



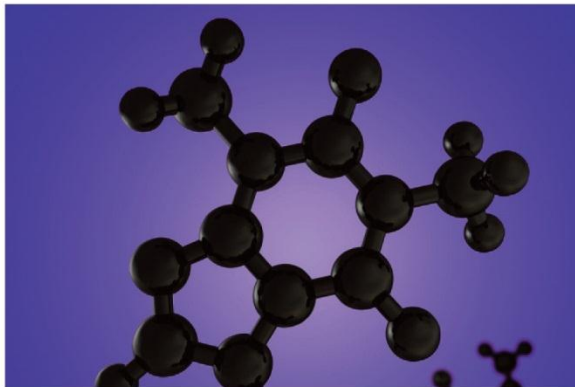
Canadian Food Inspection Agency    Agence canadienne d'inspection des aliments

# Food Safety Action Plan

## REPORT

2011-2012 Targeted Surveys

Chemistry



*Aflatoxins in Corn products, Nuts and Nut Butters*

TS-CHEM-11/12

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# Executive Summary

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

The main objectives of this targeted survey were to generate baseline surveillance data on the levels of aflatoxins in corn products, nuts and nut butters available on the Canadian retail market, and compare the prevalence of aflatoxins in corn products, nuts and nut butters in this survey with that of similar products in the 2010-2011 CFIA FSAP Aflatoxins survey.

Aflatoxins are a family of mycotoxins (naturally-occurring, toxic secondary metabolites) produced by *Aspergillus* fungi. Hot, humid conditions and pest damage during plant growth or storage can favour the growth of aflatoxin-producing fungi, leading to the presence of aflatoxins in foods. Aflatoxins are known to occur in corn and corn products, nuts and nut products, dried fruit, grains, and spices. Acute exposure to high levels of aflatoxins can cause illness (aflatoxicosis) in human which is characterized by vomiting, abdominal pain, pulmonary edema, convulsions, coma, and death. The illness is very rare in the developed world. Chronic exposure to higher levels of aflatoxin has been linked to a number of human health effects, including increasing the risk of developing liver cancer.

The 2011-2012 CFIA Aflatoxins targeted survey targeted domestic and imported corn products, nuts, and nut butters. A total of 703 samples were collected from retail stores in 11 Canadian cities between April 2011 and March 2012. The samples collected included 304 corn products (e.g. corn flour, corn tacos, corn/tortilla chips), 295 nuts, and 104 nut butters. Samples were analysed using a multi-analyte method that detects multiple aflatoxin forms. Most of the samples (89%) did not contain a detectable level of aflatoxins. The total aflatoxin levels in the remaining samples ranged from 0.1 parts per billion (ppb) to 12.5 ppb.

Of the 304 corn product samples tested, 284 did not contain detectable levels of aflatoxins. Twenty corn product samples had total aflatoxin levels that ranged from 0.1 ppb to 1.5 ppb. There are no regulations established in Canada for aflatoxin levels in corn products, so compliance with a numerical standard could not be evaluated. None of the samples were determined to pose an unacceptable concern to human health by Health Canada. No product recalls were warranted given the lack of a health concern.

Of the 295 nut samples tested, 274 did not contain detectable levels of aflatoxins. Twenty-one nut samples had total aflatoxin levels that ranged from 0.1 ppb to 7.6 ppb. Of the 104 nut butter samples tested, 70 did not contain detectable levels of aflatoxins. Thirty-four nut butter samples had total aflatoxin levels that ranged from 0.1 to 12.5 ppb. All samples of nuts and nut butters (100%) were compliant with the Canadian *Food and Drug Regulations* regulatory limit of 15 ppb total aflatoxins in nut and nut products, thus no follow-up activity was deemed necessary. The prevalence and levels of aflatoxins in corn products, nuts and nut butters in this survey were compared with that of similar products in the 2010-2011 CFIA FSAP Aflatoxins survey. The prevalence of aflatoxins were similar in the two survey years (11% positive rate in the current year and 8% positive rate in the previous year).

In general, aflatoxin levels reported in the current FSAP survey were consistent with the results obtained in the previous FSAP survey.

# 1 Introduction

## 1.1 Food Safety Action Plan

In 2007, the Canadian government launched a five-year initiative called the Food and Consumer Safety Action Plan (FCSAP), aimed to modernize and strengthen Canada's safety system for food, health and consumer products.

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

Within the FSAP, there are twelve main areas of activity, one of which is risk mapping and baseline surveillance. The main objective of this area is to better identify, assess and prioritize potential food safety hazards through risk mapping, information gathering and analysis of foods in the Canadian marketplace. Targeted surveys are one tool used to test for the presence and level of particular hazards in specific foods.

Within the current regulatory framework, some commodities (such as meat products) traded internationally and interprovincially are regulated by specific Acts. These are referred to as federally registered commodities. Under the current regulatory framework, the non-federally registered commodities encompass 70% of domestic and imported foods that are regulated solely under the *Food and Drugs Act* and *Regulations*. FSAP targeted surveys are primarily directed towards non-federally registered commodities, such as this survey on corn products, nuts and nut butters.

## 1.2 Targeted Surveys

Targeted surveys are used to gather information regarding the potential occurrence of chemical hazards in defined food commodities. The surveys are designed to answer specific questions. Therefore, unlike monitoring activities, testing for a particular hazard is targeted to commodity types and/or geographical areas.

Due to the vast number of chemical hazards and food product combinations, it is not possible, nor should it be necessary, to use targeted surveys 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, media reports, and/or a risk-based model developed by the Food Safety Science Committee (FSSC), a group of federal, provincial and territorial subject matter experts in the area of food safety. The FSSC ranked aflatoxins in nuts, nut products (including nut butters), and corn products as a high priority due to their human health effects and consumption patterns.

## 1.3 Acts and Regulations

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

Health Canada establishes the health-based maximum levels for chemical residues and contaminants in food sold in Canada. Certain maximum levels for chemical contaminants in food appear in the *Canadian Food and Drug Regulations*, where they are referred to as regulatory limits or tolerances. Regulatory limits are established as a risk management tool, and generally only for foods that significantly contribute to the total dietary exposure of that contaminant. Nuts and nut products are considered adulterated if they contain more than 15 parts per billion total aflatoxins in the nut meat portion of the product according to section B.01.046 (n) of the *Food and Drug Regulations*<sup>xiv</sup>.

There is no Canadian regulatory limit for aflatoxins in corn products. For all commodities lacking an established maximum level, including corn products, the levels of aflatoxins are examined by CFIA and assessed by Health Canada 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, and could include additional sampling, additional inspections or ultimately the recall of the product from the Canadian market place.

## 2 Survey Details

### 2.1 Aflatoxins

Aflatoxins are a family of naturally-occurring, toxic secondary metabolites produced by *Aspergillus flavus* and *A. parasiticus* fungi. At least 20 different chemical forms of aflatoxins exist. The four most common forms of aflatoxins in plant-based foods, in order of highest to lowest toxicity, are B<sub>1</sub>, G<sub>1</sub>, B<sub>2</sub>, and G<sub>2</sub>. Aflatoxin B<sub>1</sub> is the predominant aflatoxin form, while the other forms tend to co-occur with B<sub>1</sub>.

Aflatoxin-producing fungi may contaminate nuts, corn, or their products if grown, transported, stored, or processed under hot, humid conditions, prolonged periods of time, or with pest pressures resulting in bruising or cuts on the commodity<sup>i,ii</sup>. Drought pressure on corn is also a major risk factor for the occurrence of aflatoxins in the field. Due to the cooler Canadian climate, domestically-grown corn and nuts (and products thereof) are less likely to contain aflatoxins than those imported from warmer climates.

Aflatoxins are not destroyed by heating, cooking or most other processing methods<sup>iii</sup>. For this reason, if the nuts used to manufacture nut butters are contaminated with aflatoxins, there is the potential for nut butters made from these nuts to contain aflatoxins.

## 2.2 Rationale

Aflatoxins are known to contaminate corn and corn products, nuts and nut products, dried fruits, grains and spices<sup>ix,x</sup>. The major route of human exposure to aflatoxins is through the consumption of contaminated nuts, nut butters, and corn products<sup>iv</sup>, which are consumed directly as foods and as ingredients.

Aflatoxin B<sub>1</sub> is among the most potent naturally-occurring liver carcinogens known. The International Agency for Research on Cancer (IARC) classified aflatoxins to be carcinogenic to humans (Group 1 carcinogen)<sup>v</sup>. Chronic exposures to aflatoxins have also been associated with growth impairment in children living in developing countries where exposure to aflatoxins is relatively high. Aflatoxins have been shown to cause immune suppression in experimental animals<sup>vi</sup>. Please see references 7 to 8 for further information on the human and animal health effects of aflatoxin exposure<sup>vii,viii</sup>.

The Codex Alimentarius Commission, established by the United Nations' Food and Agriculture Organization and the World Health Organization in 1963, develops harmonized international food standards, guidelines and codes of practice to protect the health of the consumers and ensure fair practices in the food trade. The human health effects from aflatoxin consumption have prompted the establishment of several Codex Alimentarius Codes of Practice to prevent and to reduce aflatoxin contamination in peanuts<sup>ix</sup>, dried figs<sup>x</sup>, and tree nuts<sup>xi</sup>. To date, there are no Codex Codes of Practice specifically for the production and storage of nut butters, corn, or corn products.

Aflatoxin levels in nuts, nut butters, and corn products are not routinely monitored by the CFIA. This targeted survey provides additional baseline surveillance data for aflatoxin levels in nuts, nut butters, and corn products.

## 2.3 Sample Distribution

The 2011-2012 CFIA Aflatoxins survey targeted nuts, nut butters, and corn products. Samples were collected from retail stores in 11 Canadian cities between April 2011 and March 2012 by samplers under contract with the Government of Canada. The 703 samples collected included 289 domestic products, 249 imported products (from at least 17 countries) and 165 products of unspecified origin. Samples of unspecified origin are those for which the country of origin could not be determined from the product label or sample information. Table 1 presents the distribution of survey samples by country of origin.

It is important to note that the products sampled often contained the statement “processed in Country X”, “imported for Company A in Country Y” or “manufactured for Company B in Country Z”, and though the labelling meets the intent of the regulatory standard, it does not identify the true origin of the product ingredients. Only those products labelled with a clear statement of “Product of Country A” were considered as being from a specific country of origin.

**Table 1. Distribution of survey samples by commodity and by country of origin (in order of increasing number of samples)**

Country of Origin	Number of Corn Product Samples	Number of Nut Samples	Number of Nut Butter Samples	Total Number of Samples
Germany			1	1
India	1			1
Italy	1			1
Kenya		1		1
Poland	1			1
South Africa		1		1
Bolivia		2		2
Brazil		2		2
Philippines		1	1	2
Colombia	3			3
Belgium			4	4
China	1	3		4
Mexico	4			4
Peru		6		6
Turkey		7		7
Vietnam		7		7
Unspecified*	29	122	14	165
USA	105	67	30	202
Canada	159	76	54	289
<b>Total</b>	<b>304</b>	<b>295</b>	<b>104</b>	<b>703</b>

\* Unspecified refers to those samples for which the country of origin could not be determined from the product label or available sample information.

## 2.4 Method Details

Samples in the Aflatoxins targeted survey were analyzed by laboratories under contract with the Government of Canada. These laboratories are accredited by the Standards Council of Canada (SCC) or by the Canadian Association for Laboratory Accreditation Inc. (CALA). Laboratories were required to use analytical methods that met or exceeded the requirements and limits of detection of the equivalent CFIA methods.

The method used detects the major forms of aflatoxins, including B<sub>1</sub>, B<sub>2</sub>, G<sub>1</sub>, and G<sub>2</sub>. The method is based on a CFIA method, which consists of immunoaffinity column separation followed by mass spectrometric detection. The reporting limit for each aflatoxin form is 0.1 ppb. The aflatoxin level reported in this survey refers to the sum of the concentrations of each of the four aflatoxin forms (i.e. level of aflatoxin B<sub>1</sub> + level of aflatoxin B<sub>2</sub> + level of aflatoxin G<sub>1</sub> + level of aflatoxin G<sub>2</sub>). Samples were tested as sold, meaning that the product was not prepared as per the package instructions (if applicable).



## **2.5 Limitations**

The current targeted survey was designed to provide a snapshot of the aflatoxin levels in nuts, nut butters, and corn products available in Canada and to highlight commodities that warrant further investigation. The limited sample sizes analyzed represent a small fraction of the products available to Canadian consumers. Therefore, care must be taken when interpreting and extrapolating these results. Regional differences, impact of product shelf-life, storage conditions, or cost of the commodity on the open market were not examined in this survey.

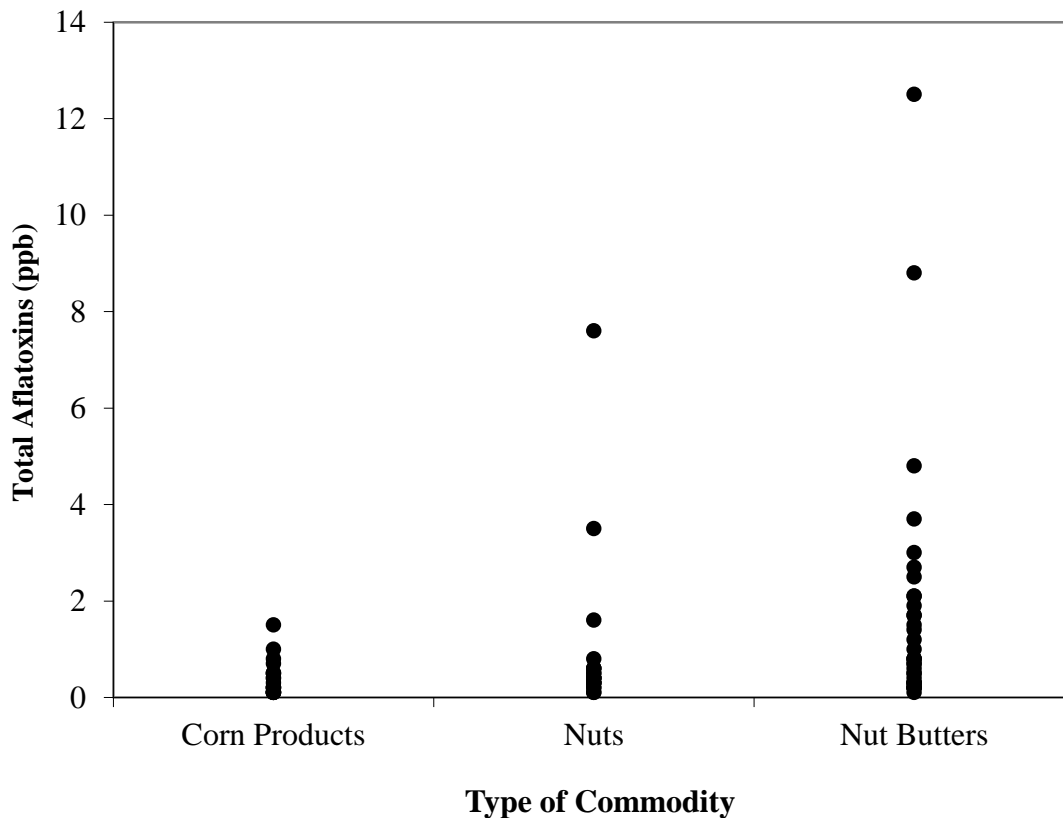
There are limitations with respect to the size of the sample taken. This is an important factor in aflatoxin testing due to the occurrence of pockets of contamination. Sampling of peanuts for compliance purposes takes that into account and requires large sample sizes, e.g. about 10 kg. Operating Characteristic (OC) curves will show that as the sample size is reduced, the probability of either overestimating or underestimating the level of contamination increases (leading to the probability of wrongly assessing the compliance of a lot). The sampling uncertainty for mycotoxin testing typically exceeds the analytical uncertainty<sup>xii</sup>. In this survey, one kilogram of product was sampled.

Minimally processed corn products such as sweet corn, corn on the cob, and corn kernels (with the exception of canned corn) were not tested.

## **3 Results and Discussion**

### **3.1 Overview of Aflatoxin Results**

The 2011-2012 Aflatoxin targeted survey tested 703 samples obtained at the Canadian retail level. The samples included 304 corn products, 295 nut samples, and 104 nut butters. Aflatoxin was not detected in 89% of the survey samples. In the 11% of samples with detectable levels of aflatoxins, the total aflatoxin levels ranged from 0.1 ppb to 1.5 ppb in corn products, from 0.1 ppb to 7.6 ppb in nuts, and from 0.1 ppb to 12.5 ppb in nut butters. Figure 1 presents the total aflatoxin levels detected per sample by product type.



**Figure 1. Distribution of total aflatoxin level per sample by product type (arranged by increasing number of samples)**

There are no maximum levels (regulatory limits, tolerances, or standards) for aflatoxin in corn products, so compliance to a numerical standard could not be assessed. For the corn products, the positive results were evaluated and Health Canada was consulted on the observed total aflatoxin levels. Health Canada determined that none of the positive corn product samples were likely to pose an unacceptable concern to human health.

The Canadian regulatory limit for total aflatoxins in nuts and nut butters is 15 ppb. All of the nuts and nut butters sampled in this survey were compliant with this regulatory limit.

### 3.2 Aflatoxin Results by Product Type

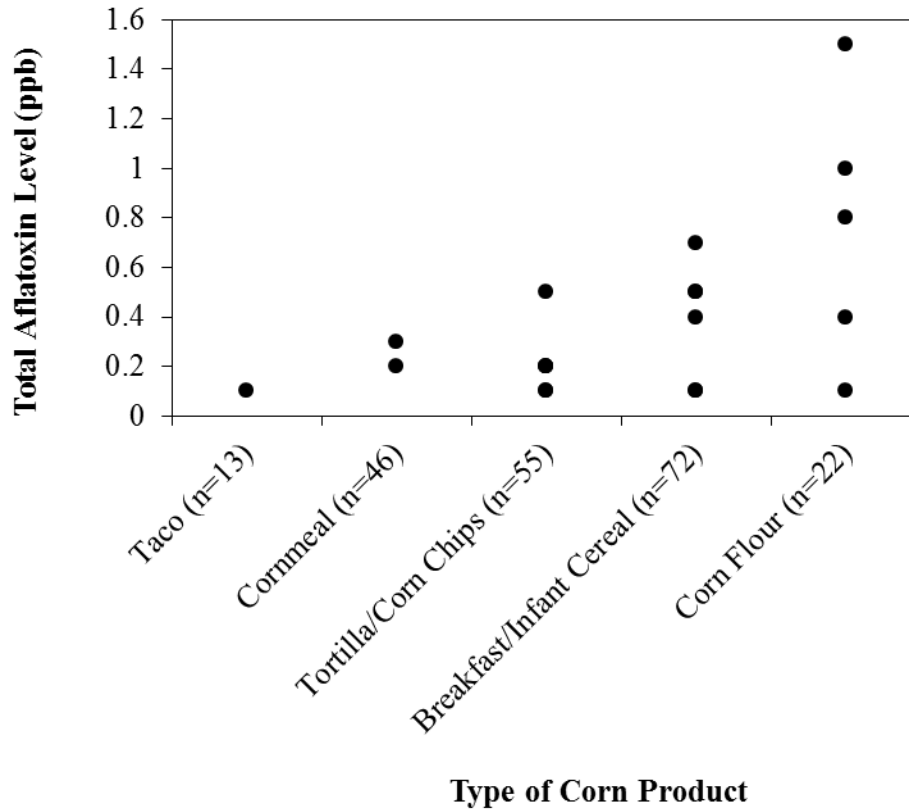
Results by product type are presented in the following sections. The results of this aflatoxin targeted survey were compared to the results of the previous 2010-2011 CFIA FSAP targeted survey on aflatoxins<sup>xiii</sup>.

#### 3.2.1 Corn Products

A total of 304 corn products were analyzed in this survey. 284 samples (93%) did not contain detectable levels of aflatoxins. The total aflatoxin levels in the remaining 20 samples ranged

from 0.1 ppb to 1.5 ppb. Health Canada determined that none of the positive corn product samples were likely to pose an unacceptable concern to human health.

Figure 2 shows the distribution of total aflatoxin results by type of corn product. Corn flour and corn-based breakfast/infant cereals had the highest total aflatoxin levels. Aflatoxins were not detected in canned corn, corn grits, popcorn, starch, and corn tortillas.



Note: canned corn, corn grits, popcorn, starch, and tortillas did not contain detectable levels of aflatoxins

**Figure 2. Distribution of total aflatoxin results by type of corn product (arranged by increasing aflatoxin level)**

For most of the corn product types, the results of the current targeted survey are consistent with the results obtained in the previous survey (see Table 2)<sup>xiii</sup>. A notable difference between the surveys was that aflatoxins were not detected in corn flour or corn meal in the previous FSAP survey<sup>xiii</sup> but these products were associated with detectable aflatoxin levels in the current survey.

The low occurrence and low concentrations seen in corn products in this survey are consistent with Canadian Grain Commission monitoring data. For the past decade, CGC has not seen any positives for aflatoxins in Canadian corn intended for export. The CGC uses a method with an limit of quantitation (LOQ) of 1 ppb for each aflatoxin (personal communication from CGC).

**Table 2. Total aflatoxin levels in corn products per survey year by product type**

<b>Product Type</b>	<b>CFIA FSAP Survey Year</b>	<b>Number of Samples</b>	<b>Number of Positive Samples</b>	<b>Minimum Total Aflatoxin Level (ppb)</b>	<b>Maximum Total Aflatoxin Level (ppb)</b>	<b>Average Total Aflatoxin Level (ppb)</b>
Canned Corn	2010-2011	30	0	< LOD	< LOD	< LOD
	2011-2012	31	0	< LOD	< LOD	< LOD
Corn Grits	2010-2011	9	0	< LOD	< LOD	< LOD
	2011-2012	1	0	< LOD	< LOD	< LOD
Popcorn	2010-2011	29	1	-	0.7	-
	2011-2012	32	0	< LOD	< LOD	< LOD
Starch	2010-2011	30	0	< LOD	< LOD	< LOD
	2011-2012	31	0	< LOD	< LOD	< LOD
Tortilla	2010-2011	10	0	< LOD	< LOD	< LOD
	2011-2012	1	0	< LOD	< LOD	< LOD
Taco	2010-2011	23	12	0.1	1.7	0.5
	2011-2012	13	1	-	0.1	-
Cornmeal	2010-2011	34	0	< LOD	< LOD	< LOD
	2011-2012	46	2	0.2	0.3	0.2
Tortilla/ Corn Chips	2010-2011	51	5	0.2	0.5	0.3
	2011-2012	55	6	0.1	0.5	0.2
Breakfast/ Infant Cereals	2010-2011	57	5	0.2	1.2	0.6
	2011-2012	72	6	0.1	0.7	0.4
Corn Flour	2010-2011	16	0	< LOD	< LOD	< LOD
	2011-2012	22	5	0.1	1.5	0.8

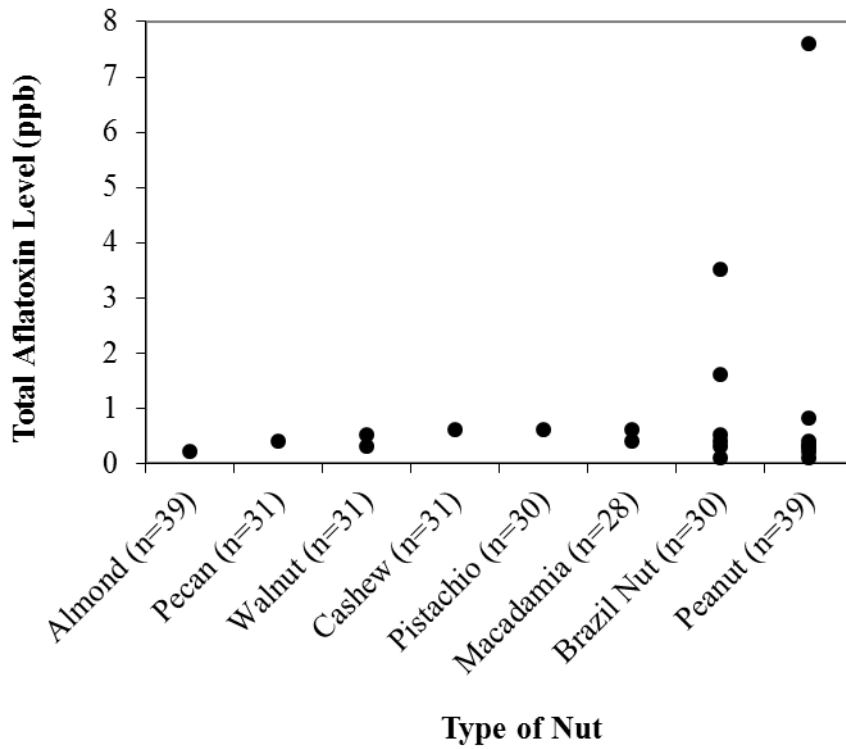
< LOD = below the limit of detection (0.1 ppb)

Note: Average values were calculated using only results for samples with detectable aflatoxin levels

### **3.2.2 Nuts**

Two hundred seventy-four of the 295 (93%) nut samples tested did not contain detectable levels of aflatoxins. The total aflatoxin levels in the remaining 21 samples ranged from 0.1 ppb to 7.6 ppb. All of the nut samples were compliant with the Canadian regulatory limit for total aflatoxins so follow-up action was not deemed necessary.

Figure 3 shows the distribution of total aflatoxin results by type of nut. Peanuts and Brazil nuts had the highest maximum total aflatoxin levels. Aflatoxins were not detected in any of the hazelnut samples.



Note: Aflatoxins were not detected in hazelnuts

**Figure 3. Distribution of total aflatoxin results by type of nut (arranged by increasing total aflatoxin level)**

For most of the nut types, the results of the current survey are consistent with the results obtained in the previous survey (see Table 3)<sup>xiii</sup>. In contrast, aflatoxins were not detected in macadamia, cashew, pistachio, and pecans in the previous FSAP survey<sup>xiii</sup>, but these products were associated with detectable aflatoxin levels in the current survey. The maximum total aflatoxin level noted in a nut sample was much lower in the current survey (7.6 ppb) than in the previous FSAP survey (28.7 ppb).

**Table 3. Aflatoxin levels in nuts per survey year by nut type**

Product Type	CFIA FSAP Survey Year	Number of Samples	Number of Positive Samples	Minimum Total Aflatoxin Level (ppb)	Maximum Total Aflatoxin Level (ppb)	Average Total Aflatoxin Level (ppb)
Hazelnut	2010-2011	21	0	< LOD	< LOD	< LOD
	2011-2012	36	0	< LOD	< LOD	< LOD
Almond	2010-2011	45	1	-	1.9	-
	2011-2012	38	1	-	0.2	-
Pecan	2010-2011	25	0	< LOD	< LOD	< LOD
	2011-2012	31	1	-	0.4	-
Walnut	2010-2011	48	3	0.2	1.9	1.1
	2011-2012	31	2	0.3	0.5	0.4
Cashew	2010-2011	17	0	< LOD	< LOD	< LOD
	2011-2012	31	1	-	0.6	-
Pistachio	2010-2011	21	0	< LOD	< LOD	< LOD
	2011-2012	30	1	-	0.6	-
Macadamia	2010-2011	8	0	< LOD	< LOD	< LOD
	2011-2012	28	2	0.4	0.6	0.5
Brazil Nut	2010-2011	13	2	0.2	0.4	0.3
	2011-2012	30	6	0.1	3.5	1.1
Peanut	2010-2011	36	6	0.1	28.7	5.3
	2011-2012	39	7	0.1	7.6	1.4

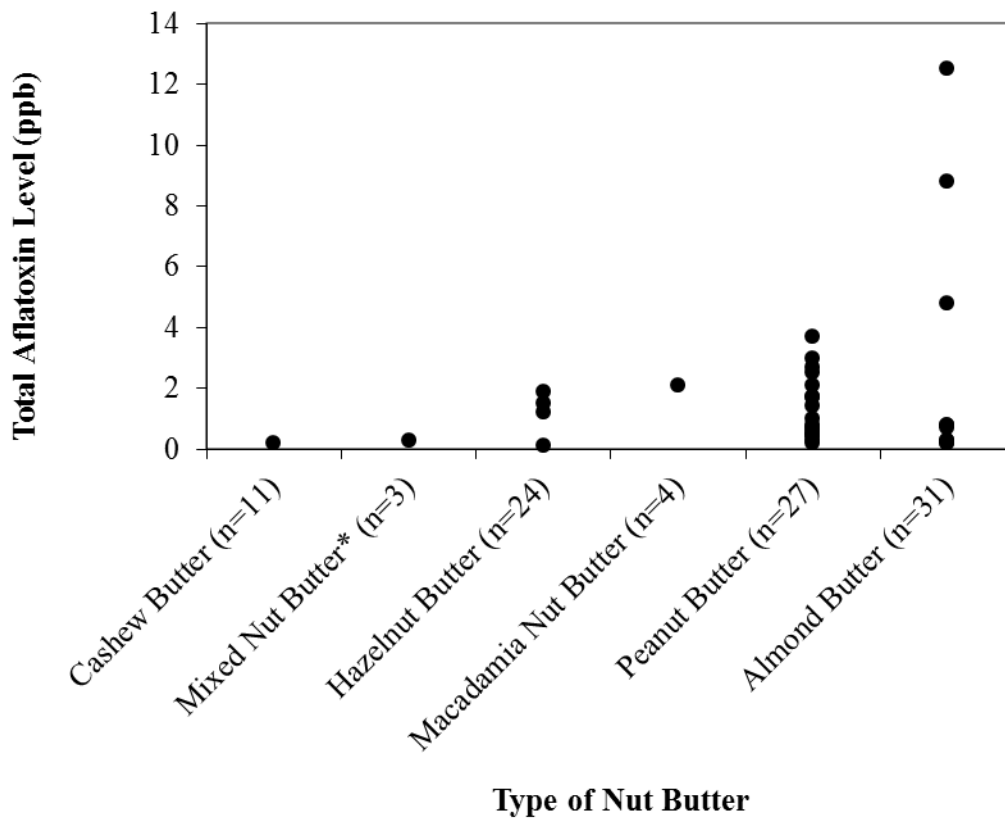
< LOD = below the limit of detection (0.1 ppb)

Note: Average values were calculated using only results for samples with detectable aflatoxin levels

### 3.2.3 Nut Butters

Seventy of the 104 (67%) nut butter samples tested did not contain detectable levels of aflatoxins. The total aflatoxin levels in the remaining 34 samples ranged from 0.1 ppb to 12.5 ppb. All of the nut butter samples were compliant with the Canadian regulatory limit for total aflatoxins so follow-up action was not deemed necessary.

Figure 4 shows the distribution of total aflatoxin results by type of nut butter. The highest total aflatoxin levels were observed in peanut butter and almond butter. Aflatoxins were not detected in the walnut butter samples.



\*Mixed nut butter refers to butter made from two or more types of nut  
 Note: Walnut butters did not contain detectable levels of aflatoxins

**Figure 4. Distribution of total aflatoxin results by type of nut butter (arranged by increasing total aflatoxin level)**

Table 4 presents a comparison of the aflatoxin levels in nut butters for the two FSAP surveys. The total number of nut butter samples has increased from 19 samples in the 2010-2011 FSAP survey to 104 samples in the 2011-2012 FSAP survey. The increased sample size may account for some of the apparent differences noted between the two survey years.

In both the current and the previous FSAP surveys<sup>xiii</sup>, the positive levels observed for nut butters were considerably higher than for the comparable nut meats. In both survey years<sup>xiii</sup>, hazelnut, almond, and peanut butter were associated with the highest detectable levels of aflatoxins. In contrast, macadamia nut and cashew butter had detectable aflatoxin levels in the current survey, but not the previous one. The maximum total aflatoxin level noted in nut butter samples was slightly lower in this FSAP survey (12.5 ppb) than in the previous FSAP survey (16.0 ppb).

**Table 4. Aflatoxin levels in nut butters per survey year by nut butter type**

Product Type	CFIA FSAP Survey Year	Number of Samples	Number of Positive Samples	Minimum Aflatoxin Level (ppb)	Maximum Aflatoxin Level (ppb)	Average Aflatoxin Level (ppb)
Walnut Butter	2010-2011	-	-	-	-	-
	2011-2012	4	0	< LOD	< LOD	< LOD
Cashew Butter	2010-2011	1	0	< LOD	< LOD	< LOD
	2011-2012	11	1	-	0.2	-
Mixed Nut* Butter	2010-2011	-	-	-	-	-
	2011-2012	3	1	-	0.3	-
Hazelnut Butter	2010-2011	2	2	0.5	0.5	0.5
	2011-2012	24	4	0.1	1.9	1.2
Macadamia Nut Butter	2010-2011	1	0	< LOD	< LOD	< LOD
	2011-2012	4	1	-	2.1	-
Peanut Butter	2010-2011	9	4	0.3	12.5	6.4
	2011-2012	27	17	0.2	3.7	1.4
Almond Butter	2010-2011	6	3	0.1	16.0	7.0
	2011-2012	31	10	0.2	12.5	2.9

< LOD = below the limit of detection (0.1 ppb)

Note: Average values were calculated using only results for samples with a detectable total aflatoxin level

\*Mixed Nut butter refers to butter prepared with two or more types of nut

## 4 Conclusions

The 2011-2012 Aflatoxins targeted survey generated additional baseline surveillance data on the total aflatoxin levels in domestic and imported corn products, nuts, and nut butters available on the Canadian retail market. The 703 samples collected included 304 corn products, 295 nuts, and 104 nut butters.

Aflatoxins were not detected in 89% of the survey samples. Aflatoxins were detected in 75 samples in this survey (20 corn products, 21 nuts, and 34 nut butters). The total aflatoxin levels ranged from 0.1 ppb to 12.5 ppb.

In general, the aflatoxin levels reported in the current FSAP survey were consistent with the results obtained in the previous FSAP survey. The maximum total aflatoxin levels in nuts and nut butters were lower in the previous survey. Some commodities (corn flour, cornmeal, macadamia nuts, cashew nuts, pistachios, pecans, macadamia nut butters and cashew nut butters) were higher in this current survey. The same method of analysis was used for both, so any differences observed may be related to differing sources, field conditions, transportation/storage/processing conditions, or simply random variation within the limited sample sizes. As the samples are picked up at retail, it is not possible to determine definitively which of these factors is responsible for the differences noted.

As there are no Canadian regulations or maximum levels (tolerances or standards) for total aflatoxins in corn products, compliance to a numerical standard could not be evaluated. Health



Canada determined that the low aflatoxin levels observed in corn products were unlikely to pose a health concern to Canadians. All the nuts and nuts butters had total aflatoxin levels below the 15 ppb regulatory limit established in the Canadian Food and Drug Regulations (100% compliance). Follow-up activities were not deemed necessary for any of the samples in this survey.

## 5 Appendix

### Established Canadian and international limits/standards/maximum limits for aflatoxin in selected foods

Commodity	Canada <sup>xiv</sup>	US <sup>xv</sup>	European Union <sup>xvi</sup>	Codex <sup>ix,x,xi</sup>
Nuts and Nut butters	15 ppb on the basis of the nut meat portion of the product	20 ppb for specific nuts, 20 ppb for all foods intended for consumption by humans	4-10 ppb (depending on nut) for ready-to-eat nuts and nut butters*; 10-15 ppb (depending on nut) for nuts intended for further physical treatment**	15 ppb for peanuts, almonds, Brazil nuts, hazelnuts and pistachios intended for further processing; and 10 ppb for ready-to-eat almonds, Brazil nuts, hazelnuts and pistachios
Corn products	None	20 ppb for all foods intended for consumption by humans	4 ppb for ready-to-eat cereals and cereal products; 10 ppb for corn intended for further physical treatment	None

\*Almond, pistachio, hazelnut and Brazil nut are subject to a maximum limit of 10 ppb aflatoxins while other tree nuts are subject to a 4 ppb regulatory limit if intended for direct human consumption;

\*\* Almond, pistachio, hazelnut and Brazil nut are subject to a maximum limit of 15 ppb aflatoxins while other tree nuts are subject to a 10 ppb regulatory limit if intended for further physical treatment

## 6 References

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