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

FOOD SAFETY ACTION PLAN

REPORT

2013-2015
TARGETED SURVEYS - CHEMISTRY

Aluminum in Baking Powders, Baking Mixes, Baked Goods, and Breads

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Executive Summary

Targeted surveys are used by the Canadian Food Inspection Agency (CFIA) to provide support for the prioritization of the Agency's activities to areas of greater concern and scientific evidence to address areas of lesser concern. Originally started under the Food Safety Action Plan (FSAP), targeted surveys have been incorporated into the CFIA's regular surveillance activities as a valuable tool for generating essential information on certain hazards in foods, identifying/characterizing new and emerging hazards, informing trend analysis, prompting/refining human health risk assessments, assessing compliance with Canadian regulations, highlighting potential contamination issues, and promoting compliance.

The main objectives of this targeted survey were to:

- generate baseline surveillance data on the levels of aluminum in selected domestic and imported baked goods, baking mixes, baking powders and breads available on the Canadian retail market, and
- compare the prevalence and levels of aluminum in foods targeted in this survey to Health Canada's Total Diet Study and to scientific literature, where feasible.

Aluminum occurs naturally in the environment and is the most abundant metallic element in the Earth's crust. The main route of aluminum exposure for humans is from its use in food additives as aluminum-containing food additives. For example sodium aluminum sulphate and potassium aluminum sulphate are each permitted for use as pH adjusters in baking powder and as carriers of benzoyl peroxide which can be used as a bleaching agent in flour production. Other aluminum compounds may be used as emulsifying agents, firming agents, anti-caking agents, and colouring agents.

There are currently no Canadian regulatory limits for aluminum in the commodities targeted with this survey although there are conditions of use set out in Health Canada's Lists of Permitted Food Additives for aluminum and aluminum-containing food additives that may be used in baking powder, flour, and whole wheat flour.

The 2013-2015 CFIA Aluminum survey targeted domestic and imported baking powders, baking mixes, baked goods, and breads. A total of 940 samples were collected from retail stores in 6 Canadian cities between May 2013 and March 2015. The samples collected included 386 baking mixes, 256 breads, 203 baked goods and 95 baking powders. As the samples were picked up at retail, there is no information readily available on the conditions (e.g. temperature, duration) during processing or storage. It is not possible to definitively determine the causes of differences in aluminum levels between product types or within a product type.

Aluminum was detected in 99% of the survey samples. The 934 positive samples had aluminum levels ranging from 0.190 parts per million (ppm) to 34943 ppm. All foods included in the survey are permitted to contain certain aluminum-containing food additives in accordance with Health Canada's Lists of Permitted Food Additives[1]. In addition, aluminum occurs naturally in the environment and is expected to be present at low levels in foods. The method of analysis report total aluminum levels but cannot be used to determine the source of the aluminum.

The prevalence and levels of aluminum were comparable with those reported in the scientific literature as well as Health Canada's Total Diet Study.

All aluminum levels were assessed by Health Canada's Bureau of Chemical Safety (BCS). The BCS concluded that the levels detected in this survey were not expected to pose a human health concern. No product recalls were warranted given the lack of a human health concern.

1. Introduction

1.1 Targeted Surveys

The Canadian Food Inspection Agency (CFIA) monitors both domestic and imported foods for the presence of allergenic, microbiological, chemical, and physical hazards. One of the tools used to maintain this oversight are targeted surveys, which are a means to establish baseline information on specific hazards and to investigate emerging risks. Targeted surveys are part of the Agency's core activities along with other surveillance strategies, which include the National Chemical Residue Monitoring Program (NCRMP), the National Microbiological Monitoring Program (NMMP), and the Children's Food Project (CFP). The surveys are complementary to other CFIA surveillance activities in that they examine hazards and/or foods that are not routinely included in those monitoring programs.

Targeted surveys are used to gather information regarding the possible occurrence or prevalence of hazards in defined food commodities. These surveys generate essential information on certain hazards in foods, identify or characterize new and emerging hazards, inform trend analysis, prompt or refine human health risk assessments, assess compliance with Canadian regulations, highlight potential contamination issues, and/or influence the development of risk management strategies as appropriate.

Due to the vast number of hazard and food commodity combinations, it is not possible, to identify and quantify all hazards in foods. To identify food-hazard combinations of greatest potential health risk, the CFIA uses a combination of scientific literature, the media, and/or a risk-based model developed by the Food Safety Science Committee, a group of federal, provincial and territorial subject matter experts in the area of food safety.

1.2 Acts, Regulations, and Codes of Practice

The specific acts and regulations applicable to this survey are described below.

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

Health Canada establishes health-based maximum levels for chemical residues, contaminants, and natural toxins in food sold in Canada. Certain maximum levels for chemical contaminants in food appear in the Canadian *Food and Drug Regulations* (FDR), 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 Canada, regulations pertaining to aluminum in foods relate to the possible use of aluminum and of aluminum-containing substances as food additives. As per the Lists of Permitted Food Additives, potassium aluminum sulphate and sodium aluminum sulphate are permitted in standardized flour and whole wheat flour at a maximum level of 900 ppm when used singly or in combination. Certain aluminum-containing food additives are also permitted for use in standardized baking powder and unstandardized foods (e.g. baking mixes, unstandardized bakery products), at levels of use consistent with Good Manufacturing Practice (GMP). GMP as defined in the *Food and Drug Regulations* is effectively the minimum amount of food additive required to achieve the desired technical effect. Health Canada's BCS has been reviewing the current uses of aluminum-containing food additives with the intent of replacing maximum levels of use that are shown as "GMP" with numerical values, where appropriate[2].

Any elevated levels of aluminum in foods may be assessed by Health Canada's Bureau of Chemical Safety (BCS) on a case-by-case basis using the most current scientific data available. Follow-up actions are initiated in a manner that reflects the magnitude of the health concern. Actions may include notification of the producer or importer, follow-up inspections, additional directed sampling, and recall of products.

2. Survey Details

2.1 Aluminum

Aluminum occurs naturally in the environment and is the most abundant metallic element in the Earth's crust[3]. It can also be released through human activities, such as its use in water treatment, paper making, fire retardant, pharmaceuticals, cosmetics and food additives.

The general population is exposed to aluminum from air, water, and food. The main route of exposure is through food, due to the use of aluminum-containing food additives. Sodium aluminum sulphate and potassium aluminum sulphate may be used as pH adjusters for baking powder and as carriers of benzoyl peroxide which is used as a bleaching agent in flour production. Other aluminum-containing food additives may be used in various foods as emulsifying agents, firming agents, anti-caking agents, and colouring agents[4]. Although aluminum-containing cookware, utensils and packaging can increase the amount of aluminum in food, this amount is considered negligible[5].

Scientific studies have shown that long-term exposure to elevated levels of aluminum may adversely affect humans and animals. For example, studies conducted in some species of experimental animals suggest that various aluminum compounds, when added to the diet or to drinking water at high enough levels, are capable of causing adverse effects related to reproduction, neurological behaviour and neurological development. Aluminum is often suggested as a possible cause of Alzheimer's disease although, to date, research results that suggest an

association between high aluminum accumulation in the body and Alzheimer's disease are not considered conclusive[2].

2.2 Rationale

There is a general lack of Canadian-specific information regarding the levels of aluminum in baking powder, baking mixes, baked goods, and breads. This survey looks to generate baseline data on the levels of aluminum in baking powder, baking mixes, baked goods, and breads. All survey data generated were shared with Health Canada's BCS for risk assessment.

2.3 Sample Distribution

The 2013-2015 Aluminum survey targeted domestic and imported baked goods, baking mixes, baking powders, and breads. A total of 940 samples were collected from grocery and specialty stores in six Canadian cities between May 2013 and March 2015. The 940 samples collected included 386 baking mixes, 256 breads, 203 baked goods and 95 baking powders. Specific brands were not targeted. Table 1 presents the distribution of the survey samples.

Table 1. Detailed description of product types and the distribution of survey samples

Product Type	Subcategories	Number of Samples	Total Number of Samples
Baking Powder	Baking Powder	95	95
Baked Goods	Cakes and Cupcakes	33	203
	Cookies	102	
	Croissants	7	
	Donuts	9	
	Misc. Baked Goods	19	
	Muffins	5	
	Pie Shells	5	
	Tarts	9	
	Waffles	14	
Breads	Bagels	36	256
	Buns and Rolls	25	
	Crumpets	4	
	English Muffins	38	
	Flatbread	4	
	Loaf Breads	94	
	Naan	11	
	Pita Bread	19	
	Tortillas	25	
Baking Mixes	Bread Mix	22	386
	Brownie Mix	38	
	Cake Mix	117	
	Cookie Mix	40	
	Muffin Mix	68	
	Pancake and Waffle Mix	83	
	Pie Crust Mix	6	
	Pizza Crust Mix	4	
	Scone Mix	8	

The survey samples included 166 domestic products, 368 imported products, and 406 products of unspecified origin. In general, an unspecified country of origin refers to those samples for which the origin could not be determined from the product label or sample information. It is important to note that the products sampled often contained the statement “imported for Company A in Country Y” or “manufactured for Company B in Country Z”, and though the labeling meets the intent of the regulatory standard, it does not specify the true origin of the product ingredients. Only those products labeled with a clear statement of “Product of”, “Prepared in”, “Made in”, “Processed in”, and “Manufactured by” were considered as being from a specific country of origin.

2.4 Limitations

This targeted survey was designed to provide a snapshot of aluminum in baked goods, baking mixes, baking powders and breads available to Canadian consumers, and highlight commodities that warrant further investigation. The limited number of samples analyzed represents a small fraction of the products available to consumers. Therefore, care must be taken when interpreting and extrapolating these results. Few inferences or conclusions were made regarding the data with respect to country of origin. Regional differences, impact of product shelf-life, storage conditions, or cost of the commodity on the open market were not examined in this survey.

Analysis was completed on products as available on the Canadian retail market. Some of the products sampled in this survey are considered ingredients and/or require preparation prior to consumption (i.e., baking mixes requires mixing with liquid and baking prior to consumption). However, the results herein represent finished food products as sold and not necessarily as they would be consumed. The analytical method used cannot definitively determine the source of the aluminum detected in the samples - whether present at background levels (due to the presence of aluminum in the environment by natural or manmade means) or through direct addition through its use as a food additive.

3. Results and Discussion

3.1 Overview of Aluminum Results

A total of 940 samples were collected from the Canadian retail market. The samples analyzed include 386 samples of baking mixes, 256 samples of breads, 203 samples of baked goods and 95 samples of baking powder. Aluminum was detected in 99% of the samples tested. Positive detection of aluminum in samples was expected as aluminum-containing food additives are known to be added to flour and to baking powder. Aluminum levels ranged from 0.190 ppm to 34943 ppm. Figure 1 illustrates the range of aluminum levels detected in the survey samples. Overall, baking powder samples contained the highest levels of aluminum detected.

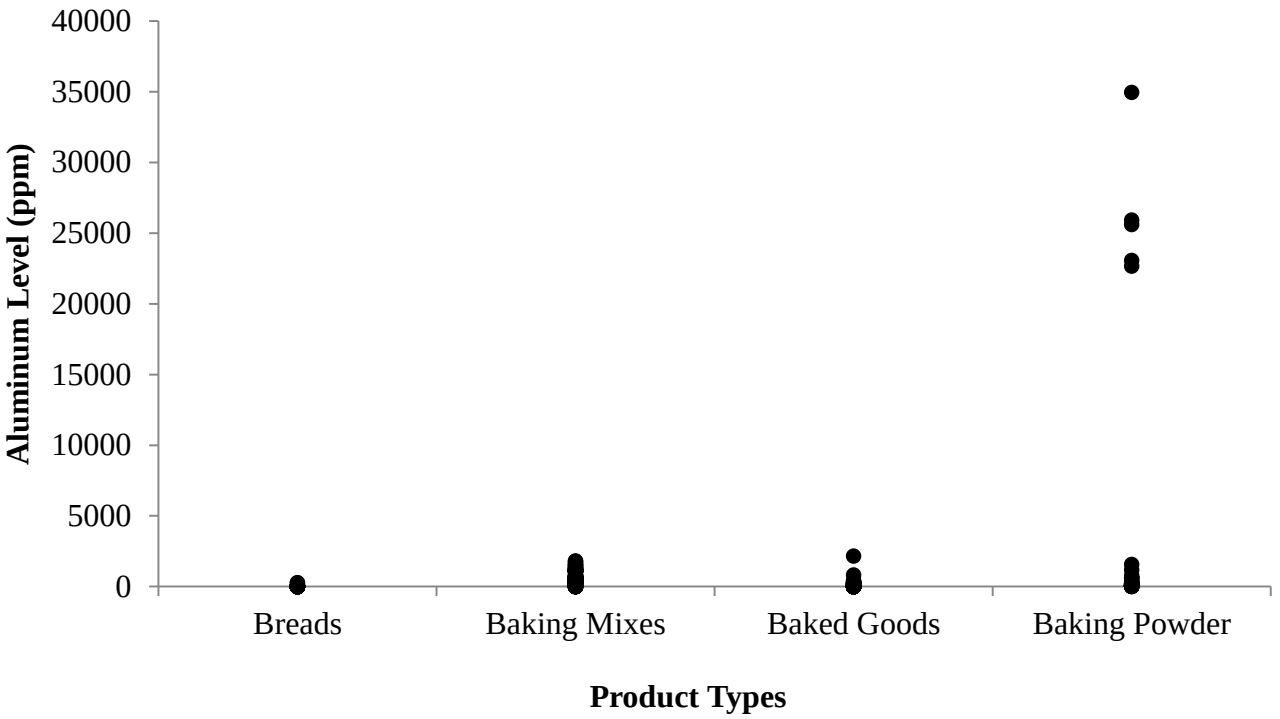

Figure 1. Levels of aluminum in food samples by product types (arranged in increasing aluminum levels)

Note: Only levels above the limit of detection (0.09 ppm) are depicted in the graph

Table 2 summarizes the number of samples with detectable levels of aluminum by product type, and the minimum, maximum, and average aluminum levels in the current survey. Breads had the lowest average aluminum level detected, while the highest average aluminum level is associated with baking powder.

Table 2. Minimum, maximum, and average levels of aluminum detected in food samples (in increasing number of samples)

Product Type	Number of Samples	Number (%) of Positive Samples	Minimum (ppm)	Maximum (ppm)	Average* (ppm)
Baking Powder	95	95 (100)	0.582	34943	1532
Baked Goods	203	203 (100)	0.224	2154	42.52
Breads	256	256 (100)	0.292	270.2	4.931
Baking Mixes	386	380 (98)	0.190	1817	215.3

*Average is calculated using only the results of the samples testing positive for aluminum

3.2 Aluminum Results by Product Type

Aluminum results by product types are presented in the following section. When possible, the current results were compared to the Health Canada (HC) Total Diet Study (TDS) and to scientific literature. In the case of the TDS results, results from the years 1993 to 2007 were used for calculations of the minimum, maximum and average levels. The lowest and highest results reported in the annual surveys represent the minimum and maximum levels used for comparison in this survey. The average level was calculated by CFIA personnel, by taking the average of the annual results testing positive for aluminum.

Care must be taken when interpreting the results of this survey to the HC TDS data for a variety of reasons. First, this survey reports results for foods as sold whereas the TDS reports results for foods as consumed. In addition, the TDS results were generated as a single result for a composite sample of several types and/or brands of a given product per year whereas individual samples were considered in this survey.

3.2.1 Baking Powders

A total of 95 baking powders were analyzed in this survey. The average aluminum levels detected was 1532 ppm, and levels ranged from 0.582 ppm to 34943 ppm. Table 3 summarizes the current survey results in baking powder and compares the results to the HC TDS and scientific literature. All samples of baking powders in the current survey, the HC TDS and scientific literature contained detectable levels of aluminum. The maximum level detected in the current survey is higher than the level reported by the HC TDS and a report by Saiyed but is comparable to aluminum levels reported by Rajwanshi in 1996. The average level in the current survey is lower than that reported in the scientific literature but higher than that found in the HC TDS.

Table 3. Summary of targeted survey, Health Canada Total Diet Study and scientific literature results on aluminum levels in baking powder

Study Author	Number of Samples	Number (%) of Samples with Detectable Levels of Aluminum	Minimum (ppm)	Maximum (ppm)	Average* (ppm)
Baking Powder					
CFIA 2013-2015	95	95 (100%)	0.582	34943	1532
HC 1993-2007[6**]	8	100%	44.518	406.558	175.022
Saiyed 2005[8]	2	2 (100%)	18000	28000	23000
Rajwanshi 1996[7]	3	3 (100%)	16420	33820	24750

* Average of positive results only

** Health Canada data taken from 1993-2007 TDS results, composite samples of foods as consumed are reported (single value for each year).

3.2.2 Baking Mixes

A total of 386 baking mixes were analyzed in this survey. The average aluminum level detected was 215.3 ppm, and levels ranged from 0.190 ppm to 1817 ppm. Figure 2 depicts the distribution of aluminum results by type of baking mix. Pancake and waffle mix contained the highest level of aluminum in comparison to the other product types.

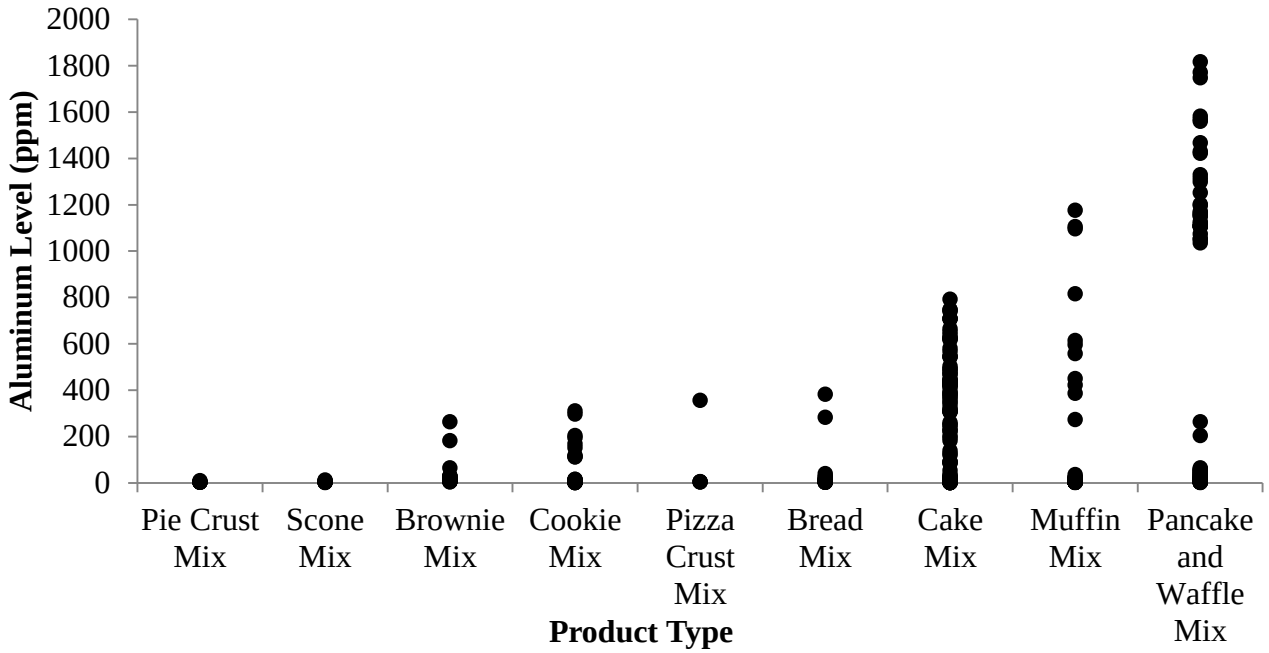

Figure 2. Level of aluminum in baking mix (arranged in increasing aluminum levels)

Note: Only levels above the limit of detection (0.09 ppm) are depicted in the graph

Table 4 summarizes the current survey results in baking mixes and compares the results to scientific literature. Health Canada did not include baking mixes in its Total Diet Study so no comparison can be made. The maximum level in the current survey is higher than levels reported by scientific literature; however, the average aluminum level in the current survey is comparable to that reported in the other studies.

Table 4. Summary of targeted survey and scientific literature results on aluminum levels in baking mixes

Study Author	Number of Samples	Number (%) of Samples with Detectable Levels of Aluminum	Minimum (ppm)	Maximum (ppm)	Average* (ppm)
Baking Mixes					
CFIA 2013-2015	386	380 (98%)	0.1897	1817	215.3
Saiyed 2005[8]	14	14 (100%)	2	1200	482
Stahl 2011[9]	37	37 (100%)	1.3	737	51

* Average of positive results only. All samples were analyzed as sold.

3.2.3 Baked Goods

A total of 197 baked goods were analyzed in this survey. The average aluminum levels detected was 42.52 ppm, and levels ranged from 0.224 ppm to 2154 ppm. Figure 3 depicts the distribution of aluminum results by type of baked good. Cakes and cupcakes contained the highest level of aluminum in comparison to the other baked goods.

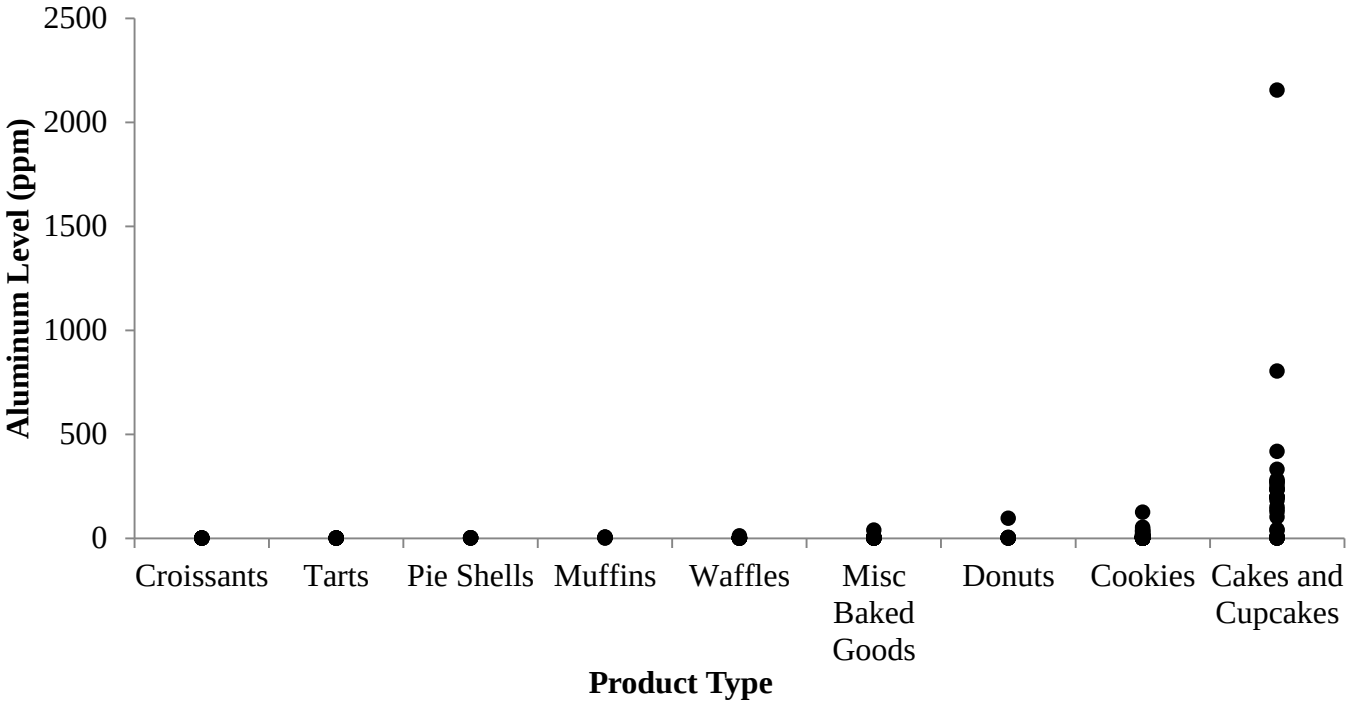

Figure 3. Level of aluminum in baked goods (arranged in increasing aluminum levels)

Note: Only levels above the limit of detection (0.09 ppm) are depicted in the graph

Table 5 summarizes the current survey results in baked goods and compares the results to the HC TDS and scientific literature. The rates of aluminum detection are identical between this year's survey and the HC TDS. The maximum level in the current survey is much higher than the levels reported by HC and by Stahl in 2011, although the average level in the current survey is comparable to the other studies.

Table 5. Summary of targeted survey, Health Canada Total Diet Study and scientific literature results on aluminum levels in baked goods

Study Author	Number of Samples	Number (%) of Samples with Detectable Levels of Aluminum	Minimum (ppm)	Maximum (ppm)	Average* (ppm)
Baked Goods					
CFIA 2013-2015	197	197 (100%)	0.224	2154	42.52
HC 1993-2007[6] **	9	100%	0.305	355.90	79.61
Stahl 2011[9]	60	60 (100%)	3	22	10
Soliman 1999[10]	38	38 (100%)	1	537	19

* Average of positive results only

** Health Canada data taken from 1993-2007 TDS results, composite samples of foods as consumed are reported (single value for each year). The other studies were analyzed as sold.

3.2.4 Breads

A total of 256 bread samples were analyzed in this survey. The average aluminum levels detected was 4.905 ppm, and levels ranged from 0.292 ppm to 270.2 ppm. Figure 4 depicts the distribution of aluminum results by type of bread. One sample of tortillas and one samples of flatbreads contained particularly high levels of aluminum.

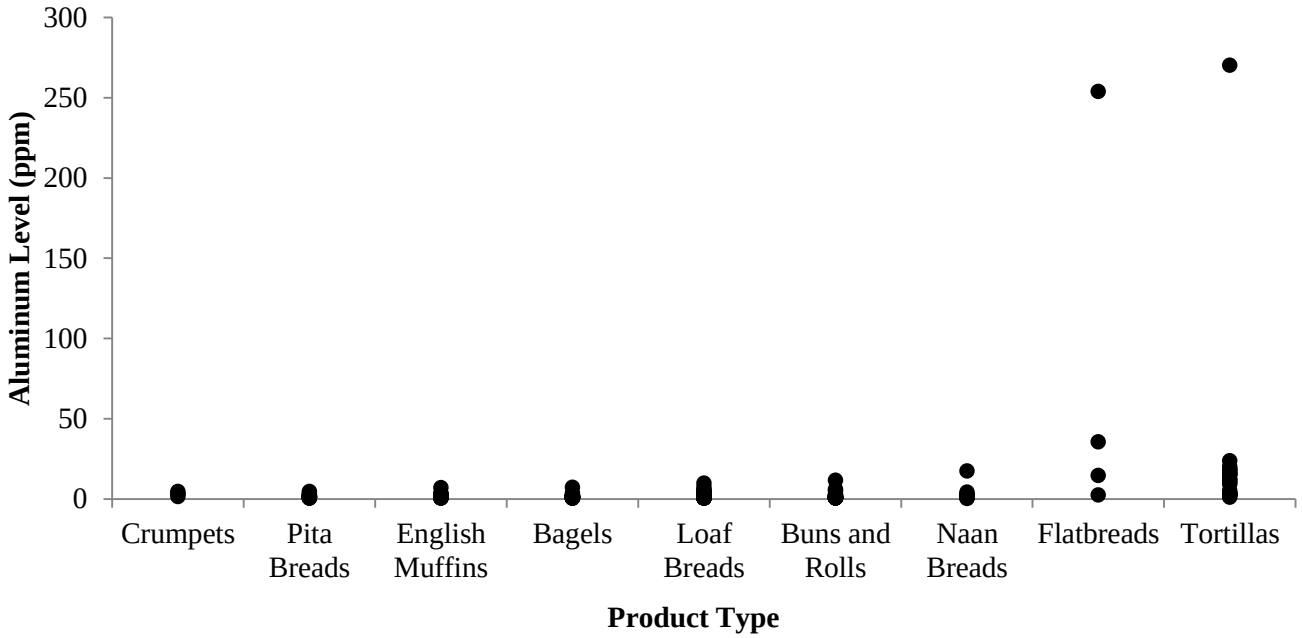

Figure 4. Level of aluminum in breads (arranged in increasing aluminum levels)

Note: Only levels above the limit of detection (0.09 ppm) are depicted in the graph

Table 6 summarizes the current survey results in breads and compares the results to the HC TDS and scientific literature. The rates of aluminum detection are comparable between this year's survey and the HC TDS. The maximum level in the current survey is much higher than levels reported by HC and by scientific literature; however, the average aluminum levels are comparable with the other studies.

Table 6. Summary of targeted survey, Health Canada Total Diet Study and scientific literature results on aluminum levels in breads

Study Author	Number of Samples	Number (%) of Samples with Detectable Levels of Aluminum	Minimum (ppm)	Maximum (ppm)	Average* (ppm)
Breads					
CFIA 2013-2015	256	256 (100%)	0.292	270.2	4.905
HC 1993-2007[6**]	9	100%	0.786	16.35	1.814
Soliman 1999[10]	15	15 (100%)	N/A	N/A	9.5
Stahl 2011[9]	107	107 (100%)	1	14	3

* Average of positive results only

** Health Canada data taken from 1993-2007 TDS results, composite samples of foods as consumed are reported (single value for each year). The other studies were analyzed as sold.

4. Conclusions

The 2013-2015 Aluminum targeted survey provided baseline surveillance data on the levels of aluminum in baking powders, baking mixes, baked goods, and breads. A total of 940 samples were collected from 6 cities across Canada. Aluminum was detected in 99% of the samples, with levels ranging from 0.190 ppm to 34943 ppm. The highest levels were detected in baking powder samples, while breads contained the lowest.

In general, aluminum levels in baked goods, baking mixes, baking powder and breads were comparable with levels reported in Health Canada's Total Diet study and the scientific literature.

All aluminum levels were assessed by Health Canada's Bureau of Chemical Safety (BCS). The BCS concluded that the levels detected in this survey were not expected to pose a human health concern. No product recalls were warranted given the lack of a human health concern.

5. References

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