



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Polycyclic Aromatic Hydrocarbons in Selected Foods - April 1, 2018 to March 31, 2019

Food chemistry - Targeted surveys - Final report



Summary

Targeted surveys provide information on potential food hazards and enhance the Canadian Food Inspection Agency's (CFIA's) routine monitoring programs. These surveys provide evidence regarding the safety of the food supply, identify potential emerging hazards, and contribute new information and data to food categories where it may be limited or non-existent. They are often used by the Agency to focus surveillance on potential areas of higher risk. Surveys can also help to identify trends and provide information about how industry complies with Canadian regulations.

Polycyclic aromatic hydrocarbons (PAHs) are products of the incomplete combustion of materials such as coal, oil, gas, wood and charbroiled meat. They are a common airborne pollutant and often contaminate crops. PAHs can also form in food during thermal processing. This survey analyses the 4 most toxic PAHs, including: benzo[a]pyrene, which has been classified as "carcinogenic to humans" by the International Agency for Research on Cancer (IARC), as well as benzo[a]anthracene, benzo[b]fluoranthene and chrysene, which have been classified as "possibly carcinogenic to humans" by the IARC¹.

This targeted survey generated baseline surveillance data on the occurrence of PAHs in domestic and imported products on the Canadian market. The CFIA sampled and analyzed 287 products, including 142 baked goods, 78 oils and 67 roasted vegetable products. PAHs were detected in 46% of samples tested, with total PAH levels ranging from 0.001 ppb to 9.17 ppb TEQ (Toxic Equivalency). Roasted vegetable products had the highest maximum and average PAH levels. Comparison of the survey results to previous surveys and scientific literature showed that the levels of PAHs in Canadian retail products are similar to those reported in a variety of scientific studies.

There are no regulations in Canada for PAH levels in food. All levels of PAH found in the products tested in this survey were evaluated by Health Canada (HC) and deemed safe for consumption by Canadians; no product recalls were required.

What are targeted surveys

Targeted surveys are used by the CFIA to focus its surveillance activities on areas of highest health risk. The information gained from these surveys provides support for the allocation and prioritization of the Agency's activities to areas of greater concern. Originally started as a project under the Food Safety Action Plan (FSAP), targeted surveys have been embedded in our regular surveillance activities since 2013. Targeted surveys are a valuable tool for generating information on certain hazards in foods, identifying and characterizing new and emerging hazards, informing trend analysis, prompting and refining health risk assessments, highlighting potential contamination issues, as well as assessing and promoting compliance with Canadian regulations.

Food safety is a shared responsibility. We work with federal, provincial, territorial and municipal governments and provide regulatory oversight of the food industry to promote safe handling of foods throughout the food production chain. The food industry and retail sectors in Canada are responsible for the food they produce and sell, while individual consumers are responsible for the safe handling of the food they have in their possession.

Why did we conduct this survey

Polycyclic aromatic hydrocarbons (PAHs) are natural and unintentional by-products of the incomplete combustion of materials such as coal, oil, gas, wood and charbroiled meat¹. As such, they can form in food during high-temperature processing and contaminate food through industrial air pollution.

PAHs include a wide range of chemicals with varying levels of carcinogenicity as classified by the IARC; this survey analyses the levels of the 4 most toxic PAHs. These 4 PAHs include the following: benzo[a]pyrene, which has been classified as "carcinogenic to humans" by the IARC, as well as benzo[a]anthracene, benzo[b]fluoranthene and chrysene, which have been classified as "possibly carcinogenic to humans" by the IARC¹.

Maximum Residue Limits (MRLs) for PAHs levels have not yet been established by HC, although the European Food Safety Authority (EFSA) has established a MRL of 2 ppb in edible oils². This survey was initiated in consultation with HC to establish further baseline surveillance data to complement and expand upon the data previously collected.

What did we sample

A variety of domestic and imported products including baked goods, oils and roasted vegetable products were sampled between April 1, 2018 and March 31, 2019. Samples were collected from local/regional retail locations located in 6 major cities across Canada. These cities encompassed 4 Canadian geographical areas: Atlantic (Halifax), Quebec (Montreal), Ontario (Toronto, Ottawa) and the West (Vancouver, and Calgary). The number of samples collected from these cities was in proportion to the relative population of the respective areas. The shelf

life, storage conditions, and the cost of the food on the open market were not considered in this survey.

Table 1. Distribution of samples based on product type and origin

Product type	Number of domestic samples	Number of imported samples	Number of samples of unspecified^a origin	Total number of samples
Baked goods	18	42	82	142
Oils	9	59	10	78
Roasted vegetable products	1	65	1	67
Grand total	28	166	93	287

^a Unspecified refers to those samples for which the country of origin could not be assigned from the product label or available sample information

How were samples analyzed and assessed

Samples were analyzed by ISO/IEC 17025 accredited food testing laboratories under contract with the Government of Canada. The samples were tested as sold, which means the product was tested as is and not prepared according to package instructions.

The list of compounds reported as part of this survey are shown in Table A-1 in the Appendix A of this report. The concentration of each PAH detected in a sample was multiplied by its respective Toxic Equivalency Factor (TEF) proposed by Nisbut and LaGoy³. Refer to Table A-1 in the Appendix A for the TEFs used in this survey. The calculated toxic equivalency (TEQ) concentrations of the individual compounds were added together to arrive at a total PAH level expressed as 'parts per billion TEQ', which is an estimate of the total relative potency of all the PAHs detected in the sample.

Currently, there are no Canadian Maximum Levels (MLs) for PAHs in food. Elevated levels in specific foods were assessed by HC on a case-by-case basis using the most current scientific data available.

What were the survey results

Of 287 products sampled in this survey, 46% (133) contained measurable levels of PAHs. Table 2 shows the range of PAH levels reported in the product types included in this survey.

Baked Goods

Sampled baked goods had the lowest detection rate (36%) of all product types included in this survey. This category included crackers and cookies, and aside from 1 sample with a total PAH level of 1.68 ppb TEQ, all other samples reported a total PAH levels of less than 0.8 ppb TEQ.

Oils

Sampled oils had the highest detection rate (71%) of all product types included in this survey. Detection rates among individual oil types ranged from 18% to 100%. As Figure 1 illustrates, peanut oils reported the highest average and maximum total PAH levels (0.94 ppb and 2.41 ppb TEQ). Canola oils reported the lowest detection rate (18%) as well as the lowest average and maximum total PAH levels (0.02 ppb and 0.03 ppb TEQ). There was no significant relationship between brand of product and total PAH levels.

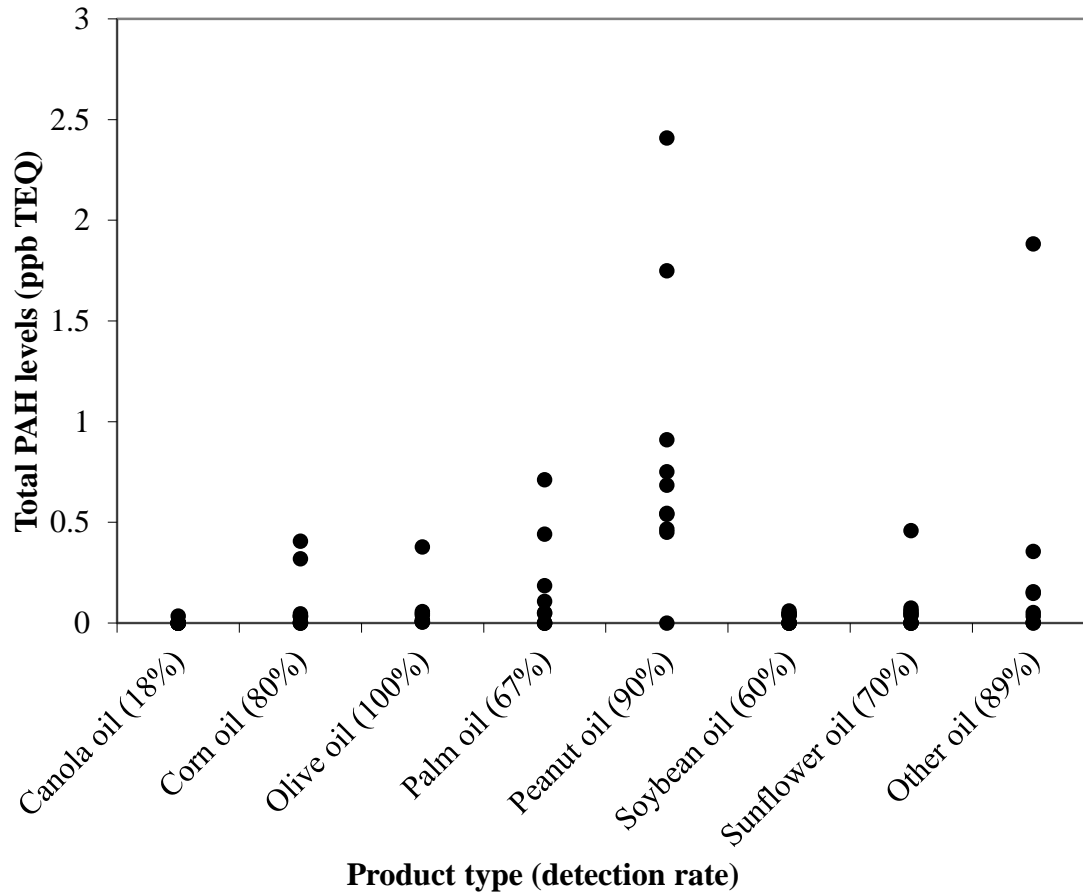


Figure 1. Distribution of total PAH levels and detection rates by oil type

Roasted vegetable products

This survey included 1 roasted red pepper sample which reported a total PAH level of 9.17 ppb TEQ, the highest in this survey. This sample contained higher-than-average levels of all 4 PAHs analysed in this survey. All the remaining roasted vegetable products report a total PAH level of less than 2.7 ppb TEQ.

Table 2. Summary of targeted survey results on PAHs in selected baked goods, oil and roasted vegetable products

Product type	Number of samples	Number of samples (%) with detected levels	Minimum PAH levels (ppb TEQ)	Maximum PAH levels (ppb TEQ)	Average PAH levels ^b (ppb TEQ)
Baked goods	142	51 (36)	0.001	1.68	0.16
Oils	78	55 (71)	0.002	2.41	0.27
Roasted vegetable products	67	27 (40)	0.004	9.17	1.16
Grand total	287	133 (46)	0.001	9.17	0.41

^b Only positive results were used to calculate the average PAH levels

What do the survey results mean

Table 3 compares the data from this survey with that available in the literature^{4,5,6}, although there was limited data available for comparison concerning PAH levels in the product types included in this survey. In general, the levels of PAHs found in this survey were comparable to, or lower than results reported in the scientific literature. The differences observed may be due to the sample size and the specific type of product tested.

Multiple sources of PAHs may exist. The grains and raw vegetables may have been contaminated by air pollution where the crops were grown^{7,8}, however, processing temperature and technique may also contribute towards the presence of PAHs in these products^{9,10}. For oils, PAHs contamination has been linked to direct drying of the seeds with combustion smoke before oil extraction, and to high temperature processing during the extraction¹¹. Peanut oil samples had highest levels of PAHs of all the oils sampled. High-temperature roasting and incomplete refining process have been shown to be associated with higher PAHs contamination of peanut oil¹².

Table 3. Minimum, maximum and average concentration of PAHs in baked goods, oils and roasted vegetable products across various studies

Product type	Study	Number of samples	Minimum PAH levels (ppb TEQ)	Maximum PAH levels (ppb TEQ)	Average PAH levels (ppb TEQ)
Baked goods	CFIA survey, 2018 to 2019	142	0.001	1.68	0.16 ^c
Baked goods	Veyrand et al. (2013)	15	-	-	0.046
Oils	CFIA survey, 2018 to 2019	78	0.002	2.41	0.27 ^c
Oils	Yu et al. (2014)	12	0.144	11.4	4.5
Oils	Veyrand et al. (2013)	6	-	-	0.46
Roasted vegetables	CFIA survey, 2018 to 2019	67	0.004	9.17	1.16 ^c
Grilled vegetables	Alomirah et al. (2011)	8	0.11 ^d	6.8 ^d	2.89 ^d

^c Only positive results were used to calculate the average PAHs levels

^d TEQs were calculated using the 8 most toxic PAHs and their respective TEFs

There are no regulations in Canada for PAH levels in food. All levels of PAH found in the products tested in this survey were evaluated by HC and deemed safe for consumption by Canadians and no product recalls were required.

References

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Appendix A

Table A-1. Toxic Equivalency Factors used in this survey

Polycyclic Aromatic Hydrocarbon	Toxic Equivalency Factor
Benzo[a]anthracene	0.1
Benzo[b]fluoranthene	0.1
Benzo[a]pyrene	1
Chrysene	0.01