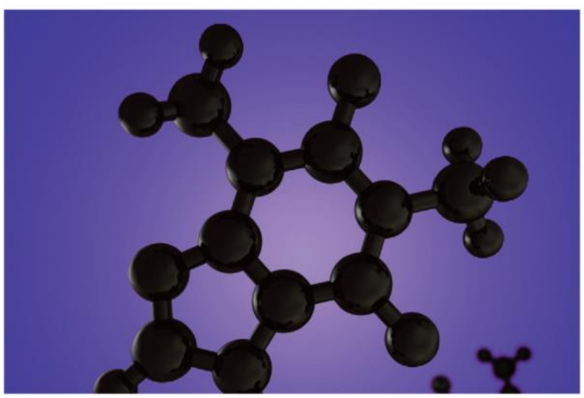
Canadian Food Inspection Agency / Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2008-2009 Targeted Surveys

Chemistry



Dioxins in Guar Gum from India

Canada

1 Executive Summary

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

Guar gum is a food additive commonly used as an emulsifier and stabilizer in processed food. It is generally a minor ingredient in food stuffs but is found in a wide variety of food products. In 2007, the European Commission discovered serious contamination of guar gum with dioxins and pentachlorophenol originating from India. As a result, a targeted survey was initiated in order to assess the levels of dioxin in guar gum originating from India.

The main objectives of the dioxins in guar gum survey were:

- To obtain a snapshot of the levels of dioxins in guar gum originating from India, an origin with a history of contamination.
- To assess whether there is merit in continuing to monitor guar gum imported from India for dioxins.

A total of 20 samples of guar gum originating from India were collected in this survey. Guar gum was sampled from importers who were importing guar gum for use in food or feed. All samples were analyzed in a Canadian Food Inspection Agency (CFIA) laboratory for dioxins, furans and polychlorinated biphenyls (PCBs).

Of the 20 samples tested, all contained measurable residues of dioxins. There is no standard for the presence of dioxins in food in Canada. However, as it is expected that dioxin may be present at very low levels, it has been suggested by the European Commission (EC) that a toxic equivalent (TEQ) of 0.75 ng TEQ/kg product be adopted in order to determine if guar gum samples contain higher than background levels of dioxin contamination. All but one of the samples analyzed had total TEQ dioxin levels lower than the EC's suggested standard. This one sample had 2.731 ng TEQ/kg total weight.

Bearing in mind that the Canadian *Food and Drug Regulations* (FDR) lists the maximum use rate of guar gum as an ingredient in processed foods as 1.0%, levels of dioxin and dioxin-like chemicals in guar gum samples would not pose an unacceptable health risk provided the guar gum is used in accordance with provisions found within the FDR.

2 Introduction

2.1 Food Safety Action Plan

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

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

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

2.2 Targeted Surveys

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

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

2.3 Guar Gum Targeted Survey

The current targeted survey reports on the level of dioxins in guar gum imported from India. The Rapid Alert System for Food and Feed (RASFF) of the European Commission received, on July 24, 2007, a finding of serious contamination by dioxins and pentachlorophenol (PCP) in guar gum originating from India.[1] The contamination levels found in certain batches of guar gum were very high. The initial finding of up to 480 pg WHO-PCDD/F-TEQ/g product and 4 mg PCP/kg gave reason for serious concern. Analyses of samples collected by the

European Commission to follow up these findings confirmed these high levels in certain batches; even higher levels were detected in few cases. However, uncontaminated guar gum was also found.[2]

As a result of the elevated levels of dioxins in Indian guar gum, an extensive investigation was conducted by the Commission of the European Communities (CEC) to gather information on the possible sources of the contamination, as well as to assess the control measures put in place by the Indian authorities to avoid the re-occurrence of this contamination.

Consequently, the European Union (EU) now requires all guar gum from India to be accompanied with a certificate of analysis stating the absence of PCP.[3] This decision was based on the results of their investigation in India, where controls were found inadequate to minimize dioxin contamination of guar gum.

The source of dioxin in the affected guar gum was never definitively identified.[4] Possible sources of contamination have been hypothesized as the wooden pallets used to transport product, the jute bags used to contain product, combustion processes, include ing wood, during the heating of the seeds to create splits and low level contamination from the use of sodium pentachlorophenate as a fungicide.[5] The ultimate recommendation of the CEC was that the separation of the food-grade and industrial-grade guar gum throughout the course of the production process should be undertaken in order to avoid such contamination in the future.

As previously stated, targeted surveys are meant to capture preliminary data related to an emerging concern. As a result of the widespread use of guar gum in food products and owing to the likelihood that guar gum used in Canada originates from India, a targeted survey sampling guar gum from India was conducted. Initially, it was difficult to speculate upon the potential source of contamination of guar gum with dioxins and PCP. It was decided that based on the human health risk associated with dioxins, the present survey would focus on the examination of dioxins and furans and dioxin-like PCBs.

2.4 Guar Gum

2.4.1 Definition

Guar gum consists primarily of the ground endosperm of the seeds from *Cyamopsis tetragonolobus* (L.) Taub. Guar gum is mainly composed of the high molecular weight polysaccharides composed of galactomannans (made of the sugars galactose and mannose).[6]

Guar bean was first widely grown as an important cash crop following World War II, after a shortage of the more commonly grown locust bean crop. India is the major producer of guar seed (80% of the world production), followed by Pakistan, USA, Brazil and Australia.[7]

In Asia, guar beans are used as a vegetable for human consumption and the crop is also grown for cattle feed and as a green manure crop (grown purely to renew the soil, it is never harvested).

2.4.2 Processing of Guar Gum

Figure 1 outlines the processing method for the production of both industrial and food grade guar gum. The seeds are crushed to eliminate the germ; the endosperm is dehusked, milled and screened to obtain the ground endosperm (native guar gum). The guar gum may be washed with ethanol or isopropanol to control the microbiological load (washed guar gum).[8]

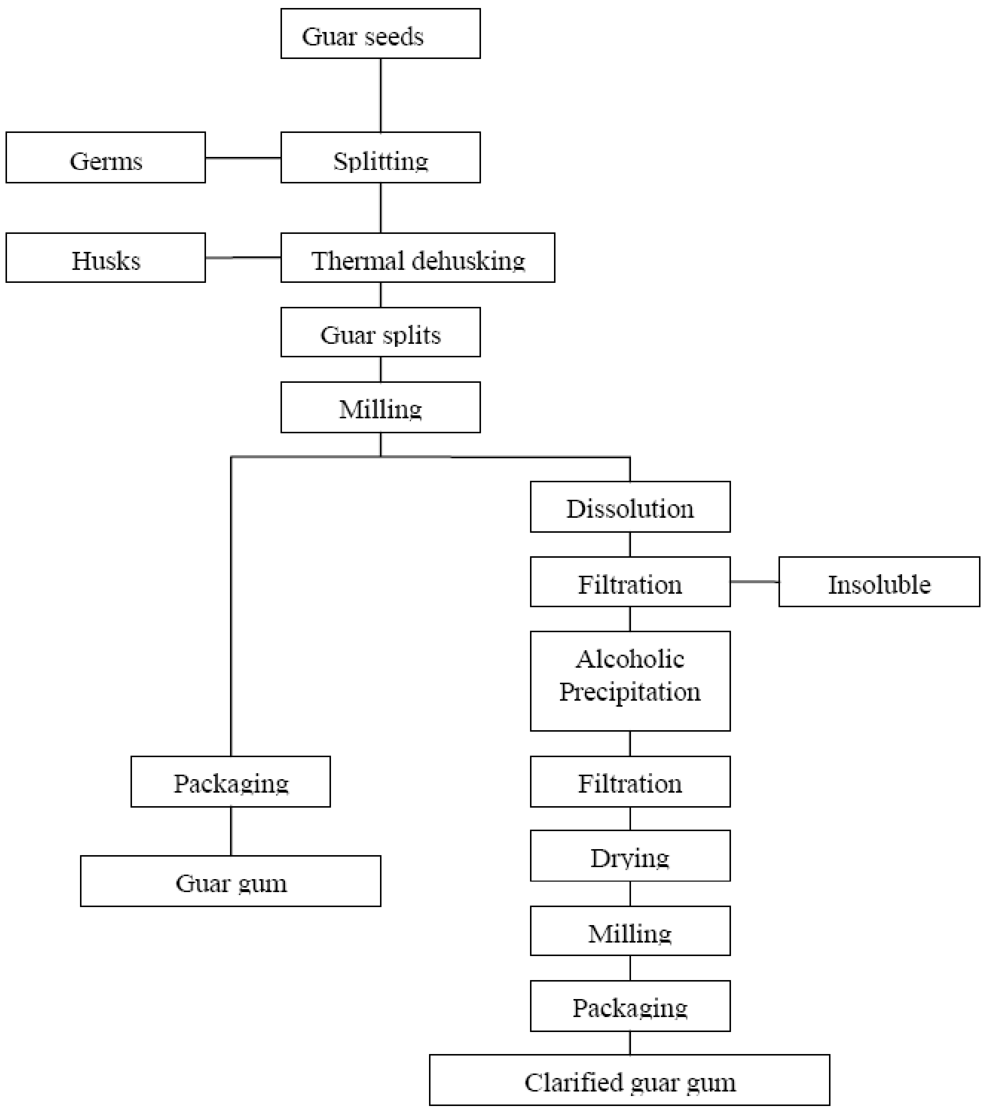


Figure 1. Guar Gum Processing Flow Chart (from Y. Kawamura 2008)

2.4.3 Uses of Guar Gum

Guar gum is a common food additive that is used as a thickener, stabilizer and emulsifier in a broad range of processed food products (baked goods, dairy products, processed vegetable, jams/jellies, etc.). Highly refined guar gum is used as a stiffener in soft ice cream, a stabilizer for cheeses, instant puddings and whipped cream substitutes, and as a meat binder. Guar gum can also be partially hydrolyzed, making it soluble in water. This allows guar to be added as a bulking agent/fibre supplement without affecting the taste or texture of a processed product[9].

Some non food/industrial applications of guar gum are as a waterproofing agent in the explosives industry, a binder in the pharmaceutical industry, a thickener in the cosmetic industry, and a controlling agent in the oil and gas industry.

In Canada guar gum is listed as a food additive for use as an emulsifier, gelling, stabilizing and thickening agent.[10] Table 1 illustrates the maximum allowable use levels of guar gum as a food additive as dictated by the Canadian *Food and Drug Regulations* (FDR).

Table 1 - Canadian Approved Uses of Guar Gum and the Corresponding Maximum Use Values

Food Category	Maximum Use Levels (% by weight)
Cream; French dressing; (naming the flavour) Milk; Mince meat; Mustard flavour; Milk; Mince meat; Mustard pickles; Relishes; Salad dressing;(naming the flavour) Skim milk;(naming the flavour) Partly skimmed milk; (naming the flavour) Skim milk with added milk solids; (naming the flavour) Partly skimmed milk with added milk solids;	GMP*
Cottage cheese; Creamed cottage cheese; Ice cream; Ice cream mix; Ice milk; Ice milk mix	0.50
Infant formula	0.03 as consumed. If used in combination with algin or carrageenan or both, the total not to exceed 0.03
Infant formula based on isolated amino acids or protein hydrolysates, or both	0.1 as consumed. If used in combination with algin or carrageenan or both, the total not to exceed 0.1%
Lactose-free infant formula based on milk protein	0.05 as consumed. If used in combination with algin or carrageenan or both, the total not to exceed 0.05
Sherbet	0.75
Unstandardized foods	GMP*
Calorie-reduced margarine	0.50
Sour cream	0.50
Canned asparagus; Canned green beans; Canned waxed beans; Canned peas	1.00
Cream cheese; Cream cheese with (named added ingredients); Cream cheese spread; Cream cheese spread with (named added ingredients); Processed cheese spread; Processed cheese spread with (named added ingredients); Cold-pack (named variety) cheese with (named added ingredients); Cold-pack cheese food; Cold-pack cheese food with (named added ingredients)	0.50

*GMP –According to good manufacturing practice

Guar gum is present in a vast number of foods. It is a minor ingredient, typically used at less than 1%.

2.5 Dioxins

The name ‘dioxins’ is often used for the family of structurally and chemically related polychlorinated dibenzo para dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Certain dioxin-like polychlorinated biphenyls (PCBs) with similar toxic properties are also included under the term ‘dioxins’. Some 419 types of dioxin-related compounds have been identified but only about 30 of these are considered to have significant toxicity, with 2,3,7,8-tetrachlorodibenzo para dioxin (TCDD) being the most toxic.[11]

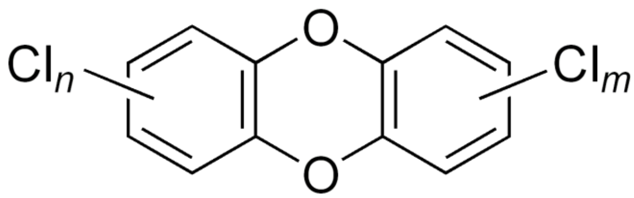
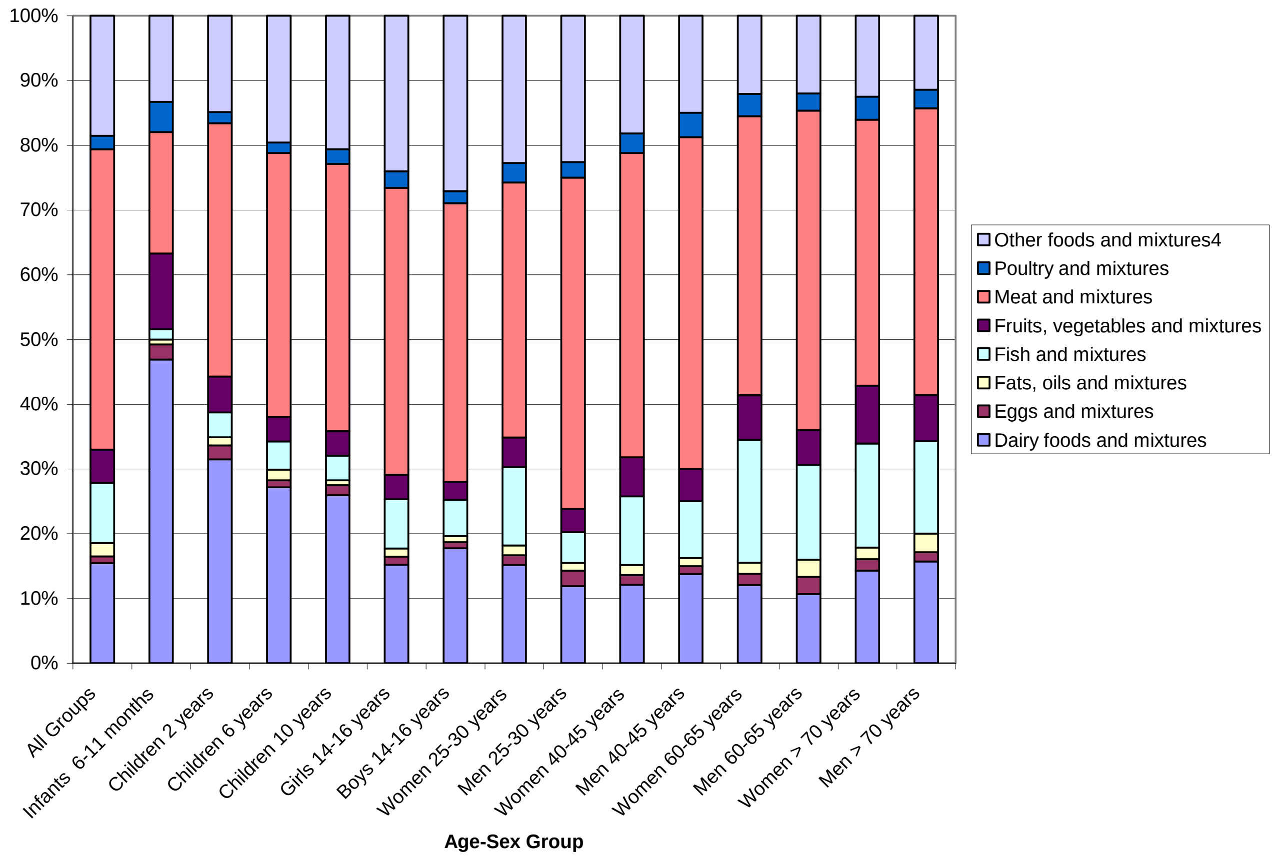


Figure 2. General structure of PCDD (*n* and *m* can range from 0 to 4 Cl molecules)

Dioxins are formed during combustion processes such as waste incineration, forest fires, and backyard trash burning, as well as during some industrial processes such as paper pulp bleaching and herbicide manufacturing. Most of these compounds pose no threat to health at the levels commonly found in the environment; however, 29 have been identified by the World Health Organization (WHO) to be of toxic concern.[12]

For most people, about 90% of the overall exposure to dioxins comes through diet.[13] The majority of dioxin intake can be attributed to consumption of animal tissues and dairy (see Figure 3).

Once dioxins have entered the body, they are absorbed by the fat tissue, where they are then stored. Their half-life in the body is estimated to be seven to eleven years.[13] Toxicology studies show that dioxins have the potential to produce a range of effects on animals and humans. Health effects associated with human exposure include skin disorders (i.e., chloracne), liver problems, impairment of the immune, endocrine, and reproductive systems, effects on the developing nervous system and other developmental events, and certain types of cancer.[11]



* Other foods and mixtures refers to grains and mixtures, legumes and mixtures and beverages (other than milk)

Figure 3. Proportional Dietary PCDD/PCDF Exposure Estimate (pg WHO-TEQ/kg body weight/month) by Food Category from US FDA TDS Foods Collected in 2001-2004 (Based on PCDD/PCDF Concentration Assuming ND = 0)[14]

In Canada, regulation B.01.046 (1p) of the FDR establishes that any food containing residues of chlorinated dibenzo-p-dioxins is considered to be adulterated. There is no reference to toxic equivalence (see Section 3.1 for an explanation of toxic equivalence) in current Canadian regulations, even though the concept is used in health risk assessments (HRA) conducted by Health Canada. The existence of a zero standard causes enforcement problems since the total absence of these fat-soluble contaminants from food cannot be achieved. Health Canada is currently conducting a reassessment of the risks posed by and standards for dioxins.

The European Union has established a list of maximum levels of total dioxins in various foodstuffs (see Table 2).[15] Specific maximum levels have not been set in the EU for dioxins in guar gum, as contamination has previously not been known or suspected. The European Regulatory authorities consider the established limit for vegetable oil (0.75 pg PCDD/F WHO TEQ/g product) as a level that would indicate higher that background levels of dioxins.[1, 16] This value was used as the best representative value for guar gum, in that it is the only plant commodity for which a maximum level has been established and it is also the most conservative value established.

Table 2. EU Maximum levels for TEQ in various foodstuffs*

Products	Maximum Levels (PCDD+PCDF) (ppt)(WHO-PCDD/F TEQ)	Maximum levels sum of dioxins, furans and dioxin-like PCBs (WHO – PCDD/F-PCB-TEQ)
Meat and meat products originating from:		
Ruminants (bovine, sheep)	3 pg/g fat	4.5 pg/g fat
Poultry	2 pg/g fat	4 pg/g fat
Pigs	1 pg/g fat	1.5 pg/g fat
Liver and derived products	6 pg/g fat	12 pg/g fat
Muscle –meat of fish and fish products (except eel)	4 pg/g fresh wt	8 pg/g fresh wt
Muscle, meat of eel and products thereof	4 pg/g fresh wt	12 pg/g fresh wt
Milk and milk products	3 pg/g fat	6 pg/g fat
Eggs and egg products	3 pg/g fat	6 pg/g fat
Oils and Fats		
Animal fat from ruminants	3 pg/g fat	4.5 pg/g fat
Animal fat from poultry and farmed	2 pg/g fat	4 pg/g fat
game	1 pg/g fat	1.5 pg/g fat
Mixed animal fat	2 pg/g fat	3 pg/g fat
Vegetable oil	0.75 pg/g fat	1.5 pg/g fat
Fish oil	2 pg/g fat	10 pg/g fat

*Taken from Commission Regulation (EC) 199/2006.

3 Survey Samples & Analytical Methods

3.1 Targeted Survey Sample Overview

Guar gum samples were obtained at the importer level. Samples were only selected from those importers who import guar gum for food or animal feed. A full description of all guar gum samples, including sample number, origin and sample description can be found in Appendix A.

There were a total of 20 samples collected for the guar gum survey, all of which originated from India.

3.2 Survey Limitations

The guar gum survey was designed to give a snapshot of the concentrations of dioxins in guar gum originating from India, an origin with a known history of contamination. There are a very limited number of samples (20 total). Definite statements cannot be made regarding trends in contamination based on such a limited number of samples, nor can any assertions be made regarding the incidence of contamination and the country of origin, as only Indian guar gum samples were tested.

The initial alarm related to contaminated guar gum from India indicated that excessive levels of dioxins and PCP were detected. Due to the severity of risk associated with dioxin contamination it was decided to focus the targeted survey on this suite of compounds.

3.3 Analytical Methods

All samples were analyzed at the CFIA laboratory in Calgary. Dioxin levels were quantified in guar gum using isotope dilution followed by capillary gas chromatography with high resolution mass spectrometry. The method used is applicable for the analysis of PCDD, PCDF and PCB residues. Results are based on total weight of sample. Typical limits of detection (LOD) for the method are 0.03 ppt (parts per trillion) for dioxins, furans and coplanar PCBs and 0.6 ppt for other PCBs on a whole weight basis depending upon the sub-sample weight extracted in the analysis.

See Appendix B for a complete description of the PCB congeners detected using the CFIAs analytical methodology.

4 Results

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

4.1 Calculation of TEQs for Dioxins and PCBs

In order to facilitate the calculation of toxicity for congener mixtures, the toxic equivalency factor (TEF) in relation to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is used. TEFs compare the potential toxicity of each dioxin-like compound comprising the mixture to the well-studied and understood toxicity of TCDD, as it is considered to be the congener of highest toxic concern.

In 1998 the WHO established TEFs for the 29 congeners of toxic concern and in 2005 these were revised.[17] TEFs are assigned based on scientific reviews of toxicological databases, along with considerations of chemical structure, persistence, and resistance to metabolism. TCDD has a TEF of 1.0 and all other congeners have TEF values ranging from 0.0001 to 1.0. In order to calculate toxic equivalence (TEQ), the concentration (wt/wt) for the congener is multiplied by its TEF.

The total TEQ is then derived by the addition of the individual TEQ for the mixture of congeners. A complete listing of the TEFs used in the calculation of the TEQs can be found in Appendix C.

In addition to the toxic congeners, the CFIA program includes testing for a total of 71 PCB congeners.[18] Only the results for the non-ortho and mono-ortho substituted PCBs identified by the WHO are included in the results reported in the following document**.**

4.2 Distribution of Dioxins in Guar Gum

Table 2 shows the TEQs calculated from this targeted survey. They were calculated on the basis of the WHO 1998 TEFs.[11]

Consistent with international reporting practice, results were reported in terms of both lower bound and upper bound levels. Upper bound levels represent the sum of detected congeners multiplied by the relevant Toxic Equivalency Factor (TEF), plus the sum of the Limit of Detection (LOD) contributions for non-detected congeners also multiplied by the relevant TEF. Lower bound levels represent solely the sum of all detected congeners multiplied by the TEF, and do not account for congeners not detected.

Table 3. Dioxin total toxic equivalence (TEQ) in guar gum samples imported from India (ng TEQ/kg total weight).

		N	Mean	Median	Minimum	Maximum	Standard Deviation
Chlorinated dibenzofurans	Lower bound	20	0.051	0.019	0.003	0.361	0.085
	Upper bound	20	0.053	0.020	0.011	0.361	0.084
Chlorinated dibenzo-p-dioxins	Lower bound	20	0.181	0.023	0.001	2.336	0.523
	Upper bound	20	0.196	0.036	0.019	2.344	0.521
Polychlorinated biphenyls (PCBs)	Lower bound	20	0.006	0.005	0.000	0.017	0.005
	Upper bound	20	0.007	0.005	0.002	0.017	0.004
Total Dioxins (∑ dioxins, furans and PCBs)	**Lower bound**	**20**	**0.238**	**0.048**	**0.006**	**2.709**	**0.598**
	Upper bound	**20**	**0.258**	**0.070**	**0.034**	**2.731**	**0.598**

Total dioxins in 20 guar gum samples from India ranged from 0.034 – 2.731ng TEQ/kg total weight (upper bound) with a mean of 0.258 ng TEQ/kg total weight (SD = 0.598). Of the 20 samples, one sample (2.731 ng TEQ/kg total weight) exceeded the European Union’s dioxin limit of 0.75 ng PCDD/F WHO-TEQ/kg product, which is considered to be unacceptably contaminated with dioxins (Figure 4).[1, 17]

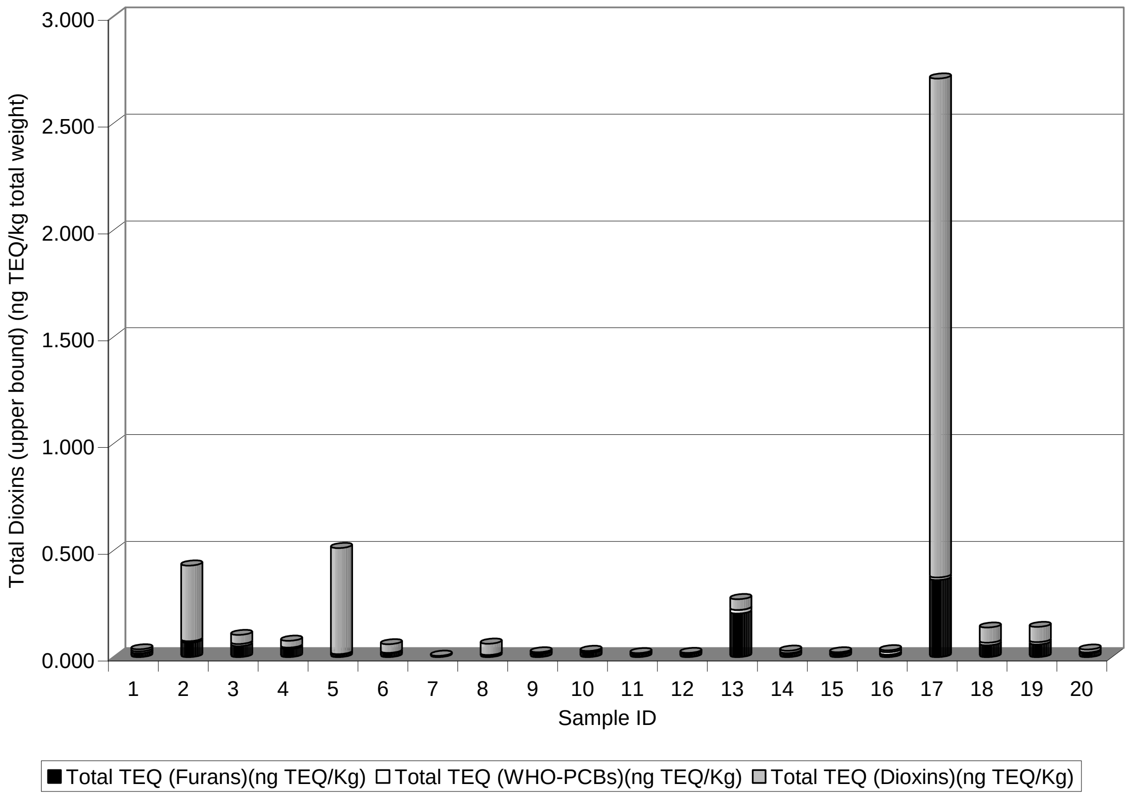


Figure 4 - Upper bound total dioxin levels (ng TEQ/kg total weight) in guar gum sampled from India. Total dioxin levels include residues from chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, non- and mono-ortho substituted PCBs.

5 Discussion

The guar gum targeted survey included 20 samples of guar gum from India. The design of the survey does not provide a statistically robust data set. However, the results obtained can provide an appreciation of the level of dioxin contamination in these samples. Of the 20 samples analyzed, all contained measurable levels of dioxins, and all but one were below the European Union's suggested maximum allowable level of contamination (0.75 ng PCDD/F WHO TEQ/kg product).

Given that in the sample found to contain the highest level of dioxins (2.73 ng TEQ/kg total wt), the level found exceeds the average of all other 19 samples (0.126 ng PCDD/F WHO TEQ/kg product) by more that 20-times, this could indicate point source contamination (see Figure 4). This sample, as well as a few other showed elevated levels of specific proportions of dioxin congeners compared to other samples, further indicating that the source of contamination is not the same for all the samples (see Figure 5). The highest levels found were still well below the maximum level detected in the EU samples (480 ng WHO-PCDD/F-TEQ/kg product).

It is interesting to note that the other samples with slightly elevated (yet still within the EUs maximum allowable level of contamination) concentration showed similar trends in proportion profiles (see samples 002, 005 and 017 in Figures 5).

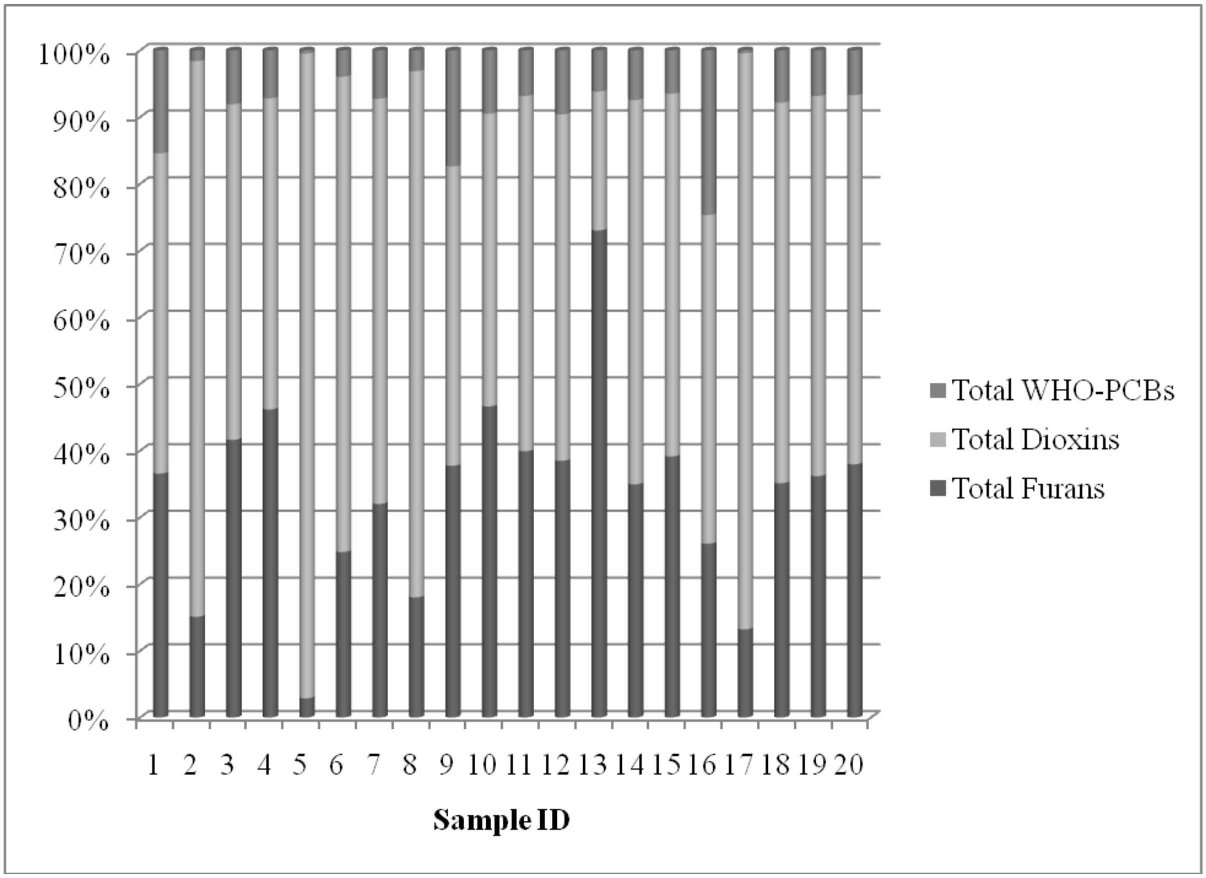


Figure 5. Proportions of WHO-PCBs, Dioxins & Furans in Guar Gum Samples.

It is necessary to examine the issue of guar gum contamination in the context of its use as a food additive/ingredient. It is difficult to get an appreciation for the amount of guar gum consumed in Canada due to its ubiquitous inclusion in a wide variety of food products. Guar gum is used as a minor food ingredient (generally comprising <1.0% of total ingredients), and the EU suggested maximum dioxin levels in guar gum are much lower than the EU established maximum TEQs for other foodstuffs (see Table 2). Therefore, it would be reasonable to conclude that guar gum contaminated with dioxins at the levels seen in the current study would not contribute significantly to the total dietary dioxin exposure of individuals who consumed products containing the maximum allowable concentrations of guar gum. Exposures to dioxins are much more likely to be from more conventional sources such as meats and other fatty animal commodities.

Health Canada performed a health risk assessment and on the available data and concluded that the levels of dioxin and dioxin-like chemicals in guar gum samples would not pose an unacceptable health risk provided the guar gum is used in accordance with provisions found within the Food and Drug Regulations (Section B.16.100 Table IV). Similarly the European Food Standards Agency (EFSA) made the following conclusion regarding contaminated guar gum used in the manufacturing of products prior to the discovery of elevated dioxin and PCP levels "*Based on the information so far available, there is no immediate health risk to consumers…*"[19]

6 Conclusions

All 20 guar gum samples tested under the current survey contained measurable residues of dioxins. Dioxins can be naturally occurring or be present as a result of contamination from chemical sources. All but one of the samples tested were within the EUs suggested maximum allowable level of contamination. Although this survey does not provide a statistically relevant set of data on which to derive guidelines, it does indicate that levels of dioxin contamination are minimal and provided that guar gum, a food ingredient, is used in accordance with the provisions found within the Food and Drug Regulations, the levels of dioxins in guar gum are unlikely to pose an unacceptable health risk to Canadian consumers.

7 Future Considerations

Given that both the EFSA and Health Canada have determined that there is no immediate health risk, and that the Indian authorities have implemented a number of safeguards to ensure that contaminated guar gum is not destined for human/animal consumption, the need for an ongoing survey is minimal.

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Appendix A

Table A1. Sample summary- List of sample numbers associated with guar gum, country of origin, and results of analysis

Sampling Plan ID.	Description	Origin	Weight Extracted (g.)		Total (Furans ng/Kg whole weight)	Total TEQ (Furans) (ng TEQ/Kg)		Total (Dioxins ng/Kg whole weight)	Total TEQ (Dioxins) (ng TEQ/Kg)		PCB Total (non-ortho, mono-ortho) ng/kg	Total TEQ (WHO-PCBs) (ng TEQ/Kg)
C2008FSR0001	GUAR GUM	IND	12.66		0.284	0.022		2.115	0.029		18.272	0.009
C2008FSR0002	GUAR GUM	IND	12.59		17.167	0.068		227.38	0.374		45.419	0.007
C2008FSR0003	GUAR GUM	IND	12.52		0.637	0.052		4.531	0.063		32.114	0.010
C2008FSR0004	GUAR GUM	IND	12.62		0.468	0.040		3.7	0.040		23.658	0.006
C2008FSR0005	GUAR GUM	IND	12.67		1.375	0.015		180.094	0.514		3.83	0.003
C2008FSR0006	GUAR GUM	IND	12.58		0.878	0.020		22.212	0.057		14.276	0.003
C2008FSR0007	GUAR GUM	IND	12.64		0.161	0.011		1.778	0.021		4.616	0.003
C2008FSR0008	GUAR GUM	IND	12.68		2.717	0.016		18.342	0.070		7.618	0.003
C2008FSR0009	guar gum 8/22 Powder	IND	12.54		0.159	0.016		0.156	0.019		41.167	0.007
C2008FSR0010	guar gum 8/22 Powder	IND	12.65		0.229	0.022		0.3	0.021		19.602	0.004
C2008FSR0011	GUAR GUM	IND	12.56		0.178	0.016		1.811	0.021		8.127	0.003
C2008FSR0012	GUAR GUM	IND	12.6		0.265	0.016		0.466	0.021		21.838	0.004
C2008FSR0013	GUAR GUM	IND	12.58		3.095	0.204		9.785	0.058		16.556	0.017
C2008FSR0014	GUAR GUM	IND	12.62		0.294	0.017		4.594	0.028		17.247	0.004
C2008FSR0015	Guar Gum (Powdered)	IND	12.51		0.185	0.017		1.756	0.024		7.639	0.003
C2008FSR0016	GUAR GUM	IND	12.63		0.173	0.013		3.335	0.025		111.837	0.013
C2008FSR0017	GUAR GUM	IND	12.54		99.9	0.361		2501.262	2.358		28.289	0.012
C2008FSR0018	Guar Gum A200	IND	12.61		2.336	0.056		27.258	0.091		63.613	0.013
C2008FSR0019	Guar Gum A200	IND	12.54		2.289	0.060		27.311	0.094		53.374	0.011
C2008FSR0020	GUAR GUM	IND	12.61		0.382	0.021		6.328	0.030		14.252	0.004

Appendix B

Table B1. List of Congeners Included in the CFIA PCB Methodology

Number	Congener	Number	Congener
PCB #001	2-Chlorobiphenyl	PCB #128	2,2',3,3',4,4'-Hexachlorobiphenyl
PCB #003	4-Chlorobiphenyl	PCB #129	2,2',3,3',4,5-Hexachlorobiphenyl
PCB #004	2,2'-Dichlorobiphenyl	PCB #137	2,2',3,4,4',5-Hexachlorobiphenyl
PCB #008	2,4'-Dichlorobiphenyl	PCB #138	2,2',3,4,4',5'-Hexachlorobiphenyl
PCB #010	2,6-Dichlorobiphenyl	PCB #141	2,2',3,4,5,5'-Hexachlorobiphenyl
PCB #015	4,4'-Dichlorobiphenyl	PCB #149	2,2',3,4,5',6-Hexachlorobiphenyl
PCB #018	2,2',5-Trichlorobiphenyl	PCB #151	2,2',3,5,5',6-Hexachlorobiphenyl
PCB #019	2,2',6-Trichlorobiphenyl	PCB #153	2,2',4,4',5,5'-Hexachlorobiphenyl
PCB #022	2,3,4'-Trichlorobiphenyl	PCB #155	2,2',4,4',6,6'-Hexachlorobiphenyl
PCB #028	2,4,4'-Trichlorobiphenyl	PCB #156	2,3,3',4,4',5-Hexachlorobiphenyl
PCB #033	2',3,4'-Trichlorobiphenyl	PCB #157	2,3,3',4,4',5'-Hexachlorobiphenyl
PCB #037	3,4,4'-Trichlorobiphenyl	PCB #158	2,3,3',4,4',6-Hexachlorobiphenyl
PCB #040	2,2',3,3'-Tetrachlorobiphenyl	PCB #167	2,3',4,4',5,5'-Hexachlorobiphenyl
PCB #041	2,2',3,4-Tetrachlorobiphenyl	PCB #168	2,3',4,4',5',6-Hexachlorobiphenyl
PCB #044	2,2',3,5-Tetrachlorobiphenyl	PCB #169	3,3',4,4',5,5'-Hexachlorobiphenyl
PCB #049	2,2',4,5'-Tetrachlorobiphenyl	PCB #170	2,2',3,3',4,4',5-Heptchlorobiphenyl
PCB #052	2,2',5,5'-Tetrachlorobiphenyl	PCB #171	2,2',3,3',4,4',6-Heptchlorobiphenyl
PCB #054	2,2',6,6''-Tetrachlorobiphenyl	PCB #177	2,2',3,3',4',5,6-Heptchlorobiphenyl
PCB #060	2,3',4,4'-Tetrachlorobiphenyl	PCB #178	2,2',3,3',5,5',6-Heptchlorobiphenyl
PCB #066	2,3',4,4'-Tetrachlorobiphenyl	PCB #180	2,2',3,4,4',5,5'-Heptchlorobiphenyl
PCB #070	2,3',4',5-Tetrachlorobiphenyl	PCB #183	2,2',3,4,4',5',6-Heptchlorobiphenyl
PCB #074	2,4,4',5-Tetrachlorobiphenyl	PCB #187	2,2',3,4',5,5',6-Heptchlorobiphenyl
PCB #077	3,3',4',4'-Tetrachlorobiphenyl	PCB #188	2,2',3,4',5,6,6'-Heptchlorobiphenyl
PCB #081	3,4,4',5-Tetrachlorobiphenyl	PCB #189	2,3,3',4,4',5,5'-Heptchlorobiphenyl
PCB #087	2,2',3,4,5'-Pentachlorobiphenyl	PCB #191	2,3,3',4,4',5',6-Heptchlorobiphenyl
PCB #095	2,2',3,5',6-Pentachlorobiphenyl	PCB #193	2,3,3',4',5,5',6-Heptchlorobiphenyl
PCB #099	2,2',4,4',5-Pentachlorobiphenyl	PCB #194	2,2',3,3',4,4',5,5'-Octachlorobiphenyl
PCB #104	2,2',4,6,6'-Pentachlorobiphenyl	PCB #199	2,2',3,3',4,5,6,6'-Octachlorobiphenyl
PCB #105	2,3,3',4,4'-Pentachlorobiphenyl	PCB #201	2,2',3,3',4,5,5',6'-Octachlorobiphenyl
PCB #110	2,3,3',4',6'-Pentachlorobiphenyl	PCB #202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl
PCB #114	2,3,4,4',5-Pentachlorobiphenyl	PCB #203	2,2',3,4,4',5,5',6-Octachlorobiphenyl
PCB #118	2,3',4,4',5-Pentachlorobiphenyl	PCB #205	2,3,3',4,4',5,5',6-Octachlorobiphenyl
PCB #119	2,3',4,4',6-Pentachlorobiphenyl	PCB #206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl
PCB #123	2',3,4,4',5-Pentachlorobiphenyl	PCB #208	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl
PCB #126	3,3',4,4',5-Pentachlorobiphenyl	PCB #209	Decachlorobiphenyl

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Appendix C

Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds

Compound	**Toxic Equivalence Factor (TEF)**[xi]
Chlorinated dibenzo-p-dioxins	
2,3,7,8-TCDD	1
1,2,3,7,8-PeTCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0001
Chlorinated dibenzofurans	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.05
2,3,4,7,8-PeCDF	0.5
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0001
Non-ortho substituted PCBs	
PCB 77	0.0001
PCB 81	0.0001
PCB 126	0.1
PCB 169	0.01
Mono-ortho substituted PCBs	
105	0.0001
114	0.0005
118	0.0001
123	0.0001
156	0.0005
157	0.0005
167	0.00001
189	0.0001

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