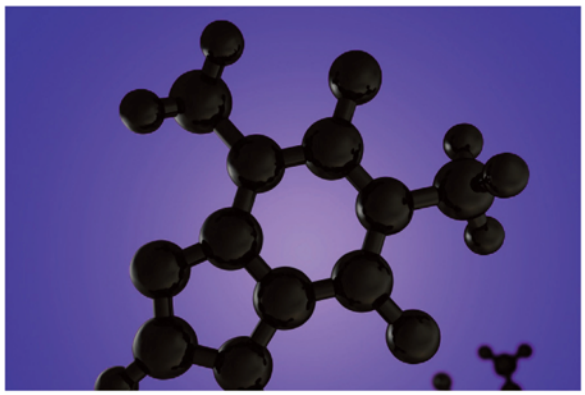
Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2009-2010 Targeted Surveys

Chemistry



Melamine, Pesticide and Metal Residues in Fluid Milk, Milk-based Products and Soy-based Products

TS-CHEM-09/10

Canada

Table of Contents

Executive Summary

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

The main objectives of the melamine in fluid milk, milk-based and soy-based products (excluding infant formulas) targeted survey were to:

- Provide baseline surveillance data for melamine levels in milk, milk-based and soy-based foods.
- Provide initial baseline data dealing with pesticide residues and metal levels in milk-based and soy-based products.

The 2009-2010 Melamine Survey targeted domestic fluid milk, domestic/imported milk-based products, and domestic/imported soy-based products. In total, 600 samples (250 domestic, 350 imports) were collected in the five following regional areas: Atlantic, Quebec, Greater Toronto, Greater Calgary and Vancouver. Overall, of the 600 samples tested, 579 had no detectable levels (<0.05 ppm) of melamine, while the remaining 21 samples were below Health Canada's interim standard of 2.5 ppm established for milk-based products. No melamine was detected in domestically sampled fluid milk. Thirteen of the 237 milk-based samples and eight of the 300 soy-based samples had detectable levels of melamine below 2.5 ppm. None of the results from the 2009-2010 melamine targeted survey exceeded the interim melamine standard of 2.5 ppm.

The CFIA also analysed the collected samples for over 200 different pesticide residues and 18 metals. Twenty-three samples contained detectable pesticide residues, 21 samples contained one pesticide residue and 2 samples contained two pesticide residues. One sample contained pirimiphos-methyl residues above the Canadian General MRL of 0.1 ppm. Of the 18 metals tested, two samples contained levels of arsenic >1.0 ppm and 11 samples had quantifiable levels of antimony. The levels of pesticide residues and metals found in the foods analysed are not considered to be of concern to health. The overall compliance rate for the pesticide residue and metals analysis was 99.8%.

1 Introduction

1.1 Food Safety Action Plan

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

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

1.2 Targeted Surveys

Targeted surveys are pilot surveys used to gather information regarding the potential occurrence of chemical residues or hazards in defined commodities. The surveys are designed to answer specific questions. Therefore, unlike monitoring activities, testing of a particular chemical hazard is targeted to commodity types and/or geographical areas. Due to the vast number of chemicals hazards and food-commodity combinations, it is not possible, nor should it be necessary, to use targeted surveys to identify and quantify all chemical hazards in foods. To identify food-hazard combinations of greatest potential health risk, the CFIA uses a combination of media reports, scientific literature and/or a risk-based model developed by the Food Safety Science Committee (FSSC). In response to the melamine crisis in 2008, a melamine targeted survey in milk, milk-based and soy-based products was initiated to establish baseline data in protein rich foods of domestic and imported origin.

The initial intent of this targeted survey was to analyze the samples for melamine only. However, the CFIA saw an opportunity to obtain further information concerning the levels of pesticide residues and metals in the same non-registered food products sampled for this survey. The CFIA analysed all of the milk, milk-based and soy-based samples for pesticide residues and heavy metals to provide a more complete picture of the products available to Canadian consumers. It should be noted that milk-based and soy-based products are not routinely tested as part of the National Chemical Residue Monitoring Program (NCRMP). Refer to Appendix B for the results and discussion pertaining to the pesticide and metal analysis.

1.3 Acts and Regulations

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

Health Canada determines the regulatory limits for contaminants in food. Certain maximum levels for chemical contaminants in food appear in the Canadian *Food and Drug Regulations*, where they are referred to as tolerances. There are also a number of maximum levels that do not appear in the Regulations and are referred to as standards. In the case of melamine, Health Canada has set an interim standard of 0.5 ppm in infant formula and sole source nutrition products (e.g., meal replacement products) and 2.5 ppm in other milk-based products[1]. The interim standards set by Health Canada are consistent with those adopted by other food regulatory agencies in Europe, Australia, New Zealand and the United States[2].

The analytical results from targeted survey samples are compared to the interim melamine standard. Levels at or below the standard are in compliance with Canadian Regulations and do not require further action. Levels above are identified as non-compliant and are assessed by the CFIA or Health Canada for potential risk to consumers' health. Follow-up actions are initiated on a case by case basis in a manner that reflects the magnitude of the health risk. Actions may include notification of the producer or importer, follow-up inspections, additional directed sampling, and recall of products.

It should be noted that there is no interim standard set for melamine in fluid milk and soy-based products. For the purposes of this targeted survey, the interim standard of 2.5 ppm melamine established for milk-based products will be used to determine if follow-up action should occur in fluid milk and soy-based products.

2 Melamine Survey

2.1 Melamine

Melamine ($C_3H_6N_6$; 1,3,5-triazine-2,4,6-triamine) is produced as a high volume synthetic chemical and is used in a variety of industrial applications (e.g., electrical equipment, laminates, permanent-press fabrics, flame-retardants). It does not naturally occur in food nor is it permitted as an additive in food. However, trace amounts of melamine can be present in food as a result of uses in food contact materials, including articles made of melamine-formaldehyde plastics, can coatings, adhesives, paper and board[3]. Also, melamine can be present as a result of environmental degradation of sanitizing solutions used for cleaning food-processing equipment and food-contact articles (trichloromelamine). Detectable levels of melamine may be present in foodstuffs through the correct use of triazine based pesticides (e.g. cyromazine). In the case of cyromazine,

melamine is a degradation product of the pesticide. Melamine may be present in animal products (i.e., milk, meat) at baseline concentrations owing to cyromazine use on crops used as animal feed or its use as a veterinary drug[4]. Depending on the purification process, melamine may contain a number of structurally related by-products, particularly ammelide, ammeline and most notably cyanuric acid[3].

2.1.1 Misuse or adulteration

In early 2007, reports surfaced of cats and dogs developing renal failure after ingesting pet foods adulterated with melamine and related compounds[5]. Contamination was traced to imported food-grade wheat gluten and rice protein concentrate laced with high concentrations of nitrogen-rich melamine and melamine related compounds (i.e., cyanuric acid)[2]. Melamine had been intentionally added to fraudulently boost the protein content of those foods. The contamination was not limited to pet foods, as melamine was also detected, at lower levels, in fish feeds[6].

In September 2008, melamine adulteration was found in a number of different brands of infant formula manufactured and sold in China. It was discovered that melamine was deliberately added to raw milk for a number of months in order to boost its apparent protein content[7]. The presence of melamine was linked to an increased incidence of kidney stones and renal failure observed in infants resulting in hospitalization and even death. It is important to note that major manufacturers of infant formula sold in Canada do not source milk ingredients from China[1]. In 2008, a number of countries detected elevated levels of melamine in certain food products. Recalls were issued for a in a variety of Chinese products, including milk-based candies, instant powdered coffee products, biscuits, chocolates, milk-based drinks, cakes, ammonium bicarbonate, animal feed and feed ingredients, egg powders and fresh eggs, and creamers[8, 9, 10].

2.1.2 Toxicity

Available data indicates that simultaneous exposure to melamine and the by-product, cyanuric acid, is more toxic than exposures to each compound individually[7]. The target for melamine and cyanuric acid toxicity is the urinary system in humans and animals. Upon investigation of pets that died due to consuming contaminated pet food, crystals containing melamine and cyanuric acid were found to be present in the kidneys. Of the infants who were affected by the adulteration of infant formula, many of them had stones in the kidney, ureter or bladder, composed of melamine and uric acid, the latter being naturally present in urine[3]. The difference between the composition of the urinary stones found in pets and human infants appears to be due to the source of the melamine to which they were exposed. The melamine added to the infant formula contained very low levels of cyanuric acid, whereas the pet food contained a crude mixture of melamine and cyanuric acid[3].

2.2 Rationale

The purpose of this survey was to target food commodities that could be adulterated with melamine. As a result of the previous cases of melamine adulteration, the criterion used to select products sampled in this survey was that they contain protein rich ingredients such as milk powder or soy protein. Products such as chocolate, candy, biscuits containing milk or milk products are regularly imported into Canada from countries where adulteration with melamine has been known to occur, therefore it is important to continue surveying for potential contamination. Soy protein is often added to products such as imitation meats, beverage powders, cheeses, creamer, etc. as a protein source, as a result the potential for adulteration is present. The targeted commodities for this survey include domestic fluid milk, domestic and imported milk-based products and domestic and imported soy-based products. The results from the survey will establish a baseline level for melamine in food and will also allow the CFIA to compare suspected cases of adulteration to baseline levels. The data may also be used to refine any human health risk assessments carried out for melamine.

The analytical method used in the current targeted survey is a confirmatory method to detect for the presence of melamine only. Although cyanuric acid was not specifically tested for in this survey, there is the potential that the presence of melamine can act as an indicator compound. As such, if melamine is found in sufficient quantities, future surveys may be planned to quantify levels of cyanuric acid.

2.3 Sample distribution

The 2009-2010 Melamine Survey targeted domestic fluid milk, domestic/imported milk-based products, and domestic/imported soy-based products. In total, 600 samples (250 domestic, 350 imports) were collected in the five following regional areas: Atlantic, Quebec, Greater Toronto, Greater Calgary and Vancouver. The distribution of samples with respect to country of origin is depicted in Figure 1. Country of origin is considered to be the country of manufacture as stated on the product label. The determination of country of origin can be hampered by the fact that raw materials may be sourced from different countries and are mixed prior to transformation into the final product.

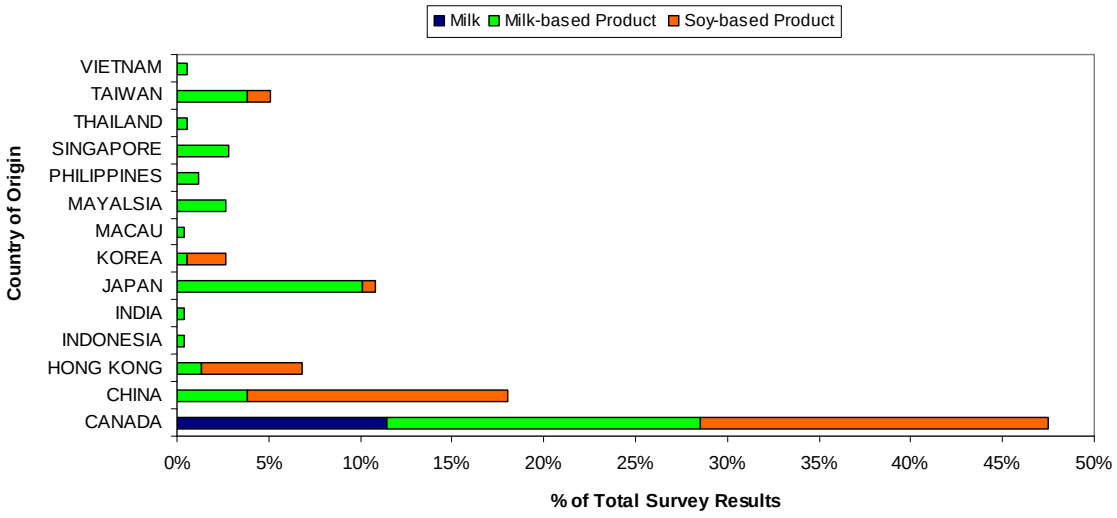


Figure 1. Distribution of samples by country of origin from the 2009-2010 targeted survey.

In the targeted survey 63 fluid milk, 237 milk-based and 300 soy-based products were sampled at retail level (Figure 2). In this survey, fluid milk refers to whole, partly skimmed, skim, cream and buttermilk. Milk-based products included any products in which milk was one of the first three ingredients indicated on the label. This included refrigerated beverages, cream cheese, yogurt, ice-cream, coffee beverages, creamers (refrigerated ready-to-serve and instant dry packets), puddings, candies and desserts. Soy-based products included refrigerated and non-refrigerated soy drinks/beverages, instant puddings, tofu and food products containing soybean meal and soy lecithin. Food products were collected in pre-packed retail containers from a mixture of grocery stores, ethnic markets and specialty stores.

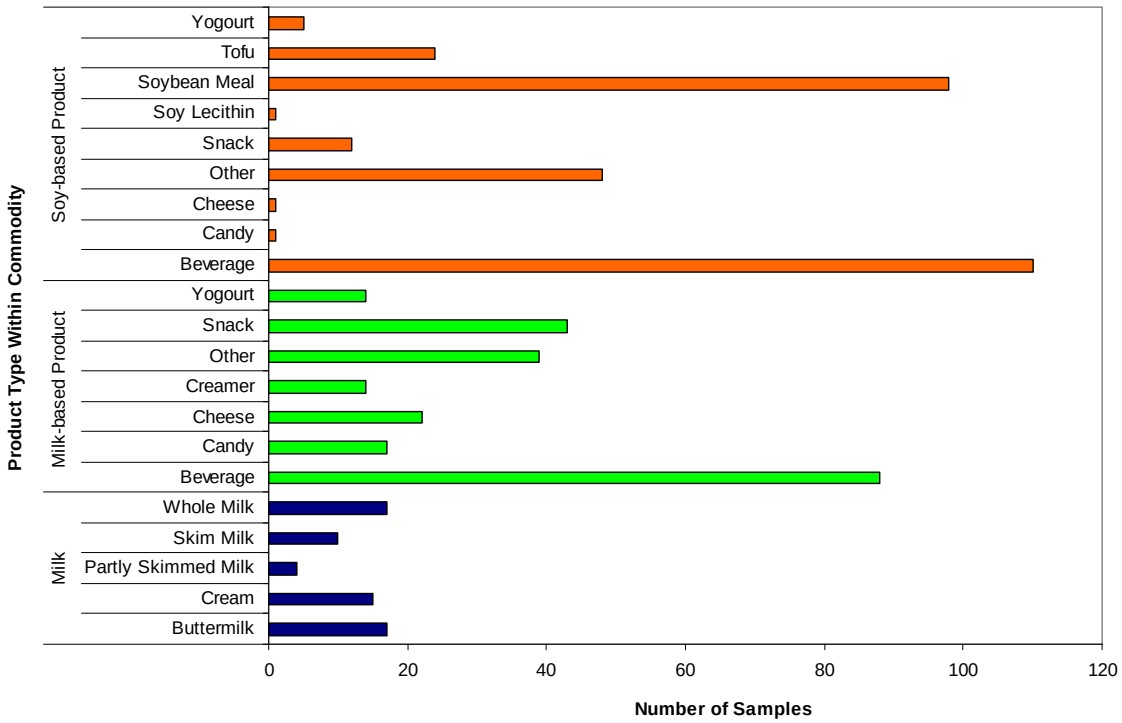


Figure 2. Distribution and number of products sampled within each commodity type from the 2009-2010 targeted survey.

2.4 Detailed method

Samples from the melamine targeted survey were analysed by an accredited third party laboratory. Third party laboratories are accredited to ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories* (or its replacement by the Standards Council of Canada (SCC)).

The CFIA reference method entitled 'Determination of Melamine using Cation Exchange and Liquid Chromatography Electrospray Ionization Mass Spectrometry (LC/ESI-MS/MS)' was used to quantify melamine levels in all products sampled. The method consisted of protein precipitation by acetonitrile/water, extraction of melamine by cation exchange solid phase extraction, and sample analysis by liquid chromatography electrospray ionization tandem mass spectrometry (LC/ESI-MS/MS). The reporting limit for this method has been validated at 0.125 ppm with a limit of detection at 0.05 ppm. The validated analytical range for the method was 0.125 ppm to 12.5 ppm.

2.5 Limitations

The melamine survey was designed to provide a snapshot of the melamine levels in food available to Canadian consumers. In comparison to the total number of milk, milk-based and soy-based products available, 600 total samples represent a small fraction of products available to consumers regionally. Therefore, care must be taken when interpreting and extrapolating using these results. Also, this survey does not examine year-to-year trends, impact of product shelf-life or cost of the commodity on the open market.

3 Results and Discussion

3.1 Directed Melamine Sampling (2007-2008)

As a result of the infant formula and pet food melamine crises, the CFIA initiated interim testing to ensure that products available on the retail market were safe. Eight hundred and eight samples were obtained by CFIA inspectors at the importer/manufacturer level originating from 23 countries. The 808 samples were divided by product type into beverages, infant formula, lysine, miscellaneous products, monosodium glutamate, protein isolate, soy protein and sweets. Seven hundred seventy–four samples (96%) had no detectable levels of melamine (Figure 3). Eight samples (1%) contained detectable levels of melamine below the interim standard of 2.5 ppm and were considered to be compliant positives. The remaining 26 samples (3%) had levels over the interim standard and were considered to be non-compliant. None of the infant formula results exceeded the interim standard of 0.5 ppm. The overall compliance rate was 97%.

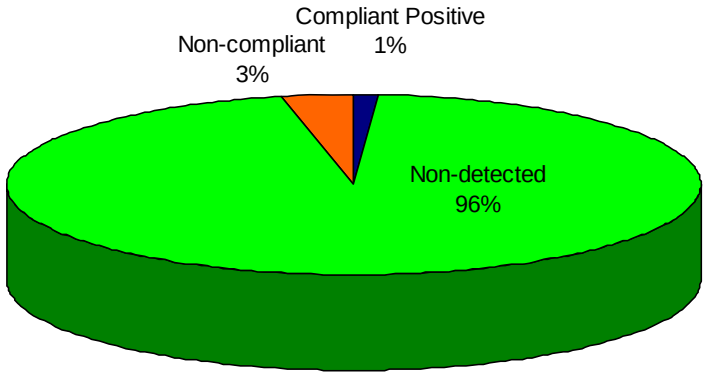


Figure 3. Distribution of samples for directed melamine sampling (2007-2008).

In total, 26 of the directed samples were not compliant with the 2.5 ppm interim standard set by Health Canada for foods containing milk or milk-derived ingredients. A detailed list of non-compliant samples is outlined in Appendix A. The majority of the non-compliant results occurred in sweets (18 products); with three beverage samples and five protein isolate (gluten meal intended for animal feed) samples exceeding the interim standard. The largest proportion of non-compliant samples were imported products originating from China (19 products) followed by Taiwan (4 products), Sri Lanka (1 product) and Singapore (1 product) (Figure 4). One non compliant sample was associated with imports that had no country of origin specified. Appropriate follow-up actions reflecting the magnitude of the health risk were taken for each non-compliant sample. These actions included notification of the producer or importer, follow-up inspections, additional directed sampling and product recalls.

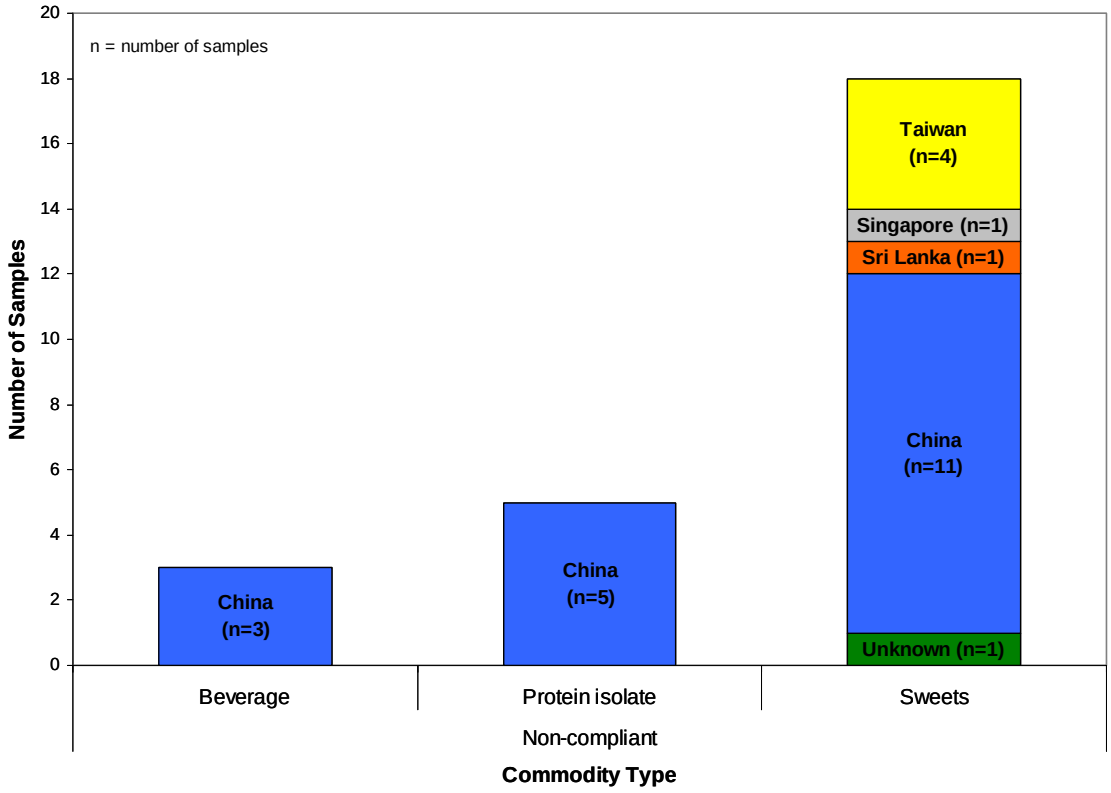


Figure 4. Distribution of non-compliant samples by commodity type and country of origin for directed melamine sampling (2007-2008).

3.2 2009-2010 Melamine Targeted Survey

In the following sections, only the results of the melamine analysis are presented. Please refer to Appendix B for further explanation and detail pertaining to the pesticide residue and metals analysis in fluid milk, milk-based and soy-based products. The levels of pesticide residues and metals analyzed as part of this survey are not considered to be of concern to human health. The data collected provides a suitable initial baseline for the levels of pesticide residues and metals in milk-based and soy-based foods.

3.2.1 General Trends

The 2009-2010 targeted survey consisted of testing 600 samples obtained at the retail level. Commodities sampled included 63 fluid milk samples (domestic only), 237 milk-based products and 300 soy-based products of both domestic and imported origins. Five hundred and seventy-nine samples had no detectable levels of melamine, while the remaining 21 samples contained levels of melamine below the interim standard of 2.5 ppm established for milk-based products (Figure 5).

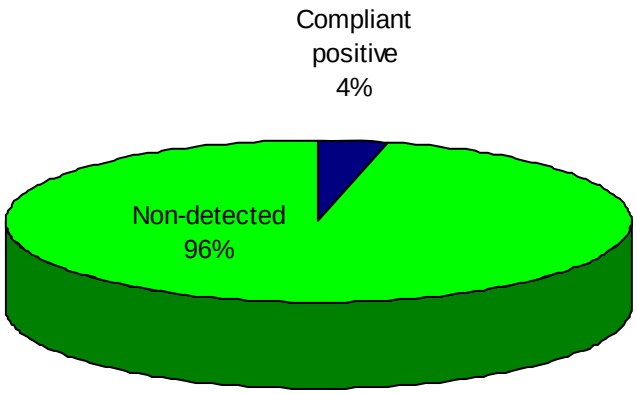


Figure 5. Distribution of samples for the 2009-2010 melamine targeted survey.

3.2.2 Melamine in Fluid Milk

Sixty-three samples of fluid milk divided between whole milk (n[1]=17), partly skimmed milk (n=4), skim milk (n=10), buttermilk (n=17) and cream (n=15) were analysed in this survey. Milk was sampled from different provinces; 14 samples from the Atlantic Provinces, 12 samples from Ontario, 13 samples from Quebec, 12 samples from Alberta

[1] n = denotes the number of individual samples tested

and 12 samples from BC. Four of the 63 samples were labelled as organic. The results indicate that melamine was not detected (<0.05 ppm) in any of the fluid milk samples.

3.2.3 Melamine in Milk-Based Products

Two hundred thirty-seven samples from 14 countries (87 domestic, 150 imported) of milk-based products were analysed in this survey. Products were considered milk-based if milk was listed as one of the first three ingredients. Samples were separated into the following categories; beverages (n=88), candy (n=17), cheese (n=22), creamers (n=14), other (n=39), snack (n=43) and yogurt (n=14). Levels of melamine detected ranged from 0.063 to 2.47 ppm (Table 1). The highest level of melamine, found in peanut cream wafers at 2.47 ppm, was below Health Canada's interim maximum limit of 2.5 ppm. The compliance rate was 100% for the milk-based products tested in this targeted survey.

Table 1. Compliant Positive Melamine Results in Milk-based Products

Commodity	Product	Country of Origin	Melamine Level (ppm)
Snack	Peanut Cream Wafers	Taiwan	2.47
Beverage	Silky Smooth Tea	Hong Kong	0.560
Beverage	Tea	China	0.443
Beverage	Milk Drink	China	0.384
Beverage	Iced Coffee Latte	China	0.317
Candy	Milk Chocolate	Singapore	0.284
Beverage	Coffee	Hong Kong	0.258
Beverage	Cereal Milk Drink, Banana Flavour	Singapore	0.202
Beverage	Milk Tea	Hong Kong	0.194
Beverage	Milk Tea	China	0.184
Other	Sesame Egg Roll	Macau	(0.118)[1]
Beverage	Milk Tea Drink	Singapore	(0.111)
Beverage	Mango Milk Drink	Singapore	(0.063)

[1](…) = Values less than the reporting limit of 0.125 ppm, but above the limit of detection of 0.05 ppm.

3.2.4 Melamine in Soy-Based Products

Three hundred samples (100 domestic, 200 imported) from ten countries of soy-based products were analysed in this survey. Products were considered soy-based if soy, soybean meal and/or soy lecithin were listed in the ingredients. Samples were separated into the following categories; beverages (n=110), candy (n=1), cheese (n=1), other (n=48), snacks (n=12), soy lecithin (n=1), soybean meal (n=98), tofu (n=24), and yogurt (n=5). Fifteen of the 300 samples were labelled as organic.

Eight soy-based product samples had detectable levels of melamine (i.e., >0.05 ppm), however only four were above the analytical method reporting limit of 0.125 ppm. The detectable values ranged from 0.065 to 0.343 ppm (Table 2). All levels of melamine were below Health Canada's interim standard of 2.5 ppm established for milk-based products.

As such, none of the levels detected in the soy-based products tested in this targeted survey pose a health risk.

Table 2. Compliant Positive Melamine Results in Soy-based Products

Commodity	Product	Country of Origin	Melamine Level (ppm)
Other	Fried Gluten with Peanuts	Taiwan	(0.065)[1]
Soybean Meal	Shiro Miso Organic White	Canada	(0.065)
Soybean Meal	Soybean Peanut Soup	Taiwan	(0.076)
Soybean Meal	Braised Gluten Tidbits	Taiwan	(0.117)
Beverage	Soy Beverage	Hong Kong	0.142
Soybean Meal	Miso Organic Soya and Rice	Canada	0.145
Soybean Meal	Mugi Miso Organic Mellow Barley	Canada	0.207
Soybean Meal	Hot Spice Bean Curd	China	0.343

[1](…) = Values less than the reporting limit of 0.125 ppm, but above the limit of detection of 0.05 ppm.

3.2.5 Discussion

Similar types of milk-based products were analysed in both the directed 2007-2008 and targeted 2009-2010 surveys. In the directed survey, maximum levels of melamine were 631 ppm in sour milk beverage and ranged from 14 – 48 ppm in milk chocolate coins (Appendix A). While in the 2009-2010 targeted survey, the maximum level of melamine was 2.47 ppm in peanut cream wafers (a milk-based product) (Tables 1 and 2). All other levels found were well below Health Canada's interim standard of 2.5 ppm established for milk-based products. A comparison of the data collected in the targeted survey versus the directed sampling illustrates that the presence of melamine has decreased dramatically.

The source of the detected melamine in the milk-based and soy-based samples is unknown. However, melamine is known to enter the food chain through a number of different sources, including from products that come into contact with food and environmental sources food and environmental sources. Sources can range from migration of melamine from approved food packaging material, environmental breakdown of the approved pesticide cyromazine, carry over from animal feed to products of animal origin, to the degradation of sanitizing solutions used on food equipment (trichloromelamine)[7]. As recently as July 2010, Chinese officials were recalling milk powders after finding adulterated products in a market in June, 2010[11]. In all the recent cases, the contaminated products were destined for Chinese consumption and appear to be leftovers from the 2008 recall[11]. The limits of 0.5 ppm in powdered infant formula and 2.5 ppm in other foods containing milk and milk-based ingredients were established by Health Canada as the appropriate level to distinguish between the unavoidable background presence of melamine (from food contact materials, pesticide use, etc.) and unacceptable adulteration. . Although one sample contained 2.47 ppm of melamine, this sample is not of concern and is below Health Canada's interim standard.

4 Conclusions

The 2009-2010 targeted survey was completed as a follow-up survey to the melamine crisis in 2007-2008. The purpose was to target food commodities that could be adulterated with melamine. No detectable levels of melamine were found in domestic fluid milk at retail. Detectable levels of melamine were found in milk-based and soy-based products at levels below Health Canada's interim standard of 2.5 ppm established for milk-based products. Within the domestic fluid milk, imported/domestic milk-based products and imported/domestic soy-based products, none of the samples exceeded the 2.5 ppm interim standard. Also, it was observed that maximum levels of melamine were substantially lower in the 2009-2010 targeted survey when compared to similar foods from the 2007-2008 directed sampling survey data. It should be noted that infant formula was not collected and analysed in this targeted survey.

The data collected from the 2009-2010 targeted survey provided CFIA with additional baseline data that may be used by Health Canada to update health risk assessments and, in turn, any risk management strategies. As a result, any data collected from future targeted surveys can be compared against the melamine baseline data in order to assess any changes to the levels of melamine over time in protein rich foods.

5 Appendix A

Table A.1. A detailed list of non-compliant samples for the directed melamine sampling (2007 to 2008).

Commodity	Product Name[1]	Level (ppm)	Total Number of Samples
Sweets	Assorted Biscuit	2.7	N=394
Sweets	Nutritious Anka Cookie	2.7	
Sweets	Chocolate Biscuit Double Chocolate Flavour	2.8	
Sweets	Strawberry Snack White Chocolate Filled Biscuit	3.1	
Sweets	Lemon Puff	3.2	
Sweets	Chocolate Biscuit	3.5	
Sweets	Extra Light Family Crackers	3.5	
Sweets	Choco Dressing Pretzel	3.7	
Sweets	Chocolate Flavour Cake	4.1	
Sweets	Strawberry Dressing Pretzel	4.2	
Sweets	Coconut Cakes	4.3	
Sweets	Chocolate Biscuit	5.6	
Sweets	Biscuit with chocolate jam	6.1	
Sweets	Mini Brown Sugar Cookie	6.2	
Sweets	Strawberry Flavour Cake	8.7	
Sweets	Gold Chocolate Coins	14.2	
Sweets	Milk Chocolate Coins	28.5	
Sweets	Milk Chocolate Coins	48.3	
Protein Isolate	Corn Gluten Meal (Animal Feed)	30	N=60
Protein Isolate	Corn Gluten Meal (Animal Feed)	54	
Protein Isolate	Corn Gluten Meal (Animal Feed)	92	
Protein Isolate	Corn Gluten Meal (Animal Feed)	96	
Protein Isolate	Corn Gluten Meal (Animal Feed)	111	
Beverages	Sour Milk Beverage	631	N=142
Beverages	Sour Milk Beverage	3.1	
Beverages	Yogurt Drink	3.7	

[1]The following website contains a list of the recalls associated with the 2007-2008 directed sampling: Canadian Food Inspection Agency. *Melamine in milk products from China (2008)*. 2010. Accessed May 31, 2010. http://www.inspection.gc.ca/english/fssa/concen/2008melamine.shtml

6 Appendix B

6.1 Pesticide Residues and Metals Survey Summary

In this targeted survey the CFIA had the opportunity to develop a more complete picture of potential chemical contaminants that could be present in fluid milk, milk-based and soy-based products. In addition to analysing for melamine, analytical methods for the determination of pesticide residue and heavy metal levels were carried out on the same samples.

6.1.1 Detailed Method

As stated in section 3.4, all samples were analysed by an accredited third party laboratory. There were two analytical tests conducted on all samples in this portion of the targeted survey; a method for the determination of pesticides in processed foods by GC-MS, and a method for the analysis of metals in processed foods by inductively-coupled plasma-mass spectrometry (ICP-MS). The methods used for pesticide residue and metals analysis were reviewed by the CFIA and were determined to meet or exceed the method accreditation requirements.

6.1.2 Results of Pesticide Residue Analysis

Pesticides are an important tool in crop management practices and are widely used around the world. Although pesticides play an important role in the protection of crops from insects, weeds and fungal pests, inappropriate uses of these chemical compounds may pose a hazard to health. Potential health risks can arise when pesticides are not used in accordance with the registered label or unregistered pesticides are used. For example, pesticides applied higher than the registered rate or harvested too soon after application, can lead to increased pesticide residues in/on the treated crops and processed finished products.

Within the 2009-2010 targeted survey, 600 samples were obtained at retail. Refer to section 3.3 for details concerning sample description and country of origin. Five hundred and seventy-seven (96%) of the samples contained no detectable pesticide residues. Of the 23 samples that contained detectable residues, 21 samples contained one pesticide residue and two samples contained two residues. There was one sample in which the pesticide residue exceeded the Canadian General MRL of 0.1 ppm as indicated in the FDA&R subsection B.15.002 (Table B.1). Strawberry cream wafers imported from Malaysia contained 0.1072 ppm of pirimiphos-methyl. Appropriate follow-up actions reflecting the magnitude of the health risk were taken. Based on MRLs for pirimiphos-methyl established in other crops and the limited information regarding the prevalence of this residue in strawberry wafers in general, it was determined that 0.1072 ppm in cream wafers represented a technical violation only. Given the factors above it was concluded that there was no human health risk associated with this sample.

6.1.3 Metal Analysis

Metals occur in food naturally, they may also be present in food as a result of the use of agricultural chemicals or processing aids, nutritional supplementation, or result from environmental uptake. The results presented in Table B.2 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 nor do they reveal the potential source (i.e., intentional versus naturally occurring).

There are very few maximum limits established for metals. Often the levels of metals found in foods are compared to observed historical values for the commodity tested. Of the 18 different metals tested, the majority of them were considered to be comparable with observed historical values for the specified metal. However, some metals/elements, such as arsenic and antimony, were either higher than observed historical values or there were no historical values for comparison.

Arsenic naturally occurs in the earth's crust typically found in combination with other elements, resulting in organic or inorganic compounds. Exposure to arsenic may occur through inhalation, drinking water and dietary intake. At present there are three tolerances for arsenic in the FDAR; fish protein (3.5 ppm), edible bone meal (1 ppm) and fruit juices, fruit nectar, beverages when ready to serve and water in sealed containers other than mineral water or spring water (0.1 ppm). However, no tolerances are established for the foods investigated in this targeted survey. Levels of arsenic were found at >1.0 ppm in two product types, soy-based instant miso soups (3 samples) and rice crackers wrapped in seaweed (1 sample). The common factors between the products were that the ingredients contained rice and seaweed. Both rice and seaweed are known to contain higher levels of arsenic than other food products[12, 13, 14]. Instant soup powders are not meant to be consumed as purchased. The level of arsenic in the soup mix as it is meant to be consumed is not of concern. Both of these products are considered specialty foods and do not have high rates of daily consumption. These products were not considered to be a health concern, based on their low contribution to the total diet of the Canadian citizen and the dilution factor of the soups when prepared as per the directions.

Antimony is typically found at very low levels in the environment. Exposure to antimony may occur through inhalation, drinking water and dietary intake. In Canada the interim maximum acceptable concentration for antimony in drinking water is 6 ppb, however there are no established guidelines for antimony in food. Of 600 samples tested, 11 had quantifiable levels of antimony ranging from 0.021 – 0.091 ppm. Antimony was found in cheese spread, pudding, packaged cakes, 3 in 1 coffee/tea mixes, sesame oil and flavoured powders. Approximately half of the products (i.e., coffee/tea mixes and flavoured powders) were purchased in a concentrated form, when prepared as per directions for consumption, the levels of antimony would be below the 6 ppb drinking water guideline. The remaining products were meant to be consumed as bought. When levels of antimony were converted to possible intakes per unit body weight, using estimated serving size, all intakes were well below the toxicological reference dose of 3 μg/kg bw/day, established by the Bureau of Chemical Safety, Health Canada[15]. Also, the

products containing detectable levels of antimony are not expected to make up a large portion of the daily diet. The levels of antimony found in a small number of milk-based and soy-based products are not considered to be a concern to human health.

6.2 Conclusions

Of the 600 samples analysed for pesticide residues, one sample contained residues of pirimiphos-methyl in cream wafers greater than the General MRL of 0.1 ppm. There was no human health risk associated with this non-compliant sample and it was determined to be a technical violation only.

The results from the analysis of the majority of metals were consistent with observed historical values and past NCRMP and Children's Food Monitoring Surveys. The arsenic and antimony samples were further investigated as they contained levels higher than observed historical values or in the case of antimony there were no historical values. All of the products with quantifiable levels of arsenic and antimony are not considered to be of concern to human health. This was based on daily intake rates and dilution factors for those products that were analysed as a concentrated product. The data collected provides a suitable initial baseline for the levels of pesticide residues and metals in milk-based and soy-based foods.

Table B.1 – Pesticide residues listed by country of origin and product type.

Country of Origin	Commodity Type	Product	Pesticide	Amount (ppm)	Comments
Canada	Soybean Meal	Meat Free Dijon Breast	Piperonyl butoxide	0.0166	< 0.1 ppm or the specific regulatory MRL, in accordance with paragraph B.15.002 of the *Food and Drug Regulations*.
	Soybean Meal	Miso Organic Soya & Rice	Biphenyl	0.0032	
	Tofu	Tofu	Endosulfan	0.0557	
	Soybean Meal	Tofu Dog	2-phenylphenol (ortho-phenylphenol)	0.0037	
	Soybean Meal	Vege-Pate	Chlorpropham	0.0499	
China	Candy	Creamy Candy	p,p'-DDE	0.0026	
	Soybean Meal	Dried Bean Curd Stick	Biphenyl	0.0036	
	Soybean Meal	Fermented Preserved Bean Curd	Biphenyl	0.0125	
	Other	Soup Base for Hot and Spicy Hot Pot	Biphenyl	0.0081	
	Other	Spicy Hotpot Seasoning	Diphenylamine	0.0022	
India or Indonesia (IND)	Cheese	Cottage Cheese Curry	BHC Total	0.0072	
			Chlorpyrifos	0.0234	
	Other	Onion and Yogurt Cooking Sauce	Triazophos	0.0077	
Japan	Candy	Caramel Candy	Diphenylamine	0.0024	
Korea	Other	Hot Kalbi Sauce, Marinade	Ethion	0.0323	
Malaysia	Snack	Cream Wafer Stick	Pirimiphos-methyl	0.1072	>0.1 ppm, however not determined to be a health risk as US tolerances[1] and CODEX MRLs[2] established in grain crops are significantly higher.
	Snack	Cream Wafer Stick	Pirimiphos-methyl	0.0757	<0.1 ppm in accordance with paragraph B.15.002 of the *Food and Drug Regulations*.
	Other	Kung Po Sauce	Chlorpyrifos	0.0053	
			Ethion	0.0716	
Singapore	Snack	Cream Cracker	Pirimiphos-methyl	0.0635	
Thailand	Beverage	Thai Tea	p,p'-DDE	0.0659	
Taiwan	Candy	Calcium Milk Candy	Chlorpyrifos	0.0068	
	Snack	Cream cracker cheese	o,p'-DDT	0.014	
	Snack	Durian Cake	p,p'-DDE	0.0067	
	Soybean Meal	Vegetarian Minced Meat	Chlorpyrifos	0.0101	

[1] U.S. National Archives and Records Administration. *Electronic Code of Federal Regulations. Title 40: Protection of the Environment, 180.409 Pirimiphos-methyl; tolerances for residues*. September 19, 2007. Accessed May 31, 2010. http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=d7e1ca1f51573ffbd7042c5c607ef747&rgn=div8&view=text&node=40:23.0.1.1.28.3.19.165&idno=40

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Table B.2 – Summary data for metals analysis.

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	Min (ppm)	Max (ppm)	Mean (ppm)	Comments
Aluminum (Al)	**600**	**50**	**550**	**<LOD**	**877.3**	**5.755**	Highest levels found in baking mixes (i.e., waffle mix), milk tea, drink mixes (i.e., tea and coffee mix) and crackers. Al-based food additives are permitted for use up to GMP[1] levels.
Milk	63	23	40	<LOD	0.657	0.06	
Milk-based product	237	24	213	<LOD	877.3	11.74	
Soy-based product	300	3	297	<LOD	46.67	2.224	
Antimony (Sb)	**600**	**590**	**10**	**<LOD**	**0.091**	**0.001**	No maximum levels (MLs) or guidelines established in Canadian food.
Milk	63	63	0	<LOD	<LOD	<LOD	
Milk-based product	237	228	9	<LOD	0.091	0.001	
Soy-based product	300	299	1	<LOD	0.042	<LOD	
Arsenic (As)	**600**	**207**	**393**	**<LOD**	**2.116**	**0.030**	Higher levels than observed historical values. The levels found in the survey are not considered to be of concern to human health.
Milk	63	35	28	<LOD	0.070	0.008	
Milk-based product	237	79	158	<LOD	0.360	0.020	
Soy-based product	300	207	93	<LOD	2.116	0.042	
Beryllium (Be)	**600**	**0**	**0**	**<LOD**	**<LOD**	**<LOD**	
Milk	63	0	0	<LOD	<LOD	<LOD	
Milk-based product	237	0	0	<LOD	<LOD	<LOD	
Soy-based product	300	0	0	<LOD	<LOD	<LOD	
Boron (B)	**600**	**104**	**496**	**<LOD**	**27.29**	**1.542**	No MLs or guidelines established in Canadian food. Higher levels than observed historical values. However B is an essential nutrient and commonly found in foods. The levels found in the survey are not considered to be of concern to human health.
Milk	63	27	36	<LOD	0.394	0.112	
Milk-based product	237	76	161	<LOD	8.468	0.504	
Soy-based product	300	1	299	<LOD	27.29	2.661	
Cadmium (Cd)	**600**	**308**	**292**	**<LOD**	**0.177**	**0.008**	No MLs or guidelines established in Canadian food. Below observed historical values.
Milk	63	63	0	<LOD	<LOD	<LOD	
Milk-based product	237	172	65	<LOD	0.097	0.004	
Soy-based product	300	73	227	<LOD	0.177	0.014	
Chromium (Cr)	**600**	**91**	**509**	**<LOD**	**0.658**	**0.035**	No MLs or guidelines established in Canadian food. Below observed historical values.
Milk	63	25	38	<LOD	0.044	0.014	
Milk-based product	237	97	140	<LOD	0.657	0.035	
Soy-based product	300	88	212	<LOD	0.658	0.039	

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	Min (ppm)	Max (ppm)	Mean (ppm)	Comments
Copper (Cu)	**600**	**120**	**480**	**<LOD**	**17.64**	**1.161**	MRL of 50 ppm Cu compounds on fresh fruits and vegetables. Although no MRLs established for the foods sampled, levels were below observed historical values. Levels found are not considered to be of concern to human health..
Milk	63	22	41	<LOD	0.116	0.030	
Milk-based product	237	61	176	<LOD	5.619	0.464	
Soy-based product	300	8	292	<LOD	17.64	1.949	
Iron (Fe)	**600**	**120**	**480**	**<LOD**	**218.4**	**10.315**	No MLs established in Canadian food. Dietary Reference Intakes are listed for iron[4]. Levels found are comparable to those reported in previous NCRMP and Children's Food Report survey and were below the listed upper dietary reference intake. Iron is an essential mineral in the human diet.
Milk	63	46	17	<LOD	1.855	0.144	
Milk-based product	237	73	164	<LOD	218.4	6.099	
Soy-based product	300	1	299	<LOD	165.3	15.781	
Lead (Pb)	**600**	**331**	**269**	**<LOD**	**0.273**	**0.007**	MLs and guidelines are established[2], however not in the foods sampled. Levels found are comparable to those reported in previous NCRMP and Children's Food Report survey. Levels found are not considered to be of concern to human health.
Milk	63	62	1	<LOD	0.002	<LOD	
Milk-based product	237	133	104	<LOD	0.056	0.005	
Soy-based product	300	136	164	<LOD	0.273	0.011	
Manganese (Mn)	**600**	**57**	**543**	**<LOD**	**224.1**	**4.108**	No MLs established in Canadian food. Higher levels than observed historical values. However Mn is an essential nutrient and commonly found in foods. Highest levels were found in tea powders/leaves, known to contain high levels of Mn[3]. Levels found in the survey were below the listed dietary reference intakes[4] and are not considered to be of concern to human health.
Milk	63	33	30	<LOD	0.269	0.019	
Milk-based product	237	23	214	<LOD	224.1	3.411	
Soy-based product	300	1	299	<LOD	33.21	5.516	
Mercury (Hg)	**600**	**599**	**1**	**<LOD**	**0.005**	**<LOD**	No MLs or guidelines established in Canadian food. Levels found are comparable to those reported in previous NCRMP and Children's Food Report surveys. The levels found in the survey are considered not to be of concern to human health.
Milk	63	63	0	<LOD	<LOD	<LOD	
Milk-based product	237	237	0	<LOD	<LOD	<LOD	
Soy-based product	300	299	1	<LOD	0.005	<LOD	

Molybdenum (Mo)	**600**	**97**	**503**	**<LOD**	**4.575**	**0.229**	No MLs or guidelines established in Canadian food. Mo is an essential micronutrient commonly found in legumes, leafy vegetables and cauliflower. The levels found in the survey are considered not to be of concern to human health.
Milk	63	0	63	0.026	0.496	0.060	
Milk-based product	237	87	150	<LOD	0.493	0.060	
Soy-based product	300	10	290	<LOD	4.575	0.398	

Metal Analyte	Total # Samples	Total # Negative	Total # Positive	Min (ppm)	Max (ppm)	Mean (ppm)	Comments
Nickel (Ni)	**600**	**176**	**424**	**<LOD**	**6.031**	**0.339**	No MLs established in Canadian food. Sources of nickel include lentils, oats and nuts. Majority of the samples with higher levels of nickel were for soy-based products. Levels found in this survey were below the listed dietary reference intake[4] and are not considered to be of concern to human health.
Milk	63	63	0	<LOD	<LOD	<LOD	
Milk-based product	237	112	125	<LOD	2.572	0.103	
Soy-based product	300	1	299	<LOD	6.031	0.597	
Selenium (Se)	**600**	**304**	**296**	**<LOD**	**1.219**	**0.043**	No MLs or guidelines established in Canadian food. Selenium is an essential trace mineral in the human diet. The higher levels found in this survey do not pose a human health risk and are comparable to the NCRMP and Children's Food Report results.
Milk	63	10	53	<LOD	0.060	0.027	
Milk-based product	237	115	122	<LOD	0.390	0.044	
Soy-based product	300	179	121	<LOD	1.219	0.045	
Tin (Sn)	**600**	**532**	**68**	**<LOD**	**2.442**	**0.015**	ML of 250 ppm established for canned foods. The levels in the survey were below observed historical values.
Milk	63	62	1	<LOD	0.028	<LOD	
Milk-based product	237	209	28	<LOD	1.260	0.016	
Soy-based product	300	261	39	<LOD	2.442	0.018	
Titanium (Ti)	**600**	**514**	**86**	**<LOD**	**9.779**	**0.092**	No MLs or guidelines established in Canadian food. Ti dioxide is added to food as a white food coloring. Ti dioxide is permitted for use up to GMP levels. The levels found do not pose a human health risk.
Milk	63	63	0	<LOD	<LOD	<LOD	
Milk-based product	237	197	40	<LOD	9.779	0.166	
Soy-based product	300	254	46	<LOD	3.289	0.053	
Zinc (Zn)	**600**	**1**	**599**	**<LOD**	**76.91**	**6.655**	No MLs established in Canadian food. Levels found are comparable to those reported in previous NCRMP and Children's Food Report surveys. The levels found in the survey were below the listed dietary reference intake[4] and do not pose a human health risk.
Milk	63	0	63	1.123	6.755	3.107	
Milk-based product	237	1	236	<LOD	53.18	4.909	
Soy-based product	300	0	300	0.296	76.91	8.779	

[1]GMP = Good Manufacturing Practices

[2]Note: Violations are determined if one of the following Canadian MRLs is exceeded: 1) 50 ppm copper in fresh fruit and vegetables, 2) 250 ppm tin in canned foods, 3) 0.1 ppm arsenic in fruit juices, fruit nectars, ready to serve beverages and water in sealed containers other than spring and mineral water, 4) 0.2 ppm lead in fruit juices, fruit nectars, ready to serve beverages or water in sealed containers other than spring and mineral water, 5) 1.5 ppm lead in tomato paste or tomato sauce, 6) 0.5 ppm lead in whole tomatoes and maple products or 7) 0.15 ppm lead in evaporated milk, condensed milk and concentrated infant formula.

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