from 0.341 ppm to 55.54 ppm. Iron is a natural component of most living organisms and is an essential nutrient in the human diet. There were no specific patterns observed for iron with respect to country of origin or juice concentrate type.

Lead

Lead exposure may result from a number of environmental and food sources. There are several tolerances and guidelines for lead in food that are found in Division 15 of the FDR. A tolerance of 0.2 ppm exists for fruit juice and fruit nectar. In addition, a 10 ppm tolerance for lead is established for food colours. Of the 186 survey samples, 117 (63%) had detectable levels of lead, ranging from 0.002 ppm to 0.232 ppm. One black cherry juice concentrate from the USA had a lead level of 0.232 ppm, which exceeds the Canadian tolerance for fruit juice. However, when considering the lead concentration in the single-strength product, the product does not exceed the tolerance for lead and is therefore considered safe. There were no specific patterns observed for lead with respect to country of origin or juice concentrate type.

Manganese

Manganese is an essential trace mineral in the human diet. At present, there are no Canadian tolerances or guidelines for manganese in foods. All but one sample had detectable levels of manganese. The levels ranged from 0.04 ppm to 177.2 ppm.

There were 19 fruit juice concentrates that had exceedingly high levels of manganese not generally observed in products in the NCRMP. The sample origins included India (n=2), the Philippines (n=5), Thailand (n=8) and the United States (n=4). The concentrates with higher amounts of manganese were pineapple (n=15) and one each for blueberry, grape, blackberry and raspberry.

Manganese is a major nutrient of pineapple. There is also evidence that manganese has been applied as a foliar spray in Thailand to help molybdenum uptake which in part helps lower the level of nitrates in pineapple. A high level of nitrate in pineapple is a serious quality problem for canneries as excess nitrate causes tin to deteriorate[15]. This application strategy, along with the pineapple's ability to uptake large amounts of manganese, may explain why higher than expected levels are being found in Thai pineapple juice concentrates. These levels have been assessed by Health Canada and are unlikely to pose a health risk to Canadians.

Mercury

None of the samples tested as part of this targeted survey had detectable levels of mercury.

Molybdenum

Molybdenum is an essential trace element in the human diet. There are no Canadian tolerances or guidelines established for molybdenum in foods. Of the 186 survey samples, 122 had detectable levels of molybdenum. The levels ranged from 0.020 ppm to 1.147 ppm. There were no specific patterns observed for molybdenum with respect to country of origin or juice concentrate type.

Nickel

Sources of nickel in fruit juice concentrates can include food processing equipment and environmental contamination. There are presently no Canadian tolerances or guidelines for nickel in food. Of the 186 survey samples, 183 had detectable levels of nickel, ranging from 0.01 ppm to 1.831 ppm. There were no specific patterns observed for nickel with respect to country of origin or juice concentrate type.

Selenium

Selenium is an essential trace element in the human diet. There are presently no Canadian tolerances or guidelines for selenium in foods. Eleven samples (6%) had detectable levels of selenium. The levels ranged from 0.021 ppm to 0.143 ppm. There were no specific patterns observed for selenium with respect to country of origin or juice concentrate type.

Tin

Tin is a major component in canning materials. The tolerance for tin in canned foods is 250 ppm. Most of the survey samples were either sold as concentrates in consumer-sized cans or as large metal drums destined for juice manufacturing companies. The level of tin ranged from 0.02 ppm to 92.88 ppm. The highest tin levels were found in pineapple juice concentrates from the Philippines. This may be explained by the background levels of nitrates in pineapple, which may accelerate degradation of can walls and result in the release of tin. All of the samples were in compliance with the Canadian tolerance for tin.

Titanium

There are presently no Canadian tolerances for titanium in foods. However, titanium dioxide is a component of food colours that can be used in food according to Good Manufacturing Practice (GMP). There were 174 samples that had detectable levels of titanium. The levels ranged from 0.106 ppm to 3.621 ppm. There were no specific patterns observed for titanium with respect to country of origin or juice concentrate type.

Zinc

Zinc is an essential trace element in the human diet. There are no Canadian tolerances or guidelines established for zinc in foods. Of the 186 survey samples, 184 had detectable levels of zinc. The levels ranged from 0.11 ppm to 12.16 ppm. There were no specific patterns observed for zinc with respect to country of origin or juice concentrate type.

4 Conclusions

The fruit juice concentrates targeted survey included 22 different fruit juice concentrates from 23 countries. The design of the survey does not provide a statistically robust data set. However, the results obtained can provide a snapshot of the fruit juice industry as a whole.

The majority of the samples (78.5%) were found to contain no detectable pesticide residues and all samples were in compliance with Canadian pesticide MRLs. These results are expected for fruit juice concentrates as it is anticipated that fewer pesticides are used on fruit intended for juice. Furthermore, processing (washing, heating, etc) may also remove or deplete pesticide residues.

All 186 survey samples contained one or more metals. Metals can be natural components of biological processes, can result from environmental contamination, nutritional fortification or arise from food processing and food packaging. It is therefore not unexpected to find low levels of metals in fruit juice concentrates. All of the 186 samples were in compliance with existing Canadian metal MRLs and tolerances. Mercury was not detected in any of the samples. All other metals were present at low concentrations that do not pose a human health risk.

5 Future Considerations

All 186 fruit juice concentrate samples were 100% compliant with Canadian standards for pesticide residues and metals. As the number of samples (186) was small, this does not represent a statistically relevant data set, but rather provides a snapshot of the industry.

A future pesticide and metal survey on fruit juice concentrates will help address the following concerns:

- Increase the number of samples to obtain a statistically-relevant data set (300 minimum);

- Identify trends (i.e. a wet year may lead to a higher number of fungicide residues or increase in levels of heavy metals due to land water contamination, etc)

- Increase the scope of analysis by incorporating a second pesticide multi-residue screen and new metal speciation methods (developed by the CFIA laboratories in 2009 and now fully validated and available);

- Focus on fruit juice concentrate types and countries with increased incidence of pesticide residues to ensure continued compliance.

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Appendix A

Types of Fruit Juice Concentrate Processing

Fruit juice processing can be broken down into two different processing technologies. The first is soft fruit processing, and includes pome fruits (apples, pears), berries, grapes and stone fruit. The other is citrus fruit processing and it involves all citrus fruits (orange, grapefruit, lemon, lime, etc.). The following information, unless otherwise indicated, was adapted from Ashurst et al., 2007.

<u>Soft Fruit Processing</u>

Juice processing requires that fruit be free from contaminants or any major damage. For example, damage to apples may be caused by mechanical harvesting, which often results in bruising and abrasions. Other fruits, like berries, are typically picked by hand. Fruit that is chosen for juicing must be thoroughly inspected for damage and washed before processing. Following washing, the majority of fruits are processed by milling, which is a technique that crushes the whole fruit and then squeezes the juice from the resulting mass[16]. The pits from stone fruits are removed in a subsequent processing step. Prior to the milling process, some preparations may be required, such as the de-stemming of grapes. Exotic soft fruits are not milled and undergo special procedures for initial processing.

The hammermill is the most commonly used tool for milling in North America. A hammermill consists of free-swinging hammers that crush fruit by forcing it through a screen. There are different hammers used depending on the desired function. Sharp hammers are used for chopping some fruits, while blunt hammers are required to grind and crush others.

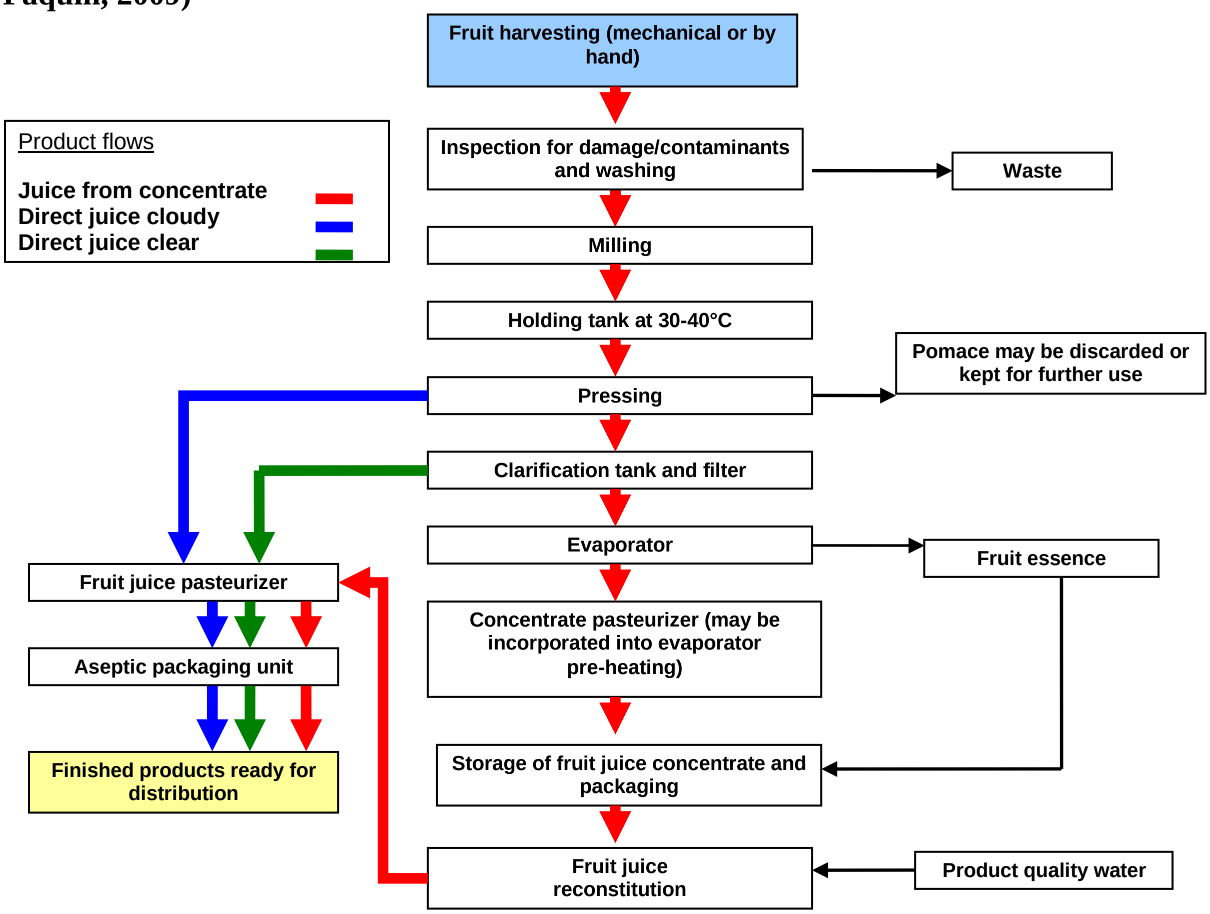
Enzymatic processing is an important factor in the preparation of fruit juices. If fruits are not easily juiced (e.g. pome fruits), pectinolytic enzymes may be used to break down their cell structure. Pectinolytic enzymes improve the extraction efficiency of juicing by degrading pectin, which is an element of the fruit cell wall. Enzyme treatment is also used to maintain the quality of berry-derived juices by preventing changes to cell structure during long-term storage. Fruits that undergo enzymatic processing are mixed with pectinolytic enzymes and then heated for 1-2 hours. Other fruit processing techniques may also be utilized, including fruit presses (e.g. Stoll Press, Belt Press) and press aids (e.g. fibrous materials like coarse wood flour, wood pulp and rice hulls).

Fruit juice can be concentrated from soft fruit using evaporators, which allow for the recovery of volatile materials (fruit essence). A classic evaporator that is used in the fruit processing industry is the falling film vacuum plate evaporator with plate-and-frame heat exchangers. This type of evaporator is particularly useful for heat-sensitive fruit juices because it has limited heat contact time and minimizes juice loss. Another type of evaporator that may be used for fruit processing is the centrifugal evaporator. Following evaporation, fruit essences are collected by fractional distillation. On average, fruit essence has a flavour that is over a 100-fold more concentrated than the original juice. Essences tend to be stored separately from bulk concentrates and are added to products prior to retail. The addition of a fruit essence to a product can recover and strengthen the natural flavour that may have been lost or diminished during processing.

A clarification process is used for certain fruit juices, like apple juice, to allow juices to be sold as translucent products. Polyphenol oxidation is prevented in juices following the addition of ascorbic acid and pasteurization. Polyphenol oxidation causes browning of juices and contributes to the formation of pulp. As was previously mentioned, pectinolytic enzymes are added to some juices to facilitate juicing. These enzymes are also used to prevent the subsequent precipitation of pectin, which contributes to the cloudy appearance of juices. In addition, gelatin may be added to fruit juices to prevent tannin precipitation.

An overview of soft fruit processing is depicted in Figure A-1.

Figure A-1: Outline of Typical Process for Soft Fruit Processing (Adapted from Paquin, 2009)



Citrus Fruit Processing

Prior to processing, citrus fruits intended for juicing may be inspected for minimum standards of °Brix (a measurement of dissolved sugar-to-water mass ratio) and acidity. Debris and microorganisms on the fruit peel are removed by washing, sometimes with the use of detergents. Potentially harmful fruits are removed by graders as the fruit is conveyed into extractors. Fruits that grow in various sizes, like oranges, are sorted automatically before entering the extractors. Extractors are used to squeeze the juice and peel oil out of citrus fruits and generally consist of cups with sharp-edged metal tubes and metal fingers that intermesh. A piston is used to push the juice through small openings of the tube walls.

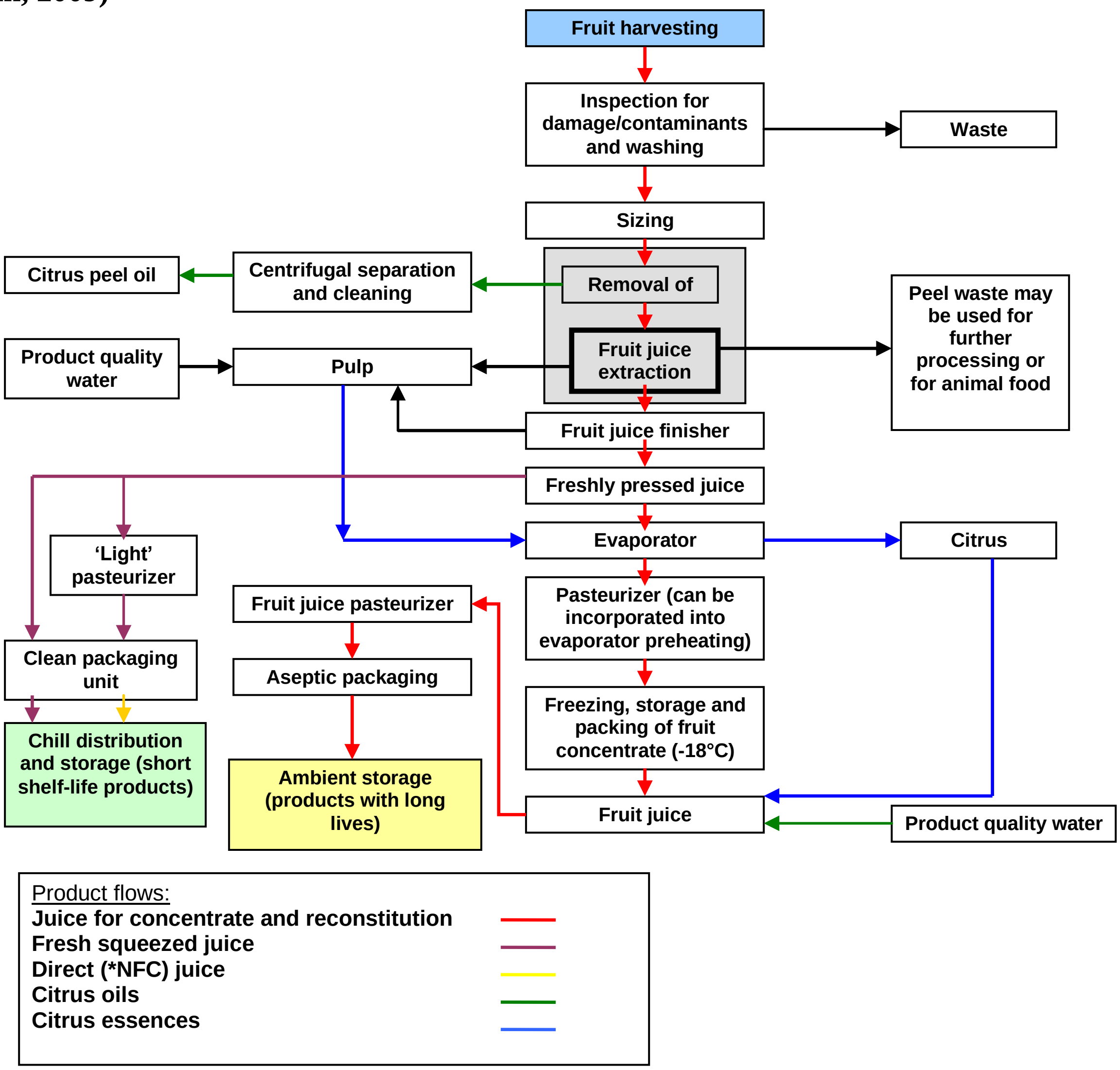
Ideally, there should be minimal interaction between the juice and the peel waste during extraction. This prevents the transfer of any bitter substances present in the peel or seeds into the juice. The amount of pulp extracted from the fruit is controlled by downstream separation in the finisher. The pulp is then washed several times to produce a solution. The pulp solution may be added back into the juice or may be concentrated to produce pulp wash solids that are used as a base for cloudy beverages.

Certain substances, such as grapefruit juice, pulp wash solids and limonin (a white crystalline substance found in orange and grapefruit seeds) can be extremely bitter to taste. A commercial process has been developed to decrease the level of bitterness in these juices. Firstly, pulp is separated from juice using centrifugation techniques followed by passing juice through resin-packed columns that selectively remove bitter compounds. Pulp is then recombined with the de-bittered juice before being concentrated in the evaporator.

The majority of orange and grapefruit juice is imported into Canada as frozen concentrates with °Brix measures of 60-65, representing a 5- to 6- fold concentrated product. Citrus juices tend to be concentrated in Thermally Accelerated Short-Time Evaporators (TASTE). These types of concentrators show many similarities to the falling film evaporators used in soft fruit processing. However, they differ in that they are designed for efficient removal of water for each kilogram of steam used for evaporation. The concentrated juice is then released, where it is flash-cooled under vacuum. Bulk vessels that hold up to 500 000 L are used to store the concentrates at -10°C. The fruit essences are typically evaporated along with water, but are recovered in separate condensation units and then are sold separately.

Some countries, including Japan, use reverse osmosis (RO) to concentrate fruit juices. RO works by forcing a fruit solution through a membrane using pressure, which retains the concentrated juice on one side and allows the excess water to pass to the other side. Similar to other methods, the pulp is first separated from the juice extract, but is then recombined with the concentrated extract following RO at 10°C. Reverse osmosis produces a less concentrated juice essence than evaporation techniques (only 42-51 °Brix), but the juice is generally regarded as tasting far superior to traditional citrus juice from concentrate. This is due to the low-thermal process of reverse osmosis, which allows flavour to be retained in citrus fruit essence. An overview of citrus fruit processing is depicted in Figure A-2.

Figure A-2: Outline of Typical Process for Citrus Fruit Processing (Adapted from Paquin, 2009)



*NFC = Not from concentrate

Appendix B

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

Table B-1 Fruit juice concentrate samples included in targeted survey

Concentrate Type	Sample Number	Origin	Sample Description
Apple	FSAP8-00122X	CHILE	APPLE JUICE CONCENTRATE
	FSAP8-02189	AUSTRIA	APPLE JUICE CONCENTRATE
	FSAP8-02257	CHINA, PEOPLE'S REPUBLIC	APPLE JUICE CONCENTRATE
	FSAP8-02266	SOUTH AFRICA	APPLE JUICE CONCENTRATE
	FSAP8-02270	CHINA, PEOPLE'S REPUBLIC	APPLE JUICE CONCENTRATE
	FSAP8-02277	CHILE	APPLE JUICE CONCENTRATE
	FSAP8-02278	BRAZIL	APPLE JUICE CONCENTRATE
	FSAP8-02280	CHINA, PEOPLE'S REPUBLIC	APPLE JUICE CONCENTRATE
	FSAP8-02284	BRAZIL	APPLE JUICE CONCENTRATE
	FSAP8-02285	CHINA, PEOPLE'S REPUBLIC	APPLE JUICE CONCENTRATE
	FSAP8-02292	CHINA, PEOPLE'S REPUBLIC	APPLE JUICE CONCENTRATE
Banana	FSAP8-02175	COLOMBIA	BANANA JUICE CONCENTRATE
Blackberry	FSAP8-02157	UNITED STATES	BLACKBERRY JUICE CONCENTRATE
Blueberry	FSAP8-02289	UNITED STATES	BLUEBERRY JUICE CONCENTRATE
Cherry	FSAP8-02276	UNITED STATES	CHERRY JUICE CONCENTRATE
	FSAP8-02288	UNITED STATES	CHERRY JUICE CONCENTRATE
	FSAP8-02300	UNITED STATES	BLACK CHERRY JUICE CONCENTRATE
Cranberry	FSAP8-02034	UNITED STATES	CRANBERRY JUICE CONCENTRATE
	FSAP8-02039X	UNITED STATES	CRANBERRY JUICE CONCENTRATE
	FSAP8-02152	UNITED STATES	CRANBERRY JUICE CONCENTRATE
	FSAP8-02154	UNITED STATES	CRANBERRY JUICE CONCENTRATE
	FSAP8-02161	UNITED STATES	CRANBERRY JUICE CONCENTRATE
	FSAP8-02162	UNITED STATES	CRANBERRY JUICE CONCENTRATE
	FSAP8-02183	CHILE	CRANBERRY JUICE

Concentrate Type	Sample Number	Origin	Sample Description
			CONCENTRATE
	FSAP8-02185	UNITED STATES	CRANBERRY JUICE CONCENTRATE
Grape	FSAP8-02011	ARGENTINA	WHITE GRAPE JUICE CONCENTRATE
	FSAP8-02023	CANADA	GRAPE JUICE
	FSAP8-02031	UNITED STATES	GRAPE JUICE FROM CONCENTRATE
	FSAP8-02032	UNITED STATES	GRAPE JUICE
	FSAP8-02033	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02035	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02040	UNITED STATES	WHITE GRAPE JUICE CONCENTRATE
	FSAP8-02041	UNITED STATES	RED GRAPE JUICE CONCENTRATE
	FSAP8-02042	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02044	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02045	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02046	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02047	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02047X	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02116	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02117	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02118	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02119	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02120	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02121	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02122	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02123	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02124	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02125	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02126	SPAIN	GRAPE JUICE CONCENTRATE
	FSAP8-02127	SPAIN	GRAPE JUICE CONCENTRATE
	FSAP8-02128	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02129	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02130	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02137	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02139	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02140	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02141	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02163	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02171	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02172	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02186	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02193	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02241	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02241X	ARGENTINA	GRAPE JUICE CONCENTRATE

Concentrate Type	Sample Number	Origin	Sample Description
	FSAP8-02259	LEBANON	GRAPE JUICE CONCENTRATE
	FSAP8-02262	MEXICO	GRAPE JUICE CONCENTRATE
	FSAP8-02263	CHILE	GRAPE JUICE CONCENTRATE
	FSAP8-02267	MEXICO	GRAPE JUICE CONCENTRATE
	FSAP8-02279	ARGENTINA	GRAPE JUICE CONCENTRATE
	FSAP8-02286	MEXICO	GRAPE JUICE CONCENTRATE
	FSAP8-02287	UNITED STATES	GRAPE JUICE CONCENTRATE
	FSAP8-02290	UNITED STATES	GRAPE JUICE CONCENTRATE
Grapefruit	FSAP8-02030	UNITED STATES	GRAPEFRUIT JUICE CONCENTRATE
	FSAP8-02053	ARGENTINA	GRAPEFRUIT JUICE CONCENTRATE
	FSAP8-02153	UNITED STATES	GRAPEFRUIT JUICE CONCENTRATE
	FSAP8-02155	UNITED STATES	GRAPEFRUIT JUICE CONCENTRATE
	FSAP8-02156	UNITED STATES	GRAPEFRUIT JUICE CONCENTRATE
	FSAP8-02158	UNITED STATES	GRAPEFRUIT JUICE CONCENTRATE
	FSAP8-02159	UNITED STATES	GRAPEFRUIT JUICE CONCENTRATE
	FSAP8-02195	UNITED STATES	GRAPEFRUIT JUICE CONCENTRATE
Guava	FSAP8-02067	BRAZIL	GUAVA PUREE
	FSAP8-02176	UNITED STATES	GUAVA JUICE CONCENTRATE
Kiwi	FSAP8-02229	CHILE	KIWI JUICE CONCENTRATE
Lemon	FSAP8-02026	PHILIPPINES	LEMON JUICE CONCENTRATE
	FSAP8-02027	UNITED STATES	LEMON JUICE CONCENTRATE
	FSAP8-02028	INDIA	LEMON JUICE
	FSAP8-02039	UNITED STATES	LEMON JUICE CONCENTRATE
	FSAP8-02048	ARGENTINA	LEMON JUICE CONCENTRATE
	FSAP8-02051	ARGENTINA	LEMON JUICE CONCENTRATE
	FSAP8-02052	ARGENTINA	LEMON JUICE CONCENTRATE
	FSAP8-02054	ARGENTINA	LEMON JUICE CONCENTRATE
	FSAP8-02056	ARGENTINA	LEMON JUICE CONCENTRATE
	FSAP8-02114	ARGENTINA	LEMON JUICE CONCENTRATE
	FSAP8-02115	SOUTH AFRICA	LEMON JUICE CONCENTRATE
	FSAP8-02174	ARGENTINA	LEMON JUICE CONCENTRATE
	FSAP8-02243	MEXICO	LEMON JUICE CONCENTRATE
	FSAP8-02281	MEXICO	LEMON JUICE CONCENTRATE
	FSAP8-02282	ARGENTINA	LEMON JUICE CONCENTRATE
Lime	FSAP8-02066	BRAZIL	LIME JUICE CONCENTRATE

Concentrate Type	Sample Number	Origin	Sample Description
	FSAP8-02184	PERU	LIME JUICE CONCENTRATE
Mango	FSAP8-02017	PHILIPPINES	MANGO JUICE
	FSAP8-02271	BRAZIL	MANGO JUICE CONCENTRATE
Orange	FSAP8-02015	PHILIPPINES	ORANGE JUICE CONCENTRATE
	FSAP8-02016	DENMARK	ORANGE JUICE CONCENTRATE
	FSAP8-02018	DENMARK	ORANGE JUICE CONCENTRATE
	FSAP8-02019	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02020	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02021	DENMARK	ORANGE JUICE CONCENTRATE
	FSAP8-02022	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02029	KOREA, REPUBLIC OF	MANDARIN ORANGE JUICE
	FSAP8-02037	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02038	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02057	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02058	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02059	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02060	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02061	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02062	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02063	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02065	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02068	BRAZIL	ORANGE JUICE
	FSAP8-02069	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02070	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02071	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02072	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02122X	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02182	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02187	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02194	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02206	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02207	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02208	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02209	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02226	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02227	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02228	UNITED STATES	ORANGE JUICE CONCENTRATE
	FSAP8-02230	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02231	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02244	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02245	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02247	CHINA, PEOPLE'S REPUBLIC	ORANGE JUICE CONCENTRATE
	FSAP8-02247X	CHINA, PEOPLE'S REPUBLIC	ORANGE JUICE CONCENTRATE

Concentrate Type	Sample Number	Origin	Sample Description
	FSAP8-02248	MEXICO	ORANGE JUICE CONCENTRATE
	FSAP8-02249	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02250	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02293	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02294	BRAZIL	ORANGE JUICE CONCENTRATE
	FSAP8-02299	BRAZIL	ORANGE JUICE CONCENTRATE
Passion Fruit	FSAP8-02012	BRAZIL	PASSION FRT JUICE CONCENTRATE
	FSAP8-02255	ECUADOR	PASSION FRUIT JUICE CONCENTRATE
	FSAP8-02264	ECUADOR	PASSION FRUIT JUICE CONCENTRATE
Peach	FSAP8-02275	SOUTH AFRICA	PEACH JUICE CONCENTRATE
Pear	FSAP8-02274	ARGENTINA	PEAR JUICE CONCENTRATE
Pineapple	FSAP8-02003	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02004	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02005	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02006	THAILAND	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02007	PHILIPPINES	PINEAPPLE JUICE
	FSAP8-02008	THAILAND	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02009	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02010	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02013	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02013B	PHILIPPINES	PINEAPPLE JUICE
	FSAP8-02014	THAILAND	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02089	INDONESIA	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02109	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02110X	THAILAND	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02111	THAILAND	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02173	THAILAND	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02242	THAILAND	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02256	PHILIPPINES	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02265	INDONESIA	PINEAPPLE JUICE CONCENTRATE
	FSAP8-02268	THAILAND	PINEAPPLE JUICE CONCENTRATE
Plum	FSAP8-02192	UNITED STATES	PLUM JUICE CONCENTRATE
	FSAP8-02273	CHILE	PLUM JUICE CONCENTRATE
Pomegranate	FSAP8-02001	ISRAEL	POMEGRANATE JUICE
	FSAP8-02151	UNITED STATES	POMEGRANATE JUICE CONCENTRATE
	FSAP8-02258	LEBANON	POMEGRANATE JUICE CONCENTRATE

Concentrate Type	Sample Number	Origin	Sample Description
	FSAP8-02269	TURKEY	POMEGRANATE JUICE CONCENTRATE
	FSAP8-02272	IRAN	POMEGRANATE JUICE CONCENTRATE
Raspberry	FSAP8-02160	UNITED STATES	RASPBERRY JUICE CONCENTRATE
Tangerine	FSAP8-02283	MEXICO	TANGERINE JUICE CONCENTRATE
Fruit Mix	FSAP8-02002	TURKEY	APPLE/POMEGRANATE JUICE
	FSAP8-02025	PHILIPPINES	TROPICAL FRUIT JUICE
	FSAP8-02191	SOUTH AFRICA	FRUIT JUICE

Appendix C

Table C-1: List of pesticides (300) included in third party method (Method for the Determination of Pesticides in Processed Foods and Animal Derived Foods)

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

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

Appendix D

Table D-1: Metal analysis results in the concentrated sample by sample origin

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Aluminum						
ARGENTINA	23	3	20	20.380	0.126	3.783
AUSTRIA	1	0	1	4.003	4.003	4.003
BRAZIL	34	0	34	4.305	0.179	0.776
CANADA	1	0	1	0.337	0.337	0.337
CHILE	6	0	6	18.930	0.341	5.430
CHINA, PEOPLE'S REPUBLIC	7	0	7	1.220	0.115	0.757
COLOMBIA	1	0	1	0.115	0.115	0.115
DENMARK	3	0	3	0.411	0.184	0.332
ECUADOR	2	0	2	0.497	0.269	0.383
INDIA	1	0	1	12.550	12.550	12.550
INDONESIA	2	0	2	1.152	0.981	1.067
IRAN	1	0	1	3.338	3.338	3.338
ISRAEL	1	0	1	1.730	1.730	1.730
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	0	2	4.418	3.009	3.714
MEXICO	7	0	7	9.209	0.113	3.117
PERU	1	0	1	2.406	2.406	2.406
PHILIPPINES	14	4	10	1.771	0.119	0.711
SOUTH AFRICA	4	0	4	3.434	0.195	1.286
SPAIN	2	0	2	5.188	4.022	4.605
THAILAND	8	0	8	0.627	0.118	0.364
TURKEY	2	0	2	14.640	3.124	8.882
UNITED STATES	62	5	57	33.050	0.103	4.121
Antimony				-	-	-
ARGENTINA	23	20	3	0.047	0.030	0.036
AUSTRIA	1	1	0	-	-	-
BRAZIL	34	34	0	-	-	-
CANADA	1	1	0	-	-	-
CHILE	6	6	0	-	-	-
CHINA, PEOPLE'S REPUBLIC	7	7	0	-	-	-
COLOMBIA	1	1	0	-	-	-
DENMARK	3	3	0	-	-	-
ECUADOR	2	2	0	-	-	-
INDIA	1	1	0	-	-	-
INDONESIA	2	2	0	-	-	-
IRAN	1	1	0	-	-	-
ISRAEL	1	1	0	-	-	-
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	2	0	-	-	-
MEXICO	7	7	0	-	-	-
PERU	1	1	0	-	-	-
PHILIPPINES	14	14	0	-	-	-

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	3	1	0.034	0.034	0.034
SPAIN	2	2	0	-	-	-
THAILAND	8	8	0	-	-	-
TURKEY	2	2	0	-	-	-
UNITED STATES	62	57	5	0.239	0.057	0.146
Arsenic						
ARGENTINA	23	1	22	0.467	0.007	0.084
AUSTRIA	1	0	1	0.033	0.033	0.033
BRAZIL	34	17	17	0.037	0.006	0.012
CANADA	1	0	1	0.012	0.012	0.012
CHILE	6	0	6	0.134	0.014	0.053
CHINA, PEOPLE'S REPUBLIC	7	2	5	0.067	0.009	0.037
COLOMBIA	1	1	0	-	-	-
DENMARK	3	0	3	0.014	0.007	0.011
ECUADOR	2	1	1	0.008	0.008	0.008
INDIA	1	0	1	0.006	0.006	0.006
INDONESIA	2	1	1	0.013	0.013	0.013
IRAN	1	0	1	0.031	0.031	0.031
ISRAEL	1	0	1	0.038	0.038	0.038
KOREA, REPUBLIC OF	1	0	1	0.005	0.005	0.005
LEBANON	2	1	1	0.006	0.006	0.006
MEXICO	7	2	5	0.099	0.011	0.046
PERU	1	1	0	-	-	-
PHILIPPINES	14	9	5	0.011	0.006	0.008
SOUTH AFRICA	4	0	4	0.011	0.006	0.008
SPAIN	2	1	1	0.014	0.014	0.014
THAILAND	8	1	7	0.049	0.014	0.031
TURKEY	2	0	2	0.070	0.019	0.045
UNITED STATES	62	14	48	0.647	0.006	0.142
Beryllium						
ARGENTINA	23	23	0	-	-	-
AUSTRIA	1	1	0	-	-	-
BRAZIL	34	34	0	-	-	-
CANADA	1	1	0	-	-	-
CHILE	6	6	0	-	-	-
CHINA, PEOPLE'S REPUBLIC	7	7	0	-	-	-
COLOMBIA	1	1	0	-	-	-
DENMARK	3	3	0	-	-	-
ECUADOR	2	2	0	-	-	-
INDIA	1	1	0	-	-	-
INDONESIA	2	2	0	-	-	-
IRAN	1	1	0	-	-	-
ISRAEL	1	1	0	-	-	-
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	2	0	-	-	-
MEXICO	7	7	0	-	-	-
PERU	1	1	0	-	-	-
PHILIPPINES	14	14	0	-	-	-

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	4	0	-	-	-
SPAIN	2	2	0	-	-	-
THAILAND	8	8	0	-	-	-
TURKEY	2	2	0	-	-	-
UNITED STATES	62	61	1	0.036	0.036	0.036
Boron						
ARGENTINA	23	0	23	52.910	0.278	18.197
AUSTRIA	1	0	1	13.610	13.610	13.610
BRAZIL	34	0	34	14.020	0.794	6.392
CANADA	1	0	1	2.421	2.421	2.421
CHILE	6	0	6	23.030	3.267	15.173
CHINA, PEOPLE'S REPUBLIC	7	0	7	15.860	5.231	10.860
COLOMBIA	1	0	1	1.401	1.401	1.401
DENMARK	3	0	3	0.428	0.231	0.338
ECUADOR	2	0	2	4.741	4.628	4.685
INDIA	1	0	1	0.838	0.838	0.838
INDONESIA	2	0	2	5.248	3.178	4.213
IRAN	1	0	1	20.160	20.160	20.160
ISRAEL	1	0	1	3.780	3.780	3.780
KOREA, REPUBLIC OF	1	0	1	0.244	0.244	0.244
LEBANON	2	0	2	3.329	2.395	2.862
MEXICO	7	0	7	29.570	2.087	13.139
PERU	1	1	0	-	-	-
PHILIPPINES	14	0	14	2.787	0.137	1.100
SOUTH AFRICA	4	0	4	7.233	2.485	5.019
SPAIN	2	0	2	25.970	25.190	25.580
THAILAND	8	0	8	4.504	2.812	3.648
TURKEY	2	0	2	20.280	2.741	11.511
UNITED STATES	62	0	62	54.940	0.623	12.961
Cadmium						
ARGENTINA	23	15	8	0.011	0.003	0.004
AUSTRIA	1	0	1	0.010	0.010	0.010
BRAZIL	34	31	3	0.003	0.002	0.003
CANADA	1	1	0	-	-	-
CHILE	6	3	3	0.040	0.002	0.015
CHINA, PEOPLE'S REPUBLIC	7	4	3	0.004	0.002	0.004
COLOMBIA	1	1	0	-	-	-
DENMARK	3	2	1	0.018	0.018	0.018
ECUADOR	2	0	2	0.044	0.038	0.041
INDIA	1	1	0	-	-	-
INDONESIA	2	0	2	0.027	0.009	0.018
IRAN	1	0	1	0.003	0.003	0.003
ISRAEL	1	1	0	-	-	-
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	0	2	0.004	0.004	0.004
MEXICO	7	4	3	0.009	0.002	0.005
PERU	1	0	1	0.003	0.003	0.003
PHILIPPINES	14	9	5	0.005	0.002	0.004

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	3	1	0.004	0.004	0.004
SPAIN	2	2	0	-	-	-
THAILAND	8	0	8	0.022	0.004	0.013
TURKEY	2	2	0	-	-	-
UNITED STATES	62	32	30	0.090	0.002	0.016
Chromium						
ARGENTINA	23	2	21	0.249	0.032	0.077
AUSTRIA	1	0	1	0.042	0.042	0.042
BRAZIL	34	0	34	0.173	0.012	0.027
CANADA	1	0	1	0.018	0.018	0.018
CHILE	6	0	6	0.403	0.033	0.121
CHINA, PEOPLE'S REPUBLIC	7	0	7	0.042	0.014	0.030
COLOMBIA	1	0	1	0.024	0.024	0.024
DENMARK	3	1	2	0.017	0.011	0.014
ECUADOR	2	0	2	0.028	0.027	0.028
INDIA	1	0	1	0.306	0.306	0.306
INDONESIA	2	0	2	0.088	0.085	0.087
IRAN	1	0	1	0.055	0.055	0.055
ISRAEL	1	0	1	0.035	0.035	0.035
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	0	2	0.049	0.039	0.044
MEXICO	7	0	7	0.099	0.013	0.049
PERU	1	0	1	0.019	0.019	0.019
PHILIPPINES	14	2	12	0.050	0.011	0.035
SOUTH AFRICA	4	1	3	0.060	0.017	0.043
SPAIN	2	0	2	0.063	0.052	0.058
THAILAND	8	0	8	0.143	0.046	0.069
TURKEY	2	0	2	0.138	0.023	0.081
UNITED STATES	62	4	58	0.426	0.010	0.101
Copper						
ARGENTINA	23	2	21	14.420	0.049	1.747
AUSTRIA	1	0	1	0.284	0.284	0.284
BRAZIL	34	0	34	2.605	0.357	1.757
CANADA	1	0	1	0.033	0.033	0.033
CHILE	6	0	6	1.932	0.402	0.864
CHINA, PEOPLE'S REPUBLIC	7	0	7	2.224	0.059	0.724
COLOMBIA	1	0	1	0.993	0.993	0.993
DENMARK	3	0	3	0.159	0.117	0.131
ECUADOR	2	0	2	2.705	2.015	2.360
INDIA	1	0	1	0.794	0.794	0.794
INDONESIA	2	0	2	2.003	1.943	1.973
IRAN	1	0	1	1.371	1.371	1.371
ISRAEL	1	0	1	0.294	0.294	0.294
KOREA, REPUBLIC OF	1	0	1	0.085	0.085	0.085
LEBANON	2	0	2	0.771	0.266	0.519
MEXICO	7	0	7	1.520	0.286	0.875
PERU	1	0	1	2.407	2.407	2.407
PHILIPPINES	14	1	13	2.292	0.035	0.976

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	0	4	1.870	0.056	0.953
SPAIN	2	0	2	0.370	0.184	0.277
THAILAND	8	0	8	2.712	1.159	1.713
TURKEY	2	0	2	1.196	0.060	0.628
UNITED STATES	62	0	62	3.354	0.035	1.081
Iron						
ARGENTINA	23	0	23	25.440	0.427	10.908
AUSTRIA	1	0	1	5.323	5.323	5.323
BRAZIL	34	0	34	22.060	1.206	5.946
CANADA	1	0	1	0.976	0.976	0.976
CHILE	6	0	6	55.540	3.658	16.355
CHINA, PEOPLE'S REPUBLIC	7	0	7	6.582	1.141	3.861
COLOMBIA	1	0	1	2.763	2.763	2.763
DENMARK	3	0	3	1.154	0.669	0.894
ECUADOR	2	0	2	10.530	9.470	10.000
INDIA	1	0	1	31.400	31.400	31.400
INDONESIA	2	0	2	13.990	10.820	12.405
IRAN	1	0	1	1.901	1.901	1.901
ISRAEL	1	0	1	2.149	2.149	2.149
KOREA, REPUBLIC OF	1	0	1	0.622	0.622	0.622
LEBANON	2	0	2	44.410	12.410	28.410
MEXICO	7	0	7	16.270	3.959	7.473
PERU	1	0	1	4.460	4.460	4.460
PHILIPPINES	14	0	14	9.421	0.341	3.512
SOUTH AFRICA	4	0	4	7.001	2.030	5.307
SPAIN	2	0	2	11.410	10.110	10.760
THAILAND	8	0	8	10.230	6.382	8.022
TURKEY	2	0	2	6.897	4.379	5.638
UNITED STATES	62	0	62	31.240	0.385	6.588
Lead						
ARGENTINA	23	2	21	0.156	0.003	0.043
AUSTRIA	1	0	1	0.022	0.022	0.022
BRAZIL	34	26	8	0.030	0.003	0.008
CANADA	1	0	1	0.004	0.004	0.004
CHILE	6	2	4	0.110	0.004	0.032
CHINA, PEOPLE'S REPUBLIC	7	2	5	0.048	0.003	0.019
COLOMBIA	1	1	0	-	-	-
DENMARK	3	2	1	0.003	0.003	0.003
ECUADOR	2	2	0	-	-	-
INDIA	1	0	1	0.144	0.144	0.144
INDONESIA	2	0	2	0.012	0.011	0.011
IRAN	1	0	1	0.119	0.119	0.119
ISRAEL	1	0	1	0.008	0.008	0.008
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	0	2	0.014	0.011	0.013
MEXICO	7	2	5	0.050	0.002	0.027
PERU	1	1	0	-	-	-
PHILIPPINES	14	1	13	0.073	0.002	0.009

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	3	1	0.020	0.020	0.020
SPAIN	2	0	2	0.026	0.020	0.023
THAILAND	8	1	7	0.014	0.003	0.007
TURKEY	2	0	2	0.056	0.034	0.045
UNITED STATES	62	23	39	0.233	0.002	0.032
Manganese						
ARGENTINA	23	1	22	6.486	0.905	2.216
AUSTRIA	1	0	1	3.126	3.126	3.126
BRAZIL	34	0	34	2.819	0.340	1.920
CANADA	1	0	1	0.306	0.306	0.306
CHILE	6	0	6	13.100	1.882	5.171
CHINA, PEOPLE'S REPUBLIC	7	0	7	2.386	1.384	1.936
COLOMBIA	1	0	1	3.075	3.075	3.075
DENMARK	3	0	3	4.867	0.085	1.704
ECUADOR	2	0	2	2.607	2.388	2.498
INDIA	1	0	1	0.687	0.687	0.687
INDONESIA	2	0	2	73.710	62.550	68.130
IRAN	1	0	1	4.395	4.395	4.395
ISRAEL	1	0	1	1.079	1.079	1.079
KOREA, REPUBLIC OF	1	0	1	0.214	0.214	0.214
LEBANON	2	0	2	1.813	0.497	1.155
MEXICO	7	0	7	6.568	0.697	2.862
PERU	1	0	1	0.966	0.966	0.966
PHILIPPINES	14	0	14	77.590	0.040	27.846
SOUTH AFRICA	4	0	4	2.248	1.110	1.656
SPAIN	2	0	2	1.697	1.581	1.639
THAILAND	8	0	8	177.200	65.820	109.944
TURKEY	2	0	2	3.265	0.713	1.989
UNITED STATES	62	0	62	70.200	0.137	4.969
Mercury						
ARGENTINA	23	23	0	-	-	-
AUSTRIA	1	1	0	-	-	-
BRAZIL	34	34	0	-	-	-
CANADA	1	1	0	-	-	-
CHILE	6	6	0	-	-	-
CHINA, PEOPLE'S REPUBLIC	7	7	0	-	-	-
COLOMBIA	1	1	0	-	-	-
DENMARK	3	3	0	-	-	-
ECUADOR	2	2	0	-	-	-
INDIA	1	1	0	-	-	-
INDONESIA	2	2	0	-	-	-
IRAN	1	1	0	-	-	-
ISRAEL	1	1	0	-	-	-
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	2	0	-	-	-
MEXICO	7	7	0	-	-	-
PERU	1	1	0	-	-	-
PHILIPPINES	14	14	0	-	-	-

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	4	0	-	-	-
SPAIN	2	2	0	-	-	-
THAILAND	8	8	0	-	-	-
TURKEY	2	2	0	-	-	-
UNITED STATES	62	62	0	-	-	-
Molybdenum						
ARGENTINA	23	10	13	0.129	0.022	0.043
AUSTRIA	1	1	0	-	-	-
BRAZIL	34	5	29	0.054	0.021	0.036
CANADA	1	1	0	-	-	-
CHILE	6	3	3	0.154	0.044	0.088
CHINA, PEOPLE'S REPUBLIC	7	5	2	0.057	0.031	0.044
COLOMBIA	1	1	0	-	-	-
DENMARK	3	3	0	-	-	-
ECUADOR	2	0	2	0.087	0.084	0.086
INDIA	1	1	0	-	-	-
INDONESIA	2	0	2	0.042	0.029	0.036
IRAN	1	1	0	-	-	-
ISRAEL	1	0	1	0.050	0.050	0.050
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	2	0	-	-	-
MEXICO	7	1	6	0.052	0.025	0.036
PERU	1	0	1	0.052	0.052	0.052
PHILIPPINES	14	9	5	0.030	0.020	0.023
SOUTH AFRICA	4	2	2	0.042	0.027	0.035
SPAIN	2	1	1	0.028	0.028	0.028
THAILAND	8	0	8	0.115	0.031	0.063
TURKEY	2	2	0	-	-	-
UNITED STATES	62	15	47	1.147	0.021	0.144
Nickel						
ARGENTINA	23	1	22	0.269	0.028	0.080
AUSTRIA	1	0	1	0.065	0.065	0.065
BRAZIL	34	0	34	0.111	0.010	0.064
CANADA	1	1	0	-	-	-
CHILE	6	0	6	0.641	0.048	0.299
CHINA, PEOPLE'S REPUBLIC	7	0	7	0.091	0.028	0.067
COLOMBIA	1	0	1	0.070	0.070	0.070
DENMARK	3	0	3	0.055	0.012	0.027
ECUADOR	2	0	2	0.186	0.083	0.135
INDIA	1	0	1	0.074	0.074	0.074
INDONESIA	2	0	2	0.150	0.125	0.138
IRAN	1	0	1	0.231	0.231	0.231
ISRAEL	1	0	1	0.076	0.076	0.076
KOREA, REPUBLIC OF	1	0	1	0.044	0.044	0.044
LEBANON	2	0	2	0.096	0.073	0.085
MEXICO	7	0	7	0.134	0.044	0.071
PERU	1	0	1	0.095	0.095	0.095
PHILIPPINES	14	1	13	0.316	0.014	0.134

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	0	4	0.220	0.016	0.093
SPAIN	2	0	2	0.049	0.048	0.049
THAILAND	8	0	8	1.225	0.388	0.707
TURKEY	2	0	2	0.440	0.051	0.246
UNITED STATES	62	0	62	1.831	0.013	0.163
Selenium						
ARGENTINA	23	22	1	0.024	0.024	0.024
AUSTRIA	1	1	0	-	-	-
BRAZIL	34	34	0	-	-	-
CANADA	1	1	0	-	-	-
CHILE	6	5	1	0.025	0.025	0.025
CHINA, PEOPLE'S REPUBLIC	7	6	1	0.032	0.032	0.032
COLOMBIA	1	1	0	-	-	-
DENMARK	3	3	0	-	-	-
ECUADOR	2	0	2	0.143	0.094	0.119
INDIA	1	1	0	-	-	-
INDONESIA	2	2	0	-	-	-
IRAN	1	1	0	-	-	-
ISRAEL	1	1	0	-	-	-
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	2	0	-	-	-
MEXICO	7	7	0	-	-	-
PERU	1	1	0	-	-	-
PHILIPPINES	14	14	0	-	-	-
SOUTH AFRICA	4	4	0	-	-	-
SPAIN	2	2	0	-	-	-
THAILAND	8	3	5	0.089	0.021	0.055
TURKEY	2	2	0	-	-	-
UNITED STATES	62	61	1	0.022	0.022	0.022
Tin						
ARGENTINA	23	0	23	0.233	0.021	0.061
AUSTRIA	1	0	1	0.114	0.114	0.114
BRAZIL	34	13	21	0.069	0.021	0.035
CANADA	1	1	0	-	-	-
CHILE	6	2	4	0.117	0.020	0.049
CHINA, PEOPLE'S REPUBLIC	7	3	4	0.042	0.025	0.031
COLOMBIA	1	1	0	-	-	-
DENMARK	3	0	3	0.113	0.035	0.082
ECUADOR	2	1	1	0.272	0.272	0.272
INDIA	1	0	1	0.072	0.072	0.072
INDONESIA	2	0	2	1.235	1.086	1.161
IRAN	1	1	0	-	-	-
ISRAEL	1	0	1	0.053	0.053	0.053
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	0	2	16.500	0.244	8.372
MEXICO	7	3	4	0.107	0.021	0.050
PERU	1	0	1	0.059	0.059	0.059
PHILIPPINES	14	1	13	92.880	0.037	29.572

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	1	3	0.049	0.029	0.039
SPAIN	2	0	2	0.031	0.027	0.029
THAILAND	8	0	8	0.092	0.022	0.050
TURKEY	2	0	2	0.040	0.028	0.034
UNITED STATES	62	20	42	0.378	0.021	0.057
Titanium						
ARGENTINA	23	1	22	2.490	0.237	1.042
AUSTRIA	1	0	1	0.505	0.505	0.505
BRAZIL	34	1	33	2.525	0.188	1.398
CANADA	1	0	1	0.195	0.195	0.195
CHILE	6	0	6	3.621	0.194	1.205
CHINA, PEOPLE'S REPUBLIC	7	0	7	1.653	0.330	0.845
COLOMBIA	1	0	1	0.145	0.145	0.145
DENMARK	3	0	3	0.746	0.488	0.648
ECUADOR	2	0	2	0.542	0.516	0.529
INDIA	1	0	1	0.381	0.381	0.381
INDONESIA	2	0	2	0.584	0.510	0.547
IRAN	1	0	1	0.637	0.637	0.637
ISRAEL	1	0	1	0.304	0.304	0.304
KOREA, REPUBLIC OF	1	1	0	-	-	-
LEBANON	2	0	2	0.351	0.211	0.281
MEXICO	7	0	7	1.200	0.495	0.850
PERU	1	0	1	1.026	1.026	1.026
PHILIPPINES	14	4	10	0.972	0.138	0.416
SOUTH AFRICA	4	1	3	1.055	0.116	0.496
SPAIN	2	0	2	1.029	0.991	1.010
THAILAND	8	0	8	1.157	0.700	0.862
TURKEY	2	0	2	0.564	0.265	0.415
UNITED STATES	62	4	58	2.558	0.106	1.228
Zinc						
ARGENTINA	23	1	22	4.636	0.122	2.039
AUSTRIA	1	0	1	2.001	2.001	2.001
BRAZIL	34	0	34	3.631	0.176	1.838
CANADA	1	0	1	0.110	0.110	0.110
CHILE	6	0	6	6.104	0.749	2.785
CHINA, PEOPLE'S REPUBLIC	7	0	7	2.203	0.426	1.304
COLOMBIA	1	0	1	1.651	1.651	1.651
DENMARK	3	0	3	0.996	0.828	0.915
ECUADOR	2	0	2	9.267	7.578	8.423
INDIA	1	0	1	1.413	1.413	1.413
INDONESIA	2	0	2	6.997	5.344	6.171
IRAN	1	0	1	3.952	3.952	3.952
ISRAEL	1	0	1	0.830	0.830	0.830
KOREA, REPUBLIC OF	1	0	1	0.155	0.155	0.155
LEBANON	2	0	2	1.839	0.774	1.307
MEXICO	7	0	7	2.514	1.090	1.743
PERU	1	0	1	3.521	3.521	3.521
PHILIPPINES	14	1	13	3.459	0.123	1.521

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
SOUTH AFRICA	4	0	4	2.603	0.214	1.407
SPAIN	2	0	2	1.714	1.440	1.577
THAILAND	8	0	8	5.863	3.304	4.449
TURKEY	2	0	2	2.571	0.397	1.484
UNITED STATES	62	0	62	12.160	0.390	2.434

Appendix E

Table E-1: Metal analysis results in the concentrated sample by fruit concentrate type

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Aluminum						
Apple	11	0	11	4.003	0.341	1.395
Banana	1	0	1	0.115	0.115	0.115
Blackberry	1	0	1	21.010	21.010	21.010
Blueberry	1	0	1	19.420	19.420	19.420
Cherry	3	0	3	5.541	1.828	3.355
Cranberry	8	1	7	33.050	0.145	12.469
Fruit Mix	3	0	3	3.124	0.195	1.176
Grape	48	1	47	20.380	0.126	3.847
Grapefruit	8	4	4	0.267	0.103	0.168
Guava	2	0	2	0.505	0.484	0.495
Kiwi	1	0	1	18.930	18.930	18.930
Lemon	15	2	13	12.550	0.109	1.204
Lime	2	1	1	4.305	4.305	4.305
Mango	2	1	1	0.404	0.404	0.404
Orange	46	2	44	2.678	0.115	0.662
Passion Fruit	3	0	3	1.160	0.269	0.642
Peach	1	0	1	0.579	0.579	0.579
Pear	1	0	1	1.448	1.448	1.448
Pomegranate	5	0	5	14.640	1.730	5.689
Pineapple	20	3	17	1.771	0.118	0.654
Plum	2	0	2	3.098	0.569	1.834
Raspberry	1	0	1	16.450	16.450	16.450
Tangerine	1	0	1	0.163	0.163	0.163
Antimony						
Apple	11	11	0	-	-	-
Banana	1	1	0	-	-	-
Blackberry	1	1	0	-	-	-
Blueberry	1	1	0	-	-	-
Cherry	3	3	0	-	-	-
Cranberry	8	6	2	0.058	0.057	0.058
Fruit Mix	3	3	0	-	-	-
Grape	48	42	6	0.239	0.030	0.120
Grapefruit	8	8	0	-	-	-
Guava	2	2	0	-	-	-
Kiwi	1	1	0	-	-	-
Lemon	15	14	1	0.034	0.034	0.034
Lime	2	2	0	-	-	-

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Mango	2	2	0	-	-	-
Orange	46	46	0	-	-	-
Passion Fruit	3	3	0	-	-	-
Peach	1	1	0	-	-	-
Pear	1	1	0	-	-	-
Pomegranate	5	5	0	-	-	-
Pineapple	20	20	0	-	-	-
Plum	2	2	0	-	-	-
Raspberry	1	1	0	-	-	-
Tangerine	1	1	0	-	-	-
Arsenic						
Apple	11	1	10	0.067	0.011	0.031
Banana	1	1	0	-	-	-
Blackberry	1	0	1	0.070	0.070	0.070
Blueberry	1	0	1	0.381	0.381	0.381
Cherry	3	0	3	0.455	0.163	0.322
Cranberry	8	2	6	0.614	0.018	0.312
Fruit Mix	3	0	3	0.019	0.006	0.010
Grape	48	3	45	0.647	0.006	0.117
Grapefruit	8	0	8	0.022	0.006	0.011
Guava	2	2	0	-	-	-
Kiwi	1	0	1	0.080	0.080	0.080
Lemon	15	4	11	0.041	0.006	0.016
Lime	2	1	1	0.015	0.015	0.015
Mango	2	0	2	0.006	0.006	0.006
Orange	46	25	21	0.018	0.005	0.010
Passion Fruit	3	2	1	0.008	0.008	0.008
Peach	1	0	1	0.010	0.010	0.010
Pear	1	0	1	0.040	0.040	0.040
Pomegranate	5	1	4	0.092	0.031	0.058
Pineapple	20	9	11	0.049	0.007	0.023
Plum	2	0	2	0.048	0.038	0.043
Raspberry	1	0	1	0.062	0.062	0.062
Tangerine	1	1	0	-	-	-
Beryllium						
Apple	11	11	0	-	-	-
Banana	1	1	0	-	-	-
Blackberry	1	1	0	-	-	-
Blueberry	1	1	0	-	-	-
Cherry	3	3	0	-	-	-
Cranberry	8	8	0	-	-	-
Fruit Mix	3	3	0	-	-	-
Grape	48	48	0	-	-	-

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Grapefruit	8	8	0	-	-	-
Guava	2	2	0	-	-	-
Kiwi	1	1	0	-	-	-
Lemon	15	15	0	-	-	-
Lime	2	2	0	-	-	-
Mango	2	2	0	-	-	-
Orange	46	46	0	-	-	-
Passion Fruit	3	3	0	-	-	-
Peach	1	1	0	-	-	-
Pear	1	1	0	-	-	-
Pomegranate	5	5	0	-	-	-
Pineapple	20	20	0	-	-	-
Plum	2	2	0	-	-	-
Raspberry	1	0	1	0.036	0.036	0.036
Tangerine	1	1	0	-	-	-
Boron						
Apple	11	0	11	22.630	3.446	12.561
Banana	1	0	1	1.401	1.401	1.401
Blackberry	1	0	1	15.570	15.570	15.570
Blueberry	1	0	1	5.100	5.100	5.100
Cherry	3	0	3	38.820	19.690	27.080
Cranberry	8	0	8	15.540	0.623	3.473
Fruit Mix	3	0	3	2.741	0.287	1.838
Grape	48	0	48	54.940	0.278	21.573
Grapefruit	8	0	8	4.407	2.075	2.872
Guava	2	0	2	1.088	1.014	1.051
Kiwi	1	0	1	16.480	16.480	16.480
Lemon	15	0	15	7.721	0.137	4.237
Lime	2	0	2	3.722	2.406	3.064
Mango	2	0	2	0.794	0.181	0.488
Orange	46	0	46	9.579	0.231	5.680
Passion Fruit	3	0	3	4.741	2.081	3.817
Peach	1	0	1	7.233	7.233	7.233
Pear	1	0	1	21.630	21.630	21.630
Pomegranate	5	0	5	25.550	2.395	14.433
Pineapple	20	0	20	5.248	0.426	2.607
Plum	2	0	2	23.600	23.030	23.315
Raspberry	1	0	1	9.540	9.540	9.540
Tangerine	1	0	1	2.087	2.087	2.087
Cadmium						
Apple	11	7	4	0.010	0.002	0.005
Banana	1	1	0	-	-	-
Blackberry	1	0	1	0.009	0.009	0.009

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Blueberry	1	0	1	0.007	0.007	0.007
Cherry	3	3	0	-	-	-
Cranberry	8	0	8	0.090	0.003	0.040
Fruit Mix	3	2	1	0.004	0.004	0.004
Grape	48	23	25	0.024	0.002	0.005
Grapefruit	8	6	2	0.002	0.002	0.002
Guava	2	2	0	-	-	-
Kiwi	1	0	1	0.003	0.003	0.003
Lemon	15	15	0	-	-	-
Lime	2	1	1	0.003	0.003	0.003
Mango	2	2	0	-	-	-
Orange	46	40	6	0.018	0.002	0.005
Passion Fruit	3	1	2	0.044	0.038	0.041
Peach	1	0	1	-	-	-
Pear	1	0	1	0.011	0.011	0.011
Pomegranate	5	2	3	0.004	0.003	0.003
Pineapple	20	5	15	0.027	0.002	0.011
Plum	2	0	2	0.003	0.002	0.003
Raspberry	1	0	1	0.083	0.083	0.083
Tangerine	1	1	0	-	-	-
Chromium						
Apple	11	0	11	0.050	0.012	0.032
Banana	1	0	1	0.024	0.024	0.024
Blackberry	1	0	1	0.123	0.123	0.123
Blueberry	1	0	1	0.426	0.426	0.426
Cherry	3	0	3	0.317	0.201	0.270
Cranberry	8	2	6	0.387	0.058	0.142
Fruit Mix	3	1	2	0.023	0.011	0.017
Grape	48	3	45	0.330	0.010	0.102
Grapefruit	8	0	8	0.066	0.010	0.040
Guava	2	0	2	0.027	0.015	0.021
Kiwi	1	0	1	0.403	0.403	0.403
Lemon	15	2	13	0.306	0.014	0.068
Lime	2	0	2	0.173	0.019	0.096
Mango	2	1	1	0.020	0.020	0.020
Orange	46	2	44	0.058	0.011	0.023
Passion Fruit	3	0	3	0.042	0.027	0.032
Peach	1	0	1	0.053	0.053	0.053
Pear	1	0	1	0.038	0.038	0.038
Pomegranate	5	0	5	0.138	0.035	0.067
Pineapple	20	0	20	0.143	0.022	0.056
Plum	2	0	2	0.069	0.026	0.048
Raspberry	1	0	1	0.079	0.079	0.079

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Tangerine	1	0	1	0.013	0.013	0.013
Copper						
Apple	11	0	11	1.079	0.056	0.465
Banana	1	0	1	0.993	0.993	0.993
Blackberry	1	0	1	0.411	0.411	0.411
Blueberry	1	0	1	1.444	1.444	1.444
Cherry	3	0	3	3.354	2.088	2.702
Cranberry	8	0	8	1.180	0.108	0.646
Fruit Mix	3	0	3	0.327	0.060	0.210
Grape	48	2	46	14.420	0.033	0.703
Grapefruit	8	0	8	2.485	1.323	2.035
Guava	2	0	2	0.624	0.443	0.534
Kiwi	1	0	1	0.862	0.862	0.862
Lemon	15	0	15	2.647	0.035	1.467
Lime	2	0	2	2.407	1.719	2.063
Mango	2	0	2	0.357	0.195	0.276
Orange	46	1	45	2.605	0.085	1.770
Passion Fruit	3	0	3	2.705	0.558	1.759
Peach	1	0	1	1.557	1.557	1.557
Pear	1	0	1	3.368	3.368	3.368
Pomegranate	5	0	5	1.371	0.266	0.888
Pineapple	20	0	20	2.712	0.217	1.493
Plum	2	0	2	1.932	1.098	1.515
Raspberry	1	0	1	0.924	0.924	0.924
Tangerine	1	0	1	0.993	0.993	0.993
Iron						
Apple	11	0	11	6.788	1.141	3.828
Banana	1	0	1	2.763	2.763	2.763
Blackberry	1	0	1	22.180	22.180	22.180
Blueberry	1	0	1	12.790	12.790	12.790
Cherry	3	0	3	6.826	3.929	5.470
Cranberry	8	0	8	19.350	0.970	9.954
Fruit Mix	3	0	3	4.379	1.191	2.533
Grape	48	0	48	44.410	0.385	8.951
Grapefruit	8	0	8	8.400	4.229	6.140
Guava	2	0	2	1.525	1.174	1.350
Kiwi	1	0	1	55.540	55.540	55.540
Lemon	15	0	15	31.400	0.742	7.850
Lime	2	0	2	22.060	4.460	13.260
Mango	2	0	2	1.206	0.341	0.774
Orange	46	0	46	8.998	0.385	5.417
Passion Fruit	3	0	3	10.530	3.633	7.878
Peach	1	0	1	5.409	5.409	5.409

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Pear	1	0	1	3.750	3.750	3.750
Pomegranate	5	0	5	12.410	1.901	5.394
Pineapple	20	0	20	13.990	1.069	6.774
Plum	2	0	2	13.430	8.909	11.170
Raspberry	1	0	1	22.180	22.180	22.180
Tangerine	1	0	1	4.975	4.975	4.975
Lead						
Apple	11	0	11	0.048	0.003	0.014
Banana	1	1	0	-	-	-
Blackberry	1	0	1	0.233	0.233	0.233
Blueberry	1	0	1	0.036	0.036	0.036
Cherry	3	1	2	0.017	0.015	0.016
Cranberry	8	3	5	0.039	0.008	0.017
Fruit Mix	3	1	2	0.034	0.003	0.018
Grape	48	5	43	0.154	0.003	0.030
Grapefruit	8	5	3	0.005	0.002	0.003
Guava	2	2	0	-	-	-
Kiwi	1	0	1	0.110	0.110	0.110
Lemon	15	5	10	0.156	0.005	0.053
Lime	2	1	1	0.030	0.030	0.030
Mango	2	2	0	-	-	-
Orange	46	39	7	0.006	0.003	0.004
Passion Fruit	3	2	1	0.005	0.005	0.005
Peach	1	1	0	-	-	-
Pear	1	0	1	0.015	0.015	0.015
Pomegranate	5	0	5	0.132	0.008	0.066
Pineapple	20	1	19	0.014	0.002	0.006
Plum	2	0	2	0.008	0.007	0.008
Raspberry	1	0	1	0.155	0.155	0.155
Tangerine	1	0	1	0.002	0.002	0.002
Manganese						
Apple	11	0	11	3.126	1.110	2.077
Banana	1	0	1	3.075	3.075	3.075
Blackberry	1	0	1	44.370	44.370	44.370
Blueberry	1	0	1	24.530	24.530	24.530
Cherry	3	0	3	2.658	1.640	2.187
Cranberry	8	0	8	13.100	1.154	4.554
Fruit Mix	3	0	3	2.756	0.713	1.612
Grape	48	1	47	32.480	0.306	3.344
Grapefruit	8	0	8	1.383	0.817	1.117
Guava	2	0	2	1.415	1.074	1.245
Kiwi	1	0	1	5.583	5.583	5.583
Lemon	15	0	15	2.248	0.058	1.282

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Lime	2	0	2	2.125	0.966	1.546
Mango	2	0	2	0.682	0.130	0.406
Orange	46	0	46	4.867	0.040	1.818
Passion Fruit	3	0	3	2.607	0.983	1.993
Peach	1	0	1	1.900	1.900	1.900
Pear	1	0	1	2.481	2.481	2.481
Pomegranate	5	0	5	4.395	0.497	2.719
Pineapple	20	0	20	177.200	2.425	70.133
Plum	2	0	2	5.313	5.260	5.287
Raspberry	1	0	1	70.200	70.200	70.200
Tangerine	1	0	1	1.548	1.548	1.548
Mercury						
Apple	11	11	0	-	-	-
Banana	1	1	0	-	-	-
Blackberry	1	1	0	-	-	-
Blueberry	1	1	0	-	-	-
Cherry	3	3	0	-	-	-
Cranberry	8	8	0	-	-	-
Fruit Mix	3	3	0	-	-	-
Grape	48	48	0	-	-	-
Grapefruit	8	8	0	-	-	-
Guava	2	2	0	-	-	-
Kiwi	1	1	0	-	-	-
Lemon	15	15	0	-	-	-
Lime	2	2	0	-	-	-
Mango	2	2	0	-	-	-
Orange	46	46	0	-	-	-
Passion Fruit	3	3	0	-	-	-
Peach	1	1	0	-	-	-
Pear	1	1	0	-	-	-
Pomegranate	5	5	0	-	-	-
Pineapple	20	20	0	-	-	-
Plum	2	2	0	-	-	-
Raspberry	1	1	0	-	-	-
Tangerine	1	1	0	-	-	-
Molybdenum						
Apple	11	11	0	-	-	-
Banana	1	1	0	-	-	-
Blackberry	1	1	0	-	-	-
Blueberry	1	0	1	0.162	0.162	0.162
Cherry	3	0	3	0.129	0.092	0.110
Cranberry	8	3	5	0.711	0.038	0.342
Fruit Mix	3	3	0	-	-	-

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Grape	48	18	30	1.147	0.022	0.142
Grapefruit	8	8	0	0.070	0.036	0.052
Guava	2	1	1	0.023	0.023	0.023
Kiwi	1	0	1	0.154	0.154	0.154
Lemon	15	6	9	0.056	0.023	0.038
Lime	2	0	2	0.052	0.048	0.050
Mango	2	2	0	-	-	-
Orange	46	7	39	0.057	0.021	0.037
Passion Fruit	3	0	3	0.087	0.021	0.064
Peach	1	0	1	0.027	0.027	0.027
Pear	1	1	0	-	-	-
Pomegranate	5	4	1	0.050	0.050	0.050
Pineapple	20	5	15	0.115	0.020	0.046
Plum	2	1	1	0.044	0.044	0.044
Raspberry	1	0	1	0.037	0.037	0.037
Tangerine	1	0	1	0.036	0.036	0.036
Nickel						
Apple	11	0	11	0.173	0.016	0.066
Banana	1	0	1	0.070	0.070	0.070
Blackberry	1	0	1	0.837	0.837	0.837
Blueberry	1	0	1	0.748	0.748	0.748
Cherry	3	0	3	0.351	0.065	0.176
Cranberry	8	0	8	0.641	0.019	0.274
Fruit Mix	3	0	3	0.051	0.027	0.035
Grape	48	2	46	0.236	0.013	0.067
Grapefruit	8	0	8	0.125	0.068	0.096
Guava	2	0	2	0.043	0.016	0.030
Kiwi	1	0	1	0.459	0.459	0.459
Lemon	15	1	14	0.162	0.025	0.097
Lime	2	0	2	0.111	0.095	0.103
Mango	2	0	2	0.039	0.014	0.027
Orange	46	0	46	0.180	0.010	0.065
Passion Fruit	3	0	3	0.186	0.083	0.120
Peach	1	0	1	0.220	0.220	0.220
Pear	1	0	1	0.269	0.269	0.269
Pomegranate	5	0	5	0.440	0.073	0.217
Pineapple	20	0	20	1.225	0.031	0.380
Plum	2	0	2	0.619	0.387	0.503
Raspberry	1	0	1	1.831	1.831	1.831
Tangerine	1	0	1	0.045	0.045	0.045
Selenium						
Apple	11	10	1	0.025	0.025	0.025
Banana	1	1	0	-	-	-

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Blackberry	1	1	0	-	-	-
Blueberry	1	1	0	-	-	-
Cherry	3	3	0	-	-	-
Cranberry	8	8	0	-	-	-
Fruit Mix	3	3	0	-	-	-
Grape	48	48	0	-	-	-
Grapefruit	8	8	0	-	-	-
Guava	2	2	0	-	-	-
Kiwi	1	1	0	-	-	-
Lemon	15	14	1	0.024	0.024	0.024
Lime	2	2	0	-	-	-
Mango	2	2	0	-	-	-
Orange	46	44	2	0.032	0.022	0.027
Passion Fruit	3	1	2	0.143	0.094	0.119
Peach	1	1	0	-	-	-
Pear	1	1	0	-	-	-
Pomegranate	5	5	0	-	-	-
Pineapple	20	15	5	0.089	0.021	0.055
Plum	2	2	0	-	-	-
Raspberry	1	1	0	-	-	-
Tangerine	1	1	0	-	-	-
Tin						
Apple	11	3	8	0.114	0.020	0.039
Banana	1	1	0	-	-	-
Blackberry	1	0	1	0.029	0.029	0.029
Blueberry	1	0	1	0.045	0.045	0.045
Cherry	3	0	3	0.041	0.021	0.030
Cranberry	8	2	6	0.164	0.041	0.089
Fruit Mix	3	0	3	0.194	0.028	0.087
Grape	48	14	34	16.500	0.021	0.529
Grapefruit	8	1	7	0.043	0.029	0.036
Guava	2	1	1	0.043	0.043	0.043
Kiwi	1	0	1	0.025	0.025	0.025
Lemon	15	1	14	0.233	0.021	0.084
Lime	2	0	2	0.059	0.052	0.056
Mango	2	2	0	-	-	-
Orange	46	18	28	0.378	0.021	0.054
Passion Fruit	3	2	1	0.272	0.272	0.272
Peach	1	0	1	0.049	0.049	0.049
Pear	1	0	1	0.030	0.030	0.030
Pomegranate	5	2	3	0.244	0.040	0.112
Pineapple	20	0	20	92.880	0.022	19.340
Plum	2	0	2	0.034	0.022	0.028
Raspberry	1	0	1	0.076	0.076	0.076

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Tangerine	1	1	0	-	-	-
Titanium						
Apple	11	1	10	1.542	0.330	0.679
Banana	1	0	1	0.145	0.145	0.145
Blackberry	1	0	1	1.878	1.878	1.878
Blueberry	1	0	1	1.737	1.737	1.737
Cherry	3	0	3	1.708	0.840	1.394
Cranberry	8	2	6	2.128	0.194	1.032
Fruit Mix	3	1	2	0.265	0.116	0.191
Grape	48	3	45	2.490	0.115	0.950
Grapefruit	8	0	8	2.558	1.019	1.886
Guava	2	0	2	0.202	0.106	0.154
Kiwi	1	0	1	3.621	3.621	3.621
Lemon	15	1	14	2.059	0.261	0.893
Lime	2	0	2	1.473	1.026	1.250
Mango	2	2	0	-	-	-
Orange	46	2	44	2.525	0.188	1.439
Passion Fruit	3	0	3	0.542	0.207	0.422
Peach	1	0	1	0.316	0.316	0.316
Pear	1	0	1	0.622	0.622	0.622
Pomegranate	5	0	5	0.744	0.211	0.492
Pineapple	20	0	20	1.157	0.138	0.608
Plum	2	0	2	1.037	0.908	0.973
Raspberry	1	0	1	1.335	1.335	1.335
Tangerine	1	0	1	1.129	1.129	1.129
Zinc						
Apple	11	0	11	2.001	0.214	0.933
Banana	1	0	1	1.651	1.651	1.651
Blackberry	1	0	1	5.218	5.218	5.218
Blueberry	1	0	1	6.945	6.945	6.945
Cherry	3	0	3	3.207	2.155	2.856
Cranberry	8	0	8	3.229	0.431	1.845
Fruit Mix	3	0	3	0.461	0.337	0.398
Grape	48	1	47	5.551	0.110	1.804
Grapefruit	8	0	8	3.000	1.789	2.342
Guava	2	0	2	1.026	0.932	0.979
Kiwi	1	0	1	3.614	3.614	3.614
Lemon	15	0	15	3.360	0.123	2.156
Lime	2	0	2	3.631	3.521	3.576
Mango	2	0	2	0.572	0.289	0.431
Orange	46	1	45	2.519	0.155	1.835
Passion Fruit	3	0	3	9.267	2.203	6.349
Peach	1	0	1	2.603	2.603	2.603

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	MAX (ppm)	MIN (ppm)	MEAN (ppm)
Pear	1	0	1	4.636	4.636	4.636
Pomegranate	5	0	5	3.952	0.774	2.416
Pineapple	20	0	20	6.997	0.605	3.342
Plum	2	0	2	6.391	6.104	6.248
Raspberry	1	0	1	12.160	12.160	12.160
Tangerine	1	0	1	1.090	1.090	1.090