



Investigation into levels of Polycyclic Aromatic Hydrocarbons (PAHs) in food on the Irish market

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Summary

The Food Safety Authority of Ireland (FSAI) has carried out a surveillance study of levels of Polycyclic Aromatic Hydrocarbons (PAHs) in a variety of foodstuffs, including chocolate, dried fruit, infant food, meat products, fish and fishery products, dietary supplements and vegetable oils. The study is the first such study carried out on Irish food, and was undertaken against the background of increased awareness in the European Union of the possible health risks, including carcinogenic effects, posed by these environmental/industrial contaminants. It also reflects Ireland's participation in the 2005 EC monitoring recommendation for the background presence of PAHs in foodstuffs, which has been agreed between the European Commission and the Member States.

The study has shown that levels of PAHs in products sourced on the Irish market are generally low, with the exception of a small number of food supplements, for which maximum levels have not yet been set. The lowest concentration of 0.51 µg/kg fresh weight for the sum total of the 15 PAHs recommended by the EU Scientific Committee on Food (referred to as SCF-15) for monitoring purposes (sum of SCF-15) was found in a sample of baby food, while, the highest level of 548.55 µg/kg fresh weight was found in a dietary supplement.

Median upper-bound levels of the sum of SCF-15 detected were as follows: chocolate and chocolate products 2.26 µg/kg fresh weight, dried fruit 1.11 µg/kg fresh weight, fats/oils 2.31 µg/kg fresh weight, shellfish 0.85 µg/kg fresh weight, smoked fish 0.60 µg/kg fresh weight, smoked shellfish 13.22 µg/kg fresh weight, infant food 0.60 µg/kg fresh weight, smoked meat products 0.65 µg/kg fresh weight and dietary supplements 5.58 µg/kg fresh weight. Benzo(a)pyrene (B(a)P) is currently the only PAH for which legal limits have been established under Commission Regulation 466/2001, and none of the products tested had levels of benzo(a)pyrene above these legal limits, with the exception of a small number of food supplements, for which maximum levels have not yet been set.

A toxicological assessment of dietary PAHs has recently been carried out by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). JECFA concluded that there was a very large margin of exposure between estimated levels of dietary intake of B(a)P and the levels of B(a)P in PAH mixtures found to cause cancer. Following the findings of this survey, and taking the JECFA assessment into account, the Food Safety Authority of Ireland concludes that the levels of PAHs present in food on the Irish market are not generally of concern for human health, although the survey found high levels of PAHs including B(a)P in a small number of food supplements. The FSAI has contacted the manufacturers and suppliers of these supplements, advising them to explore the feasibility of changes to raw material sources and production processes in order to keep PAH levels in their products as low as reasonably achievable.

The full study report follows, providing further details and discussion of these results.

Abbreviations

b.w.	“body weight“
congener	“term referring to one of many configurations of a common chemical structure”
EC	“European Community”
EFSA	“European Food Safety Authority”
FSAI	“Food Safety Authority of Ireland”
JECFA	“FAO/WHO Joint Expert Committee Food Additives/Contaminants”
LOD	“Limit of Detection”
Lower-bound	“Analytical results reported below the LOD are set at zero for calculation purposes”
µg	“microgram” (0.000001 g)
ppb	“parts per billion“ (equal to ng/g or µg/kg)
SCF	“Scientific Committee of Food”
SCF-15	“15 PAH congeners identified by the SCF to be genotoxic”
Upper-bound	“Analytical results reported below the LOD are set at the LOD value for calculation purposes”
w.w.	“wet weight or whole weight, equivalent to fresh weight”
BB	“body burden“
[BaP]	“benzo[a]pyrene”
[BaA]	“benz”(a)“anthracene”
[CP]	“cyclopenta[c,d]pyrene”
[CHR]	“chrysene”
[5-MC]	“5-methylchrysene”
[BbFl]	“benzo[b]fluoranthene”
[BjFl]	“benzo[j]fluoranthene”
[BkFl]	“benzo[k]fluoranthene”
[IP]	“indeno[1,2,3-cd]pyrene”
[DBahA]	“dibenz[ah]anthracene”
[BghiP]	“benzo-[g,h,i]perylene”
[DBaP]	“dibenzo[a,l]pyrene”
[DBaP]	“dibenzo[a,e]pyrene”
[DBaP]	“dibenzo[a,i]pyrene”
[DBaP]	“dibenzo[a,h]pyrene”
[ACL]	“acenaphthylene”
[AC]	“acenaphthene”
[FL]	“fluorene”
[PHE]	“phenanthrene”
[AN]	“anthracene”
[FA]	“fluoranthene”
[BcFL]	“benzo[c]fluorene”
[PY]	“pyrene”
[BghiF]	“benzo[ghi]fluoranthene”
[BNTH]	“benzo[b]naphtho[2,1-d]thiophene”
[BeP]	“benzo[e]pyrene”
[ATR]	“anthanthrene”
[COR]	“coronene”

Background

The Food Safety Authority of Ireland (FSAI) has a statutory responsibility to ensure the safety of food consumed, distributed, produced and sold on the Irish market. In this respect, the FSAI co-ordinates the collation of food safety surveillance information from laboratories run by its official agents, the Health Service Executive (HSE), the Department of Agriculture and Food, the Department of Communication, Marine and Natural Resources, the Marine Institute and the local authorities. The FSAI also conducts targeted food safety surveillance in areas where potential safety issues have been identified and/or on food contaminants for which there are currently no testing facilities¹ in Ireland, such as Multiple Polycyclic Aromatic Hydrocarbons (PAHs).

This report provides the results of a surveillance study on levels of 28 different PAH congeners in a variety of products available on the Irish market.

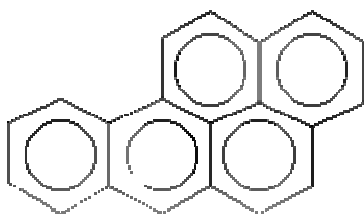
This study is the first such study carried out on Irish food, and was undertaken against the background of increased awareness in the European Union of the possible health risks posed by these substances in the food chain. It also reflects Ireland's participation in the 2005 EC monitoring recommendation for the background presence of PAHs in foodstuffs which has been agreed between the European Commission and the Member States via Commission Recommendation 2005/108/EC of 4 February 2005 on the further investigation into the levels of polycyclic aromatic hydrocarbons in certain foods (European Commission, 2005a).

Introduction

The term 'polycyclic aromatic hydrocarbons' commonly refers to a large class of organic compounds containing two or more fused aromatic rings made up of carbon and hydrogen atoms. Figure 1 shows the structure of benzo(a)pyrene (B(a)P), one of the best characterised members of the PAH family. The general characteristics common to the class are high melting- and boiling-points, low vapour pressure, and very low water solubility which tends to decrease with increasing molecular mass. PAHs are soluble in many organic solvents and are highly lipophilic (WHO, 1998). Hundreds of individual PAHs may be formed and released during incomplete combustion or pyrolysis of organic matter, during industrial processes and other human activities. PAHs are also formed in natural processes, such as carbonisation (Scientific Committee on Food, 2002).

¹ The Public Analyst Laboratory in Dublin; Sir Patrick Dunn's, is currently developing methodology for multiple PAH analysis. Analysis for benzo(a)pyrene has been available through the public analyst laboratories for a number of years.

Figure 1 Chemical Structure of benzo(a)pyrene



Food can be contaminated by PAHs that are present in air, soil or water or are formed during processing (during drying or smoking) and cooking (during grilling, roasting or frying).

Studies in experimental animals on individual PAHs, most notably benzo[a]pyrene (BaP), have shown various toxicological effects, such as haematological effects, reproductive and developmental toxicity and immunotoxicity, however, it is the carcinogenic and genotoxic potential of these compounds that has attracted most attention. A number of PAHs as well as coal-tar and some occupational exposures to combustion emissions containing these compounds have shown carcinogenicity in experimental animals and genotoxicity and mutagenicity *in vitro* and *in vivo* (WHO, 1998, SCF, 2002).

The EU Scientific Committee on Food (SCF) identified 15 PAHs (the SCF-15, see Table 3) that may be genotoxic and carcinogenic to humans. It concluded that it was not possible to establish a threshold level below which risk would be insignificant and therefore a Tolerable Daily Intake could not be set (SCF, 2002). It considered that benzo(a)pyrene could be used as a marker of the occurrence and effect of the carcinogenic PAHs in food and concluded, based on a conservative assessment, that the carcinogenic potency of total PAHs in food would be ten times higher than expected from benzo(a)pyrene alone. Consequently, the SCF recommended that exposures to PAHs from food should be as low as reasonably achievable.

In a recent toxicological assessment of dietary PAHs, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) also concluded that benzo(a)pyrene could be used as a marker for genotoxic and carcinogenic PAHs in food (JECFA, 2005). In assessing consumer exposure to PAHs in food, JECFA estimated a representative mean intake of 4 ng benzo(a)pyrene/kg bw per day and a high-level intake of 10 ng benzo(a)pyrene/kg bw per day (JECFA, 2005). Following comparison of these intakes with a level of benzo(a)pyrene known to cause cancer in animal studies, the Committee concluded that the margin of exposure (MOEs) was very large (25,000 and 10,000, for the estimated mean intake and high-level intake, respectively). Based on these MOEs, the Committee concluded that the estimated intakes of PAHs were of low concern for human health.

The EC has recently introduced maximum levels for PAHs in certain foodstuffs via Commission Regulation (EC) No. 208/2005, amending Commission Regulation 466/2001² which sets maximum levels for certain contaminants in foodstuffs (European Commission, 2005b). Currently, maximum levels are only set for benzo(a)pyrene (see Table 1), serving as a marker for the presence of other PAHs in food, however, further analyses of the relative proportions of these PAHs in foods are necessary to inform a future review of the suitability of maintaining benzo(a)pyrene as a marker.

The EU Commission therefore also published a Recommendation (European Commission, 2005a) to investigate the respective levels of benzo(a)pyrene and other PAHs, in particular those highlighted to be carcinogenic by the Scientific Committee on Food and to assess the relative proportions of these PAHs in the foods listed in Regulation (EC) No 208/2005. It is also recommended to investigate the levels of PAHs in other foods that can contain high levels of PAHs, such as dried fruits and food supplements.

Table 1 Maximum Levels for polycyclic aromatic hydrocarbons (PAHs) in food

Product	Maximum level (µg/ kg wet weight)
7.1. Benzo(a)pyrene ⁽¹⁾	
7.1.1. Oils and fats intended for direct human consumption or use as an ingredient in foods ⁽²⁾	2.0
7.1.2. Foods for infants and young children	
7.1.2.1. Baby foods and processed cereal-based foods for infants and young children ⁽³⁾	
7.1.2.2. Infant formulae and follow-on formulae, including infant milk and follow-on milk ⁽⁴⁾	1.0
7.1.2.3. Dietary foods for special medical purposes ⁽⁵⁾ intended specifically for infants	
7.1.3. Smoked meats and smoked meat products	5.0
7.1.4. Muscle meat of smoked fish and smoked fishery products ⁽⁶⁾	5.0
7.1.5. Muscle meat of fish ⁽⁷⁾ , other than smoked fish	2.0
7.1.6. Crustaceans, cephalopods, other than smoked	5.0
7.1.7. Bivalve molluscs	10.0

⁽¹⁾ Benzo(a)pyrene, for which maximum levels are listed, is used as a marker for the occurrence and effect of carcinogenic PAHs. These measures therefore provide full harmonisation on PAHs in the listed foods across the Member States. The Commission shall review the maximum levels for PAHs in the listed food categories by 1 April 2007, taking into account the progress in scientific and technological knowledge on the occurrence of benzo(a)pyrene and other carcinogenic PAHs in food.

⁽²⁾ Cocoa butter is excluded from this category whilst investigations into the presence of benzo(a)pyrene in cocoa butter are made. This derogation will be reviewed by 1 April 2007.

⁽³⁾ Baby foods and processed cereal-based foods for infants and young children as defined in Article 1 of Directive 96/5/EC. The maximum level refers to the product as sold.

⁽⁴⁾ Infant formulae and follow-on formulae as defined in Article 1 of Directive 91/321/EEC. The maximum level refers to the product as sold.

⁽⁵⁾ Dietary foods for special medical purposes as defined in Article 1(2) of Directive 1999/21/EC. The maximum level refers to the product as sold.

⁽⁶⁾ Fish and fishery products as defined in the category (b), (c), and (f) of the list of Article 1 of Regulation (EC) N° 104/2000.

⁽⁷⁾ Fish as defined in the category (a) of the list of Article 1 of Regulation (EC) N° 104/2000

² A new regulation consolidating all contaminants legislation will be adopted in 2006. This new Regulation will replace Commission Regulation 466/2001 and all its amendments.

This survey aims to fulfil the requirements of the Commission Recommendation (European Commission, 2005a) by providing data on the occurrence of PAHs in relevant foodstuffs available on the Irish market. Results obtained will be forwarded to the European Food Safety Authority (EFSA) for use in a refinement of the risk assessment for these substances in food.

Study Outline

A total of 120 samples comprising different food categories (see Table 2) were purchased in different retail outlets located in Dublin. Samples were selected to cover the categories for which currently maximum levels exist or are being considered, and also for which EFSA is seeking to collect further occurrence information.

This survey did not include an exhaustive list of all food categories likely to contain PAHs. Rather, it provides a snapshot in time of a number of products from those food categories for which legislative limits for benzo(a)pyrene have been established (oils and fats, foods for infants and young children, smoked meats and smoked meat products, fish and fishery products, see Table 1), together with a number of products from food categories for which establishment of legislative limits is under consideration and for which more information is required (food supplements, dried fruits, chocolate/chocolate products).

Single samples only of each product selected for inclusion were analysed. The results provided relate solely to the sample tested and may not necessarily be representative of the general PAH status of that product. Since the survey was designed to measure broad compliance with the regulations and a risk assessment was not conducted, no inference can be drawn on the risk or the safety of the products concerned, or from the results obtained for a particular brand of a product included in the survey.

Table 2 Food categories included in the survey

Food Category	No of samples
Chocolate and chocolate biscuits	18
Dried fruit	11
Fats/oils	10
Fish and fish products	22
Infant food	10
Smoked meats	25
Supplements	24
Total number of samples	120

The majority of samples comprised a number of sub-samples (see Appendix I, p.15) and were analysed for the following 28 PAH congeners, including the 15 PAH congeners identified by the SCF to be possibly carcinogenic and genotoxic to humans:

Table 3 PAHs included in the survey

15 PAHs (SCF)	Additional PAHs
Benzo(a)pyrene (BaP)	Acenaphthene
Benz(a)anthracene (BaA)	Acenaphthylene
Dibenz(a,h)anthracene (DBaA)	Anthanthrene
Benzo(b)fluoranthene (BbFl)	Anthracene
Benzo(j)fluoranthene (BjFl)	Benzo[b]naphtho[2,1-d]thiophene
Benzo(k)fluoranthene (BkFl)	Benzo[c]fluorene
Benzo(g,h,i)perylene (BghiP)	Benzo[e]pyrene
Chrysene (Chrysene)	Benzo[ghi]fluoranthene
Cyclopenta(c,d)pyrene (CP)	Coronene
Dibenzo(a,e)pyrene (DBaP)	Fluoranthene
Dibenzo(a,h)pyrene (DBaP)	Fluorene
Dibenzo(a,i)pyrene (DBaP)	Phenanthrene
Dibenzo(a,l)pyrene (DBaP)	Pyrene
Indeno(1,2,3-c,d)pyrene (IP)	
5-Methylchrysene (5-MC)	

Methodology

Samples were analysed by the Central Science Laboratory, UK, under contract to the FSAI. The samples were fortified with appropriate ¹³C Internal standards and subjected to saponification using methanolic potassium hydroxide. This was followed by liquid-liquid extraction using cyclohexane. Clean-up was by DMF/cyclohexane partition, followed by elution through a silica gel column. The analysis was performed using high resolution gas chromatography – low resolution mass spectrometry (HRGC-LRMS). Analysis was performed using HRGC-LRMS. The analytical procedure used is UKAS accredited (Testing lab 1642) to the ISO 17025 standard. Each batch of samples analysed incorporated a certified reference material (CRM458) and included a full reagent blank extract.

Results

The most frequently PAHs occurring above the Limit of Detection (LOD) were chrysene, fluoranthene, pyrene, phenanthrene, benz(a)anthracene, benzo[ghi]fluoranthene and anthracene. These seven PAHs were determined in more than 80% of all samples (N=120) tested. Table 4 provides an overview of frequency of occurrence of all PAHs covered in this survey, in the 120 samples tested,.

Table 4 Frequency of occurrence of PAH congeners above the LOD in the 120 samples tested.

SCF-15 PAHs	Frequency	Other PAHs	Frequency
CHR	109	FA	109
BaA	100	PY	108
BbFl	79	PHE	103
BjFl	73	BghiF	100
BghiP	68	AN	96
BaP	60	ACL	88
CP	58	FL	83
BkFl	57	BeP	77
IP	42	BcFL	74
DBahA	13	AC	66
DBaP	6	BNTH	23
DBaeP	3	COR	19
DBaiP	3	ATR	2
5-MC	2		
DBahP	1		

Results by category are summarised for the SCF-15 PAHs in Table 5, and are described in summary form in the following paragraphs. Results are expressed as upper-bound values ($<LOD=LOD$), however, it must be noted that a number of PAH congeners rarely occur above the LOD (see Table 7), hence the results reported are like to be an over-estimate of the true occurrence. Full individual results, including information on additional PAHs for all samples are listed in Appendix I.

Chocolate and chocolate containing products

This category includes 18 samples, comprising plain milk chocolate, dark chocolate and chocolate coated biscuits sourced from different retail outlets and containing a variety of brands. Total SCF15 PAHs ranged from 1.13-3.87 $\mu\text{g/kg}$ fresh weight, with chrysene being the dominant PAH in the pattern.

Dietary Supplements

This group contains a wide range and variety of supplement types including vitamins supplements, plant oils, herb extracts, bee products and marine products. A total of 24 samples from different manufacturers were analysed. The range of occurrence of PAHs

in this group was extremely large, ranging from 0.82-558.5 µg/kg fresh weight. Vitamin supplements and plant oils generally showed levels at the lower end of the range, whereas herbal product, marine products and one bee product were at the high end of the range. The highest levels, which were the highest levels found overall in this survey, were detected in a sample of propolis extract and a sample of green tea supplements.

Dried fruit

This group contained 11 samples comprising dried vine fruit, other dried fruit and dried tomatoes. Upperbound levels for SCF-15 ranged from 0.54-1.86 µg/kg fresh weight, chrysene, benz(a)anthracene and benzo[b]fluoranthene being the most abundant congeners.

Infant Food

This group comprises ten samples of biscuits, infant formula and mixed jars, with upperbound levels ranging from 0.51-1.12 µg/kg fresh weight. For the majority of samples and congeners, levels found were either below the LOD or very close to the LOD, and as expected. This group shows the overall lowest occurrence of PAHs in all samples tested in this survey.

Shellfish

Five samples of shellfish were analysed showing upperbound levels between 0.54-9.02 µg/kg fresh weight for SCF-15. Whereas four of the samples generally showed total levels below 0.89 µg/kg fresh weight, one sample of fresh mussels showed considerably higher levels, which is reflected in the wide range of occurrence reported above.

Smoked fish

This group contained 14 samples comprising white and oily fish species. Upperbound levels for SCF-15 ranged from 0.55-3.48 µg/kg fresh weight, with chrysene being the most abundant congener.

Smoked meat products

This group mainly contained bacon, ham and sausage products, with an overall total of 25 samples and showed levels ranging from 0.52-1.02 µg/kg fresh weight. The most abundant congeners were chrysene and benz(a)anthracene, the majority of the remaining 13 congeners were found below the LOD.

Smoked shellfish

This category shows highest occurrence levels, however, this group only contained three samples of different smoked shellfish types, all processed by the same supplier. These findings can, therefore, only be considered as indicative of the particular manufacturing/smoking process, rather than as general indication of occurrence levels in smoked shellfish.

Vegetable oils

Ten samples of different vegetable oils were included and showed upperbound levels for SCF-15 of 1.38-8.0 µg/kg fresh weight. The highest level of 8 ppb was found in a

grapeseed oil, followed by a mixed vegetable oil (4.84 ppb). The remaining samples all showed levels below 3.5 ppb.

Table 5 Upperbound results (range, median and mean) expressed in µg/kg for SCF-15 PAHs

	Chocolate & Chocolate Biscuits n = 18			Dried fruit n = 11			Vegetable oils n = 10		
	Range	Med	Mean	Range	Med	Mean	Range	Med	Mean
[BaP]	0.06-0.3	0.18	0.17	0.02-0.08	0.02	0.03	0.08-0.72	0.19	0.27
[BaA]	0.07-0.63	0.26	0.24	0.01-0.59	0.06	0.11	0.09-0.93	0.17	0.28
[CP]	0.02-0.4	0.10	0.14	0.01-0.08	0.01	0.02	0.01-0.12	0.05	0.05
[CHRY]	0.16-1.05	0.48	0.48	0.03-0.49	0.18	0.23	0.21-3.32	0.74	0.91
[BbFl]	0.08-0.37	0.20	0.20	0.01-0.14	0.06	0.06	0.06-1.08	0.16	0.32
[BjFl]	0.04-0.32	0.14	0.15	0.01-0.09	0.03	0.04	0.04-0.43	0.10	0.16
[BkFl]	0.02-0.15	0.08	0.08	0.01-0.07	0.02	0.02	0.03-0.36	0.08	0.12
[BghiP]	0.06-0.28	0.16	0.16	0.01-0.09	0.02	0.03	0.04-0.59	0.22	0.25
[IP]	0.06-0.2	0.11	0.12	0.01-0.11	0.03	0.04	0.05-0.48	0.11	0.16
[DBahA]	0.02-0.07	0.03	0.03	0.01-0.03	0.01	0.01	0.03-0.19	0.05	0.07
[5-MC]	0.01-0.02	0.01	0.01	0.01-0.02	0.01	0.01	0.01-0.04	0.01	0.02
[DBaIP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10
[DBaeP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.18	0.10	0.11
[DBaiP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10
[DBahP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10
SUM 15 UB	1.13-3.87	2.26	2.18	0.54-1.86	1.11	1.01	1.38-8	2.31	3.02
	Shellfish n = 5			Smoked fish n = 14			Smoked shellfish n = 3		
	Range	Med	Mean	Range	Med	Mean	Range	Med	Mean
[BaP]	0.02-0.4	0.02	0.10	0.02-0.1	0.02	0.04	0.41-0.67	0.57	0.55
[BaA]	0.01-1.14	0.04	0.28	0.02-0.72	0.03	0.12	0.78-1.47	1.38	1.21
[CP]	0.01-0.04	0.01	0.02	0.01-1.1	0.02	0.12	0.5-1.01	0.59	0.70
[CHRY]	0.03-2.14	0.14	0.51	0.03-0.83	0.07	0.17	3.64-5.11	3.84	4.20
[BbFl]	0.01-1.71	0.02	0.36	0.01-0.11	0.01	0.03	2.09-2.49	2.20	2.26
[BjFl]	0.01-0.91	0.01	0.20	0.01-0.08	0.01	0.02	0.95-1.73	1.18	1.29
[BkFl]	0.01-0.69	0.01	0.15	0.01-0.06	0.01	0.02	0.59-1.34	0.83	0.92
[BghiP]	0.01-0.97	0.01	0.21	0.01-0.07	0.01	0.02	0.7-1.56	0.78	1.01
[IP]	0.01-0.51	0.01	0.11	0.01-0.06	0.01	0.02	0.36-0.84	0.68	0.63
[DBahA]	0.01-0.12	0.01	0.03	0.01-0.02	0.01	0.01	0.1-0.21	0.20	0.17
[5-MC]	0.01-0.01	0.01	0.01	0.01-0.01	0.01	0.01	0.01-0.03	0.02	0.02
[DBaIP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.22	0.10	0.14
[DBaeP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.11	0.10	0.10
[DBaiP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10
[DBahP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10
SUM 15 UB	0.54-9.02	0.85	2.37	0.55-3.48	0.60	0.98	12.89-14.08	13.22	13.40

n = number of samples

[BaP]=benzo[a]pyrene, [BaA]=benz (a) anthracene, [CP]=cyclopenta[c,d]pyrene, [Chry]=chrysene, [5-MC]=5-methylchrysene, [BbFl]=benzo[b]fluoranthene, [BjFl]=benzo[j]fluoranthene, [BkFl]=benzo[k]fluoranthene, [IP]=indeno[1,2,3-cd]pyrene, [DBahA]=dibenz[ah]anthracene, [BghiP]=benzo-[g,h,i]perylene, [DBaIP]=dibenzo[a,i]pyrene, [DBaeP]=dibenzo[a,e]pyrene, [DBaiP]=dibenzo[a,i]pyrene, [DBahP]=dibenzo[a,h]pyrene,

Table 5 continued: Upperbound results expressed in µg/kg for SCF-15

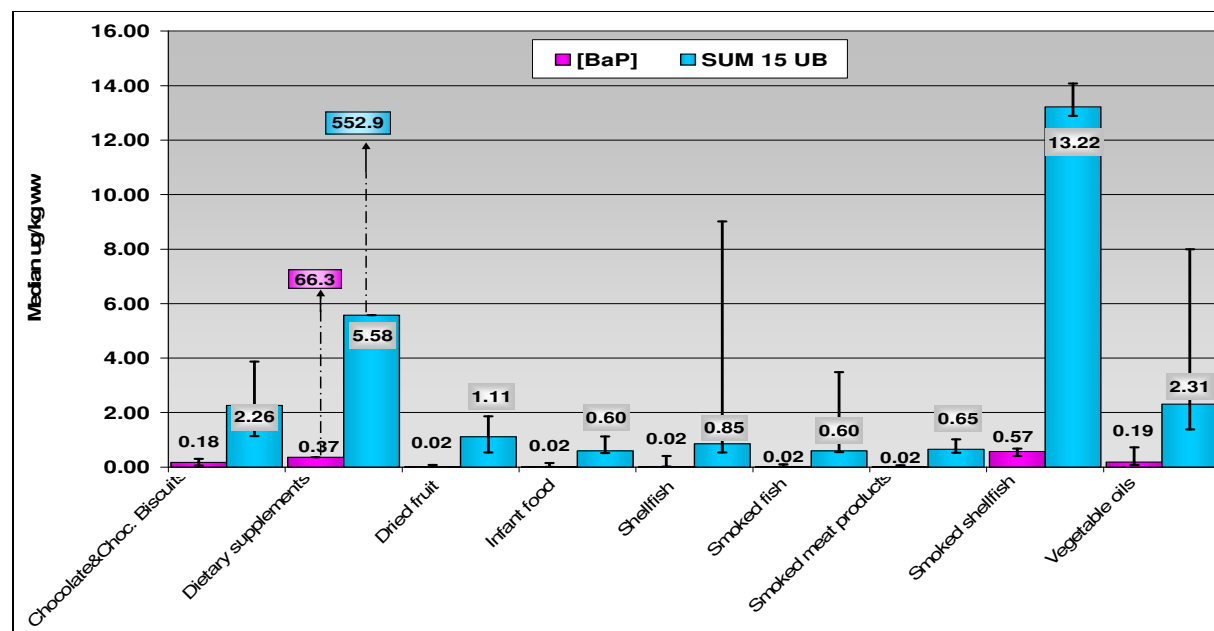
	Smoked meat products n = 25			Infant food n = 10			Dietary supplements n = 24		
	Range	Med	Mean	Range	Med	Mean	Range	Med	Mean
[BaP]	0.02-0.07	0.02	0.03	0.01-0.15	0.02	0.04	0.07-66.68	0.37	4.46
[BaA]	0.01-0.2	0.05	0.06	0.01-0.11	0.02	0.03	0.03-103.07	0.50	7.20
[CP]	0.01-0.16	0.02	0.03	0.01-0.01	0.01	0.01	0.01-5.83	0.04	0.70
[CHRY]	0.01-0.17	0.06	0.07	0.01-0.24	0.03	0.07	0.06-120.1	0.99	12.57
[BbFl]	0.01-0.08	0.02	0.02	0.01-0.06	0.02	0.03	0.05-71.93	0.63	6.13
[BjFl]	0.01-0.04	0.01	0.02	0.01-0.03	0.01	0.02	0.02-40.28	0.35	3.20
[BkFl]	0.01-0.03	0.01	0.01	0.01-0.02	0.01	0.01	0.02-38.5	0.32	2.74
[BghiP]	0.01-0.03	0.01	0.01	0.01-0.06	0.03	0.03	0.04-37.98	0.54	3.47
[IP]	0.01-0.04	0.01	0.02	0.01-0.05	0.03	0.03	0.05-45.27	0.34	3.48
[DBahA]	0.01-0.02	0.01	0.01	0.01-0.02	0.01	0.01	0.06-9.55	0.13	0.84
[5-MC]	0.01-0.01	0.01	0.01	0.01-0.01	0.01	0.01	0.01-1.45	0.02	0.09
[DBaIP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-14.1	0.10	0.77
[DBaEP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-6.45	0.10	0.63
[DBaIP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-2.45	0.10	0.27
[DBaHP]	0.1-0.1	0.10	0.10	0.1-0.1	0.10	0.10	0.1-0.37	0.10	0.12
SUM 15 UB	0.52-1.02	0.65	0.69	0.51-1.12	0.60	0.67	0.82-558.45	5.58	46.66

n = number of samples

[BaP]=benzo[a]pyrene, [BaA]=benz (a) anthracene, [CP]=cyclopenta[c,d]pyrene, [Chry]=chrysene, [5-MC]=5-methylchrysene, [BbFl]=benzo[b]fluoranthene, [BjFl]=benzo[j]fluoranthene, [BkFl]=benzo[k]fluoranthene, [IP]=indeno[1,2,3-cd]pyrene, [DBahA]=dibenz[ah]anthracene, [BghiP]=benzo-[g,h,i]perylene, [DBaIP]=dibenzo[a,i]pyrene, [DBaEP]=dibenzo[a,e]pyrene, [DBaIP]=dibenzo[a,i]pyrene, [DBaHP]=dibenzo[a,h]pyrene,

Figure 2 compares the median occurrence of SCF-15 PAHs in all categories included in this survey.

Figure 2 Median upperbound concentration of Benzo(a)pyrene and sum 15 SCF per µg/kg fresh weight (bars showing minimum and maximum values)



Conclusions

This is the first survey of levels of PAHs in food on the Irish market, and hence no comparisons can be made with previous results. However, similar surveys in the UK on infant food (Food Standards Agency, 2006) and food supplements (Food Standards Agency, 2005) have shown comparable levels.

The study has shown that levels of PAHs in products sourced on the Irish market are generally low, with the exception of a small number of food supplements, for which maximum levels have not yet been set. None of the samples tested are in exceedance of currently existing maximum regulatory limits for benzo(a)pyrene, which range from 1 µg /kg wet weight for infant food to 10 µg /kg for bivalve molluscs (Table 1). No maximum levels have been set for food supplements yet, however, 16% of the food supplement samples covered by this survey contained a level of benzo(a)pyrene above 2 µg/kg, and very high levels of 66.68 µg/kg and 20.29 µg/kg were found respectively for a sample of propolis extract and a sample of green tea supplement, the highest levels found in this survey. The setting of maximum levels has been discussed for food supplements at EU level and may be adopted at the next review of this legislation in 2007. The FSAI has contacted the manufacturers and suppliers of these supplements, advising them to explore the feasibility of changes to raw material sources and production processes in order to keep PAH levels in their products as low as reasonably achievable.

In assessing consumer exposure to PAHs in food, JECFA estimated a representative mean intake of 4 ng benzo(a)pyrene/kg bw per day and a high-level intake of 10 ng benzo(a)pyrene/kg bw per day (JECFA, 2005). Following comparison of these intakes with a level of benzo(a)pyrene known to cause cancer in animal studies, the Committee concluded that the margin of exposure (MOEs) was very large (25,000 and 10,000, for the estimated mean intake and high-level intake, respectively).

Following the findings of this survey, and taking the JECFA assessment into account, the Food Safety Authority of Ireland concludes that the levels of PAHs present in food on the Irish market are not of concern for human health, although the survey found high levels of PAHs including B(a)P in a small number of food supplements.

Appendix I

Table 6 Sample Details

No	Retailer	Category	Brand	Sample name	BBD	Country of production	Batch Number	Packs
1	Lidl	Chocolate	Parkside	Plain chocolate digestive	18/03/2006	n/a	204 10:04	3
2	Dunnes	Chocolate	Jacob's biscuits	Chocolate Digestive	01/05/2006	Ireland	5118	3
3	Dunnes	Chocolate	Bolands	Bourbon Creams Biscuits	03/06/2006	Ireland	5152	3
4	Lidl	Chocolate	Mister choc	Dark chocolate	01/03/2006	n/a	5221A	3
5	Dunnes	Chocolate	Dunnes Stores	Plain chocolate digestive biscuits	05/11/2005	Ireland	04 17:04	3
6	Dunnes	Chocolate	Cadbury	Chocolate Rings	15/01/2006	UK	06A5110	3
7	Dunnes	Chocolate	McVitie's	Chocolate biscuits	22/10/2005	UK	T1C	3
8	Superquinn	Chocolate	Euroshopper	Milk Chocolate	30/10/2006	Germany	L151412	3
9	Tesco	Chocolate	Tesco	Swiss plain chocolate	01/07/2006	Switzerland	AAR56	3
10	Dunnes	Chocolate	Green&Black's	Organic Dark chocolate	19/10/2006	Italy	L5109	3
11	Lidl	Chocolate	Bellarom Excellence	Edelherbe Sahne	31/08/2006	n/a	L215243	3
12	Lidl	Chocolate	J.D. Gross	Dark chocolate	27/05/2007	n/a	L45668C	3
13	Tesco	Chocolate	Galaxy	Milk chocolate	03/12/2005	UK	U6B#02	3
14	Tesco	Chocolate	Cadbury	Plain chocolate	01/04/2006	n/a	LB5H1091224	3
15	Dunnes	Chocolate	Nestle	Chocolate snack bar	01/01/2006	n/a	509710121	3
16	Lidl	Chocolate	Bellarom	Finest Milk chocolate	30/05/2006	n/a	L351911	3
17	Tesco	Chocolate	Homecook	Wonderbar cake covering	01/03/2006	Ireland	1406805	3
18	Tesco	Chocolate	Cadbury	Cocoa powder	01/05/2007	n/a	5138X	3
19	Dunnes	Smoked meats	Danepark	Prime smoked back bacon rashers	12/08/2005	Denmark	-	3
20	Dunnes	Smoked meats		Premium oak smoked ham	20/07/2005	Ireland	-	3
21	Tesco	Smoked meats	Ballyfree	Smoked turkey rashers	21//05	n/a	-	3
22	Tesco	Smoked meats	Leeway Foods 5/9/05	Smoked bacon grills	05/09/2005	Ireland	-	3
23	Dunnes	Smoked meats	Dunnes Stores	Traditional rindless back rashers lightly smoked	15//7/05	Ireland	-	3
24	Lidl	Smoked meats	Dulano	Smoked turkey and park salami with herb, pepper, crum&cheese coating	10/08/2005	Germany	-	3
25	Lidl	Smoked meats	Dulano	Kabanossi, spicy smoked pork sausage	18/08/2005	Germany	-	3
26	Lidl	Smoked meats	Gebirgsjaeger	Smoked pork sasages	30/07/2005	Germany	-	3

No	Retailer	Category	Brand	Sample name	BBD	Country of production	Batch Number	Packs
27	Lidl	Smoked meats	Lidl	Premium traditional smoked ham	29/07/2005	Germany	-	3
28	Lidl	Smoked meats	Dulano	Smoked salami	07/08/2005	Germany	-	3
29	Lidl	Smoked meats	cygnet	Premium quality smoked rindless back bacon	04/08/2005	UK	-	3
30	Dunnes	Smoked meats	Dunnes Stores	Dry cure back rashers	02/08/2005	Ireland	-	3
31	Superquinn	Fish/Fish products	Superquinn	Fresh mussels farmed	08/07/2005	Ireland	-	1
32	Dunnes	Fish/Fish products		Smoked cod fresh and prepacked	07/07/2005	Ireland (north east atlantic)	-	3
33	Tesco	Fish/Fish products	Tesco	Smoked haddock fresh and prepacked	01/07/2005	Ireland (north east atlantic)	-	3
34	Tesco	Smoked meats	Tesco	Smoked ham porkleg	24/07/2005	Ireland	-	3
35	Superquinn	Smoked meats	Superquinn	Streaky traditional rashers	21/07/2005	Ireland	-	3
36	Tesco	Smoked meats	Tesco	Traditional irish oak and peat smoked salmon, farmed	19/07/2005	Ireland	-	3
37	Superquinn	Smoked meats	Superquinn	Irish smoked back rashers rindless	20/07/2005	Ireland	-	3
38	Dunnes	Dried fruit	Preda fair trade	Dried papaya	01/02/2006	n/a	139B	3
39	Dunnes	Dried fruit	Preda fair trade	Dried pineapple	01/02/2006	n/a	1300104A	3
40	Dunnes	Dried fruit	Dunnes Stores	Sultanas	01/04/2006	n/a	L1094	3
41	Dunnes	Dried fruit	Forest feast	Raisins	01/12/2005	n/a	0742701B	3
42	Dunnes	Dried fruit	Forest feast	Sundried tomatoes	01/02/2006	n/a	1260505A	3
43	Tesco	Dried fruit	Jan's	Sundried tomatoes	01/11/2005	italy	B490B395B454	3
44	Tesco	Dried fruit	Jan's	Dried Cranberries	01/01/2006	USA	B500	3
45	Dunnes	Dried fruit	Forest feast	Dried figs	01/10/2005	n/a	1580605A	3
46	Dunnes	Dried fruit	Forest feast	Medjool Dates	01/09/2005	n/a	1391904B	3
47	Tesco	Dried fruit	Shamrock	Fruit Mix (raisins, sultanas, mixed peel, currants, veg oil)	01/10/2005	n/a	4287B	3
48	Tesco	Dried fruit	Sunsweet	Californian large stoned prunes	01/09/2006	n/a	L075520018	3
49	Dunnes	Infant food	Milupa	Infant Formula	08/02/2006	EU	22:34:06 4B	3
50	Dunnes	Infant food	Cow&Gate	Infant Formula	07/02/2006	EU	09:33:07 4A	3
51	Dunnes	Infant food	Heinz	Oat porridge	01/10/2006	UK	516D	3
52	Dunnes	Infant food	Cow&Gate organic	Pure baby rice with added thiamin	14/03/2007	EU	2507, 2508, 2982	3
53	Dunnes	Infant food	Heinz	Biscuits	01/11/2006	UK	5133, 5144	3
54	Dunnes	Infant food	Danone	Biscuits	01/05/2006	n/a	139k09	3
55	Dunnes	Infant food	Organix	Bread sticks	01/04/2007	Italy	-	3

No	Retailer	Category	Brand	Sample name	BBD	Country of production	Batch Number	Packs
56	Dunnes	Infant food	SMA	Infant Formula	28/03/2007	n/a	JSE115K14	3
57	Dunnes	Fish/Fish products	Dunnes Stores	Hand slices bbq irish salmon	11/07/2005	Ireland	-	
58	Dunnes	Fish/Fish products	Dunnes Stores	Oak and peat smoked irish salmon	29/07/2005	Ireland	-	
59	Tesco	Smoked meats	Tesco	German Salami	19/07/2005	Germany	-	3
60	Dunnes	Fish/Fish products	Fish out of water Limited	Smoked mussels	21/07/2005	Ireland	-	3
61	Dunnes	Fish/Fish products	Fish out of water Limited	Smoked oysters	21/07/2005	Ireland	-	3
62	Tesco	Smoked meats	German salami co	Pepperoni	22/08/2005	n/a	-	3
63	Tesco	Fish/Fish products	Tesco	Fresh smoked coley	11/07/2005	Ireland (north east atlantic)	-	3
64	Tesco	Fish/Fish products	Tesco	Smoked cod fillets	11/7/05 8/7/05	Northern Ireland	-	3
65	Tesco	Smoked meats	Tesco	Slikced smoked pancetta	06/08/2005	Italy	-	3
66	Dunnes	Smoked meats	Galtee	Tender Cure back rashers	12/08/2005	Ireland	-	3
67	Dunnes	Fish/Fish products	St.Bernard	Cold water crayfish tail	23/07/2005	Ireland	-	3
68	Tesco	Smoked meats	Tesco	Smoked rindless back rashers	26/07/2005	Ireland	-	3
69	Dunnes	Fish/Fish products	Sea Star	Smoked peppered wild Mackerel	28/7/05, 1/8/05	Ireland	-	3
70	Dunnes	Fish/Fish products	Dunnes Stores	Smoked coley	09/07/2005	Ireland (north east atlantic)	-	3
71	Dunnes	Fish/Fish products	St.Bernard	Smoked Kippers	07/07/2005	n/a	-	3
72	Dunnes	Fish/Fish products	Nolans	Farmed smoked salmon	19/07/2005	Scotland	-	
73	Dunnes	Fish/Fish products	St Bernard	Smoked fillets	01/05/2006	Northern Ireland	-	
74	Dunnes	Fish/Fish products	Lyons Seafoods	Cooked mussels	11/07/2005	Chile	-	3
75	Dunnes	Fish/Fish products	Lyons Seafoods	Large peeled prawns	11/07/2005	Ireland (north east or north west atlantic)	-	3
76	Dunnes	Smoked meats	Denny	Waifos, Smoked turkey	17/07/2005	Ireland	-	3
77	Dunnes	Smoked meats	Shaws	Smoked backrashers	22/07/2005	Ireland	-	3
78	Superquinn	Smoked meats	Superquinn	Premium Oak smoked ham	24/07/2005	Ireland	-	3
79	Dunnes	Smoked meats	Denny	Hickory Back Rashers	02/08/2005	Ireland	-	3
80	Dunnes	Fish/Fish products	Dunnes Stores	Smoked Whiting	09/07/2005	Northern Ireland	-	3
81	Dunnes	Fish/Fish products	Dunnes Stores	Smoked haddock	09/07/2005	Northern Ireland	-	3
82	Tesco	Fats/oils	Flora	Sunflower oil	01/02/2006	n/a	-	1
83	Tesco	Fats/oils	Crisp'nDry	Vegetable oil	01/01/2006	n/a	133	1

No	Retailer	Category	Brand	Sample name	BBD	Country of production	Batch Number	Packs
84	Tesco	Fats/oils	Roma	Olive oil	27.04.06	n/a	L2136	1
85	Tesco	Fats/oils	Tesco	Olive oil	01/06/2006	EU	L517251500	1
86	Tesco	Fats/oils	Lifeforce	Soya oil	01/12/2006	n/a	-	1
87	Tesco	Fats/oils	Homecook	Grapeseed Oil	01/07/2006	n/a	L29	1
88	Tesco	Fats/oils	Homecook250 ml	Groundnut oil	01/05/2006	n/a	L513930952	1
89	Tesco	Fats/oils	Tesco	Toasted sesame oil	01/01/2006	n/a	L5103	1
90	Tesco	Fats/oils	Tesco	Chili infused olive oil	01/10/2006	n/a	L5116	1
91	Tesco	Fats/oils	Lakeshore	Stir fry oil	01/05/2006	n/a	L514621306	1
92	IHTA	Supplements	Holland & Barrett	Vitamin E	01/12/2007, 01/11/08	n/a	36065204, 5848201	8
93	IHTA	Supplements	Cardinova	Vitamin E supplement	01/12/2006 01/04/2006	Sweden	Batches 313091026314 (4), 31307102RG798 (4)	8
94	IHTA	Supplements	Seatone	Green lipped mussel extract capsules	30/09/2006	New Zealand	-	5
95	IHTA	Supplements	Holland & Barrett	Evening Primrose Oil	30/11/2007 30/4/08	n/a	1438, 360106-03	2
96	IHTA	Supplements	Comvita	Propolis Extract alcohol free	01/03/2009	New Zealand	313348	4
97	IHTA	Supplements	Solgar	Evening Primrose Oil	30/06/2006	USA	76086	4
98	IHTA	Supplements	Solgar	Vitamin A	01/03/2007	USA	83809	4
99	IHTA	Supplements	Solgar	Vitamin E	30/01/2008	USA	03500EN01NE batch 83946	6
100	IHTA	Supplements	Holland & Barrett	Starflower Oil	01/10/08, 01/07/08	n/a	36093402, 36059103	2
101	IHTA	Supplements	FMD (Flora Manufacturing and Distributing Ltd)	Certified Organic Flax Oil cold pressed unrefined	06/10/2005	Canada	50406	1
102	IHTA	Supplements	Salus (Irl: Natural Medicine Company, Wicklow)	Valerian 100% pure fresh plant juice organic	01/01/2007	Germany	T 0173	1
103	IHTA	Supplements	Equazen	Marine fish oil/Starflower oil	01/10/2006, 01/12/2006, 01/07/2006	UK	505714, 505715, 505716	3
104	IHTA	Supplements	Arkopharma	Valerian Capsules	01/04/2007,	n/a	MO2994	4

No	Retailer	Category	Brand	Sample name	BBD	Country of production	Batch Number	Packs
105	McNamaras, Swords	Supplements	Sona	Evening Primrose Oil	01/03/2007	n/a	BN 0583	2
106	IHTA	Supplements	Arkopharma	Green Tea Capsules	01/09/2007, 05/2008	n/a	MO5929, NO2438A	3
107	IHTA	Supplements	Arkopharma	Seaweed Capsules	01/10/2006	n/a	L13901	4
108	McNamaras, Swords	Supplements	Lanes Modern Herbals	Ginko	none given	UK	PL 2452/5000R	4
109	IHTA	Supplements	Arkopharma	Ginseng	01/10/2006, 11/2007	n/a	L14188A, MO6931	3
110	IHTA	Supplements	Vitz womens health	Starflower oil	01/05/2005	Ireland	-	2
111	IHTA	Supplements	Seven Seas	Pure starflower	28/02/2007	n/a	350508	4
112	IHTA	Supplements	Beeline	Vitamin E	30/01/2007	n/a	6NK13040	4
113	IHTA	Supplements	All Seasons health	Spirulina Blue Green Algae (organic)	08/03/2007	n/a	H030803	1
114	IHTA	Supplements	Holland & Barrett	Klamath Lake Blue green algae	28/02/2008	n/a	67194-06	1
115	IHTA	Supplements	Holland & Barrett	Natural chinese chlorella	30/09/2007	n/a	6592104	1
116	-	Infant food	Heinz	Minted vegetables with lamb	01/01/2007, 01/07/2006	EU	0985 (2), 3364	3
117	-	Infant food	Cow and Gate	Vegetable and Pork Dinner potatoes, carrots and swede with pork and apple	10/03/2008	n/a	CGM013	3
118	-	Fish/Fish products	Fish out of water Limited	Smoked scallops	21/7/05, 05/08/05	Ireland	-	3
119	-	Fish/Fish products	Dunn's Dublin	Oak smoked Kippers uncooked	27/07/2005	Ireland	1112605	3
120	-	Fish/Fish products	Goldwater	Prawns in brine	03/08/2005	Sweden	-	3

Table 7 Occurrence levels of 28 PAHs (µg/kg ww) in individual samples (see Table 6 for sample details)

Sample	BaP	BaA	CP	CHR	5-MC	BbFl	BjFl	BkFl	IP	DBahA	BghiP	DBaP	DBaP	DBaP	DBaP
1	0.08	0.07	0.06	0.16	<0.01	0.09	0.07	0.04	0.08	<0.02	0.08	<0.1	<0.1	<0.1	<0.1
2	0.14	0.13	0.12	0.25	<0.01	0.11	0.06	0.04	0.08	<0.04	<0.15	<0.1	<0.1	<0.1	<0.1
3	0.09	0.08	0.02	0.16	<0.01	0.08	0.04	0.03	<0.06	<0.04	0.12	<0.1	<0.1	<0.1	<0.1
4	0.22	0.26	0.07	0.49	<0.01	0.29	0.22	0.12	0.20	<0.05	0.20	<0.1	<0.1	<0.1	<0.1
5	0.21	0.28	0.31	0.65	<0.01	0.19	0.13	0.09	<0.19	<0.04	<0.28	<0.1	<0.1	<0.1	<0.1
6	0.08	0.10	0.06	0.20	<0.01	0.10	0.07	0.04	0.07	<0.02	0.10	<0.1	<0.1	<0.1	<0.1
7	0.17	0.16	0.40	0.28	<0.01	0.15	0.11	0.07	0.15	<0.03	0.24	<0.1	<0.1	<0.1	<0.1
8	0.18	0.42	0.15	0.70	<0.01	0.25	0.22	0.09i	0.11	<0.02	0.10	<0.1	<0.1	<0.1	<0.1
9	0.22	0.41	0.29	0.79	<0.01	0.28	0.26	0.10i	0.13	<0.02	0.16	<0.1	<0.1	<0.1	<0.1
10	0.20	0.28	<0.04	0.59	<0.01	0.34	0.21	0.14	0.19	<0.05	0.16	<0.1	<0.1	<0.1	<0.1
11	0.14	0.27	0.11	0.57	<0.01	0.20	0.18	0.07i	0.09	<0.02	0.09	<0.1	<0.1	<0.1	<0.1
12	0.23	0.31	0.30	0.71	<0.01	0.26	0.23	0.09i	0.14	<0.02	0.19	<0.1	<0.1	<0.1	<0.1
13	0.18	0.35	0.12	0.66	<0.01	0.22	0.20	0.10i	0.11	<0.02	0.13	<0.1	<0.1	<0.1	<0.1
14	0.23	0.25	0.06	0.47i	<0.02	0.25	0.10	0.08	0.14	<0.07	0.28	<0.1	<0.1	<0.1	<0.1
15	0.14	0.24	0.08	0.45	<0.01	0.19	0.15	0.07i	0.10	<0.02	0.11	<0.1	<0.1	<0.1	<0.1
16	0.30	0.63	0.25	1.05	<0.01	0.37	0.32	0.15i	0.17	<0.04	0.18	<0.1	<0.1	<0.1	<0.1
17	0.11	0.08	0.02	0.29	0.01	0.11	0.04	0.04i	<0.09	<0.05	0.24	<0.1	<0.1	<0.1	<0.1
18	0.06	0.07	0.03	0.23	<0.01	0.12	0.11	0.02	<0.06	<0.02	0.06	<0.1	<0.1	<0.1	<0.1
19	0.04	0.09	<0.02	0.08	<0.01	0.03	0.02	<0.02	<0.03	<0.01	0.01	<0.1	<0.1	<0.1	<0.1
20	<0.02	0.05	0.03	0.05	<0.01	<0.02	<0.03	<0.01	<0.02	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
21	<0.02	0.02	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
22	<0.02	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
23	<0.02	0.04	<0.03	0.05	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
24	<0.04	0.20	<0.02	0.17	<0.01	0.05	0.04	<0.03	<0.03	<0.01	0.02	<0.1	<0.1	<0.1	<0.1
25	<0.02	0.03	<0.03	<0.07	<0.01	<0.03	<0.01	<0.01	<0.02	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
26	<0.02	0.07	0.02	0.12i	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
27	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
28	<0.02	0.03	<0.02	0.05	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1

Sample	BaP	BaA	CP	CHR	5-MC	BbFl	BjFl	BkFl	IP	DBahA	BghiPI	DBaP	DBaEP	DBaIP	DBahP
29	0.06	0.15	<0.01	0.12	<0.01	0.04	0.02	0.01	<0.03	<0.01	0.01	<0.1	<0.1	<0.1	<0.1
30	<0.04	0.11	0.16	0.12	<0.01	0.03	0.03	<0.02	<0.03	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
31	0.40	1.14	0.02	2.14	<0.01	1.71	0.91	0.69	0.51	0.12	0.97	<0.1	<0.1	<0.1	<0.1
32	<0.02	0.02	<0.02	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
33	<0.02	0.03	<0.02	0.05	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
34	<0.04	0.07	<0.01	0.07	<0.01	0.02	0.01	<0.01	<0.02	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
35	<0.02	0.04	0.02	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
36	<0.02	0.02	0.01	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
37	<0.02	0.07	<0.01	0.07	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
38	0.02	0.05	0.02	0.08	<0.01	0.03	0.02	<0.02	<0.02	<0.01	0.02	<0.1	<0.1	<0.1	<0.1
39	0.05	0.17	0.08	0.18	<0.01	0.06	0.03	0.03	<0.04	<0.01	0.05	<0.1	<0.1	<0.1	<0.1
40	0.02	0.06	<0.01	0.44	<0.01	0.07	0.09	0.02	0.05	<0.01	0.03	<0.1	<0.1	<0.1	<0.1
41	0.03	0.09	0.06	0.29	<0.01	0.07	0.05	0.02	0.04i	<0.01	0.06	<0.1	<0.1	<0.1	<0.1
42	0.08	0.12	<0.01	0.30	<0.01	0.14	0.08	0.07	0.11	<0.03	0.09	<0.1	<0.1	<0.1	<0.1
43	0.03	0.09	<0.01	0.39	<0.01	0.10	0.05	0.03	<0.03	<0.01	0.02	<0.1	<0.1	<0.1	<0.1
44	<0.02	0.01	<0.01	0.03	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
45	<0.02	0.03	<0.01	0.11	<0.02	0.02	0.01	<0.01	<0.02	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
46	<0.02	0.03	<0.01	0.11	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
47	<0.02	<0.01	<0.01	0.09	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	0.01	<0.1	<0.1	<0.1	<0.1
48	0.03	0.59	<0.04	0.49	<0.01	0.07	0.08	<0.03	0.05	<0.01	0.06	<0.1	<0.1	<0.1	<0.1
49	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
50	<0.02	<0.02	<0.01	0.02	<0.01	<0.02	<0.01	<0.01	<0.03	<0.01	<0.06	<0.1	<0.1	<0.1	<0.1
51	<0.02	<0.01	<0.01	<0.02	<0.01	<0.02	<0.01	<0.01	<0.02	<0.01	<0.03	<0.1	<0.1	<0.1	<0.1
52	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
53	0.03	0.02	<0.01	0.04	<0.01	0.03	0.02	0.01	<0.04	<0.01	0.03	<0.1	<0.1	<0.1	<0.1
54	<0.07	0.03	<0.01	0.07	<0.01	0.04	0.02	<0.02	<0.05	<0.02	0.03	<0.1	<0.1	<0.1	<0.1
55	<0.06	0.04	0.01	0.21	<0.01	0.04	0.03	<0.02	<0.04	<0.02	0.03	<0.1	<0.1	<0.1	<0.1
56	<0.15	0.11	<0.01	0.24	<0.01	<0.06	<0.03	<0.02	<0.03	<0.02	<0.04	<0.1	<0.1	<0.1	<0.1
57	0.07	0.25	0.10	0.32	<0.01	0.07	0.04	0.03	<0.05	<0.01	0.07	<0.1	<0.1	<0.1	<0.1
58	0.03	0.08	0.05	0.11	<0.01	0.02	0.01	<0.01	<0.03	<0.01	0.01	<0.1	<0.1	<0.1	<0.1
59	<0.02	0.05	<0.02	0.06i	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1

Sample	BaP	BaA	CP	CHR	5-MC	BbFl	BjFl	BkFl	IP	DBahA	BghiPI	DBaP	DBaP	DBaP	DBaP
60	0.57	1.38	0.50	3.84	<0.01	2.20	1.73	0.83	0.84	0.21	1.56	<0.1	<0.11	<0.1	<0.1
61	0.41	1.47	1.01	5.11	<0.03	2.09	0.95	0.59	0.36i	0.10i	0.70i	<0.1	<0.1	<0.1	<0.1
62	<0.07	0.08i	<0.06	0.15	<0.01	<0.08	<0.04	<0.03	<0.03	<0.01	0.03	<0.1	<0.1	<0.1	<0.1
63	<0.02	<0.03	<0.01	0.04	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
64	<0.02	0.02	0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
65	<0.02	0.03	<0.01	0.05	<0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
66	<0.02	0.04	0.03	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
67	<0.03	0.19	<0.01	0.14	<0.01	0.02	0.01	<0.01	<0.01	<0.01	0.01	<0.1	<0.1	<0.1	<0.1
68	<0.03	0.08	<0.01	0.08	<0.01	<0.03	<0.02	<0.01	<0.02	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
69	0.10	0.72	1.10	0.83	<0.01	0.11	0.08	0.05	<0.04	<0.01	0.03	<0.1	<0.1	<0.1	<0.1
70	<0.02	0.02	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
71	0.05	0.15	0.15	0.34	<0.01	0.06	0.03	0.03	<0.04	<0.01	0.02	<0.1	<0.1	<0.1	<0.1
72	<0.02	0.02	<0.02	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
73	0.09	0.13	0.07	0.20i	<0.01	0.09	0.04	0.06	0.06	<0.02	0.06	<0.1	<0.1	<0.1	<0.1
74	<0.02	0.04	0.04	0.20	<0.01	0.04	0.05	0.02	<0.03	<0.01	0.03	<0.1	<0.1	<0.1	<0.1
75	<0.02	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
76	<0.02	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
77	<0.05	0.04	0.04	0.04	<0.01	<0.03	<0.01	<0.02	<0.03	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
78	0.06	0.11	<0.02	0.10	<0.01	0.04	0.03	0.02	<0.04	<0.01	0.02	<0.1	<0.1	<0.1	<0.1
79	<0.02	0.05	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
80	<0.02	0.03	0.02	0.07	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
81	<0.02	0.02	0.02	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
82	<0.11	0.10	<0.05	0.45	<0.01	<0.06	0.04	<0.03	<0.05	<0.04	<0.04	<0.1	<0.1	<0.1	<0.1
83	0.61	0.41	0.02	0.70	<0.01	0.70	0.43	0.36	0.48	0.13	0.59	<0.1	<0.1	<0.1	<0.1
84	0.08	0.12	0.10	0.77	<0.01	0.13	0.08	0.06	<0.07	<0.03	0.18	<0.1	<0.1	<0.1	<0.1
85	<0.23	<0.09	<0.05	0.37	<0.01	<0.14	<0.05	<0.08	<0.12	<0.12	<0.08	<0.1	<0.18	<0.1	<0.1
86	0.14	0.10	<0.01	0.21	<0.01	0.13	0.07	0.06	0.09	<0.03	0.13	<0.1	<0.1	<0.1	<0.1
87	0.72	0.93	<0.04	3.32	<0.04	1.08	0.39	0.18	0.22	0.19i	0.49	<0.1	<0.1	<0.1	<0.1
88	0.09	0.13	0.03	0.37	<0.01	0.11	0.06	<0.05	<0.09	<0.03	0.16	<0.1	<0.1	<0.1	<0.1
89	0.29	0.37	0.07	0.91	<0.02	0.35	0.20	0.15	0.20	<0.06	0.31	<0.1	<0.1	<0.1	<0.1
90	0.14	0.20	0.12	0.99	<0.01	0.17	0.11	0.08	0.09	<0.03	0.25	<0.1	<0.1	<0.1	<0.1

Sample	BaP	BaA	CP	CHR	5-MC	BbFl	BjFl	BkFl	IP	DBahA	BghiPI	DBaP	DBaP	DBaP	DBaP
91	0.27	0.37	0.04	0.98	<0.02	0.35	0.18	0.10	0.20	0.06	0.30	<0.1	<0.1	<0.1	<0.1
92	<0.35	<0.12	0.35	<0.27	<0.01	<0.24	<0.09	<0.15	<0.37	<0.21	<0.66	<0.1	<0.1	<0.12	<0.1
93	0.87	0.60	2.57	1.14	<0.04	0.76	0.45	0.39	0.43i	<0.11	0.70	<0.1	<0.1	<0.1	<0.1
94	0.09	0.11	<0.03	0.33	<0.01	0.19	0.10	0.09	0.09	<0.06	0.14	<0.1	<0.1	<0.1	<0.1
95	<0.18	0.19	<0.04	0.76	<0.02	<0.12	0.05	<0.08	<0.1	<0.11	<0.05	<0.1	<0.1	<0.1	<0.1
96	66.68i*	103.07	1.69	120.10	<0.05	71.93	40.28	38.50	45.27	9.55	37.98	14.10i	6.45	2.45	0.35
97	<0.18	0.52	<0.03	0.84	<0.01	0.22	0.11	<0.08	<0.1	<0.11	0.08	<0.1	<0.1	<0.1	<0.1
98	<0.07	<0.03	<0.01	<0.06	<0.01	<0.05	<0.02	<0.02	<0.05	<0.06	<0.04	<0.1	<0.1	<0.1	<0.1
99	0.23	0.31	<0.04	3.28	<0.01	1.22	0.41	0.46	<0.28	<0.11	0.25	<0.1	<0.1	<0.1	<0.1
100	<0.07	<0.03	<0.01	<0.06	<0.01	<0.05	<0.02	<0.02	<0.07	<0.27	<0.04	<0.1	<0.1	<0.1	<0.1
101	<0.18	<0.06	<0.01	0.15	<0.01	<0.12	<0.04	<0.08	<0.1	<0.11	<0.05	<0.1	<0.1	<0.1	<0.1
102	<0.17	<0.08	<0.03	<0.15	<0.03	<0.12	<0.04	<0.06	<0.13	<0.14	<0.11	<0.17	<0.17	<0.18	<0.16
103	1.27	1.22	<0.03	1.80	<0.02	1.59	0.87	0.60	0.64	0.23i	1.00	<0.1	<0.1	<0.1	<0.1
104	0.79	1.15	0.03	3.11	<0.01	1.75	0.70	0.56	0.86	<0.21	1.01	<0.1	<0.27	<0.1	<0.1
105	<0.21	<0.14	<0.03	0.24	<0.02	<0.15	<0.05	<0.09	<0.12	<0.11	<0.09	<0.1	<0.18	<0.1	<0.1
106	20.29i*	34.89	5.83	94.31	<0.2	37.15	18.07	11.92	18.09	5.00	23.64	1.06i	4.11	1.28	<0.37
107	0.38	0.48	<0.01	0.84	<0.01	0.49	0.29	0.25	0.30	<0.11	0.42	<0.1	<0.27	<0.1	<0.1
108	1.10	1.37	0.07	2.74	<0.01	1.52	0.92	0.83	1.02	<0.23	0.96	<0.1	<0.25	<0.1	<0.1
109	5.15	14.34	4.03	23.76	1.45	8.19	4.79	3.58	3.21	<0.87	3.78	0.68i	<0.96	<0.25	<0.1
110	1.71	0.60	<0.02	1.55	<0.04	6.96	2.95	2.41	4.55	0.94	1.76	0.42i	<0.1	<0.1	<0.1
111	<0.18	0.13	<0.04	0.37	<0.01	<0.12	<0.06	<0.08	<0.1	<0.11	<0.05	<0.1	<0.1	<0.1	<0.1
112	<0.18	0.12	0.02	0.33i**	<0.01	0.12	0.07i	0.09	<0.1	<0.11	0.11	<0.1	<0.1	<0.1	<0.1
113	0.79	1.58	0.08	12.11i**	<0.03	3.17	1.02	0.81	0.98	0.22	1.11	<0.1	<0.1	<0.1	<0.1
114	1.48	1.19	1.54	1.98i**	<0.02	1.24	0.91	0.58	1.92	<0.11	4.55	<0.1	<0.1	<0.1	<0.1
115	4.40	10.43	0.20	31.33i**	<0.05	9.68	4.52	4.12	4.53	1.08	4.58	0.29i	0.94	0.32	<0.1
116	<0.01	<0.01	<0.01	0.03	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
117	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1
118	0.67	0.78	0.59	3.64	<0.02	2.49	1.18	1.34i	0.68	0.20	0.78	0.22	<0.1	<0.1	<0.1
119	<0.02	0.19	<0.02	0.16	<0.01	0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.1	<0.1	<0.1	<0.1
120	<0.02	<0.01	<0.01	0.04	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.1	<0.1	<0.1	<0.1

No	ACL	AC	FL	PHE	AN	FA	BcFL	PY	BghiF	BNTH	BeP	ATR	COR
1	0.19	0.19	0.36	2.93	0.16	0.79	0.12	0.63i	0.10	<0.04	0.07	<0.1	<0.1
2	0.17i	0.16i	0.29	2.60	0.22	0.78	0.07	0.73i	0.11	0.05	0.11	<0.1	<0.1
3	0.13i	0.11i	0.26i	1.33	0.12	0.37	0.02	0.34	0.05	<0.02	0.14	<0.1	<0.1
4	0.32i	0.22i	1.00i	6.78	0.38	1.65	0.16	1.35i	0.25	0.08	0.24	<0.1	<0.1
5	0.19i	0.23i	0.59i	4.51	0.38	1.25	0.16	1.26i	0.26	<0.22	0.18	<0.1	0.10
6	0.20i	0.16i	0.38i	3.67	0.18	0.97	0.09	0.86i	0.13	<0.04	0.08	<0.1	<0.1
7	0.47i	0.40i	0.60i	4.54	0.28	1.72	0.10	1.96i	0.37	0.06	0.14	<0.1	<0.1
8	0.31i	0.32i	0.98i	8.37	0.88	3.57	0.21	2.79i	0.40	<0.06	0.17	<0.1	<0.1
9	0.79i	0.53i	1.02i	12.56	0.87	4.61	0.26	4.10i	0.61	<0.09	0.21	<0.1	<0.1
10	0.39i	0.56i	1.36	12.46	0.36	3.48	0.17	2.69i	0.31	0.13	0.24	<0.1	<0.1
11	0.51i	0.29i	0.95i	11.37	0.87	3.53	0.23	2.69i	0.37	<0.07	0.13	<0.1	<0.1
12	1.00i	0.62i	1.43i	13.66	0.77	4.04	3.61	3.32i	0.54	<0.17	0.21	<0.1	<0.1
13	0.49i	<0.28	0.78i	8.60	0.76	3.09	0.19	2.60i	0.38	<0.1	0.18	<0.1	<0.1
14	0.42i	<0.36	0.87	4.90	0.40	1.11	0.13	1.15	0.13	0.11	0.32	<0.1	<0.1
15	0.38i	0.40i	0.58i	6.67	0.54	2.40	0.17	1.90i	0.24	<0.07	0.13	<0.1	<0.1
16	0.80i	<0.27	0.92i	11.94	1.33	5.24	0.30	4.30i	0.61	<0.06	0.26	<0.1	<0.1
17	0.20i	<0.26	<0.28	1.36	0.18	0.50	<0.08	0.43i	0.05	<0.02	0.20	<0.1	<0.1
18	0.22i	<0.23	0.53i	6.79	0.30	1.71	0.15	1.25	0.17	<0.06	<0.04	<0.1	<0.1
19	9.02i	1.92i	6.22i	6.51i	1.72i	0.72	0.10	0.57	0.03	<0.01	0.02	<0.1	<0.1
20	0.50i	<0.15	0.36i	1.07	0.31	0.42	0.03	0.39i	0.03	<0.01	<0.02	<0.1	<0.1
21	0.19	<0.14	0.30	0.52	0.06	0.14	<0.02	0.19i	<0.01	<0.01	<0.01	<0.1	<0.1
22	<0.14	<0.16	0.22i	0.22	<0.25	0.05	<0.01	0.06i	<0.01	<0.01	<0.01	<0.1	<0.1
23	3.53i	0.57i	3.37i	4.30	1.46	0.57	0.04	0.50	0.03	<0.01	<0.02	<0.1	<0.1
24	4.32i	0.73i	5.33i	9.04	2.34	1.21	0.08	1.03i	0.07	<0.01	<0.04	<0.1	<0.1
25	0.81i	0.28i	1.36i	1.38	<0.23	0.34	0.04	0.57i	0.02	<0.03	<0.02	<0.1	<0.1
26	0.37i	0.31i	1.85i	5.75	1.36	1.02	0.05	0.78i	0.03	<0.01	0.01	<0.1	<0.1
27	0.14i	<0.16	<0.18	<0.2	<0.25	0.04	<0.01	0.04	<0.01	<0.01	<0.01	<0.1	<0.1
28	2.73i	0.53i	3.86i	4.99	1.53	0.69	0.04	0.59	0.03	<0.01	<0.02	<0.1	<0.1
29	2.10i	0.85i	6.73i	8.42	2.72	1.04	0.18	0.99i	0.04	<0.01	0.03	<0.1	<0.1
30	11.85i	1.41	6.76	9.08	2.57	1.43	0.08	1.25	0.09	<0.02	0.02	<0.1	<0.1
31	0.17	0.15	0.43	2.11	0.13	2.01	0.16	1.91i	1.43	<0.01	3.28	<0.1	0.22

No	ACL	AC	FL	PHE	AN	FA	BcFL	PY	BghiF	BNTH	BeP	ATR	COR
32	2.42i	0.34i	1.97i	5.97	1.34	0.73	0.03	0.55	0.02	<0.01	<0.01	<0.1	<0.1
33	3.53i	0.57i	1.98i	7.20	1.05	0.64	0.03	0.69	0.02	<0.01	<0.01	<0.1	<0.1
34	0.20i	<0.15	1.16i	2.12	0.78	0.34	0.04	0.34i	0.02	<0.01	<0.04	<0.1	<0.1
35	5.35i	0.61i	2.16i	3.99	0.76	0.66	0.04	0.53	0.03	<0.01	<0.01	<0.1	<0.1
36	7.31i	1.19i	4.15i	7.73	1.43	0.79	0.03	0.51	0.02	<0.01	<0.01	<0.1	<0.1
37	1.55i	0.60i	3.85i	4.80	1.80	0.65	0.08	0.59	0.02	<0.01	<0.02	<0.1	<0.1
38	0.06	<0.18	<0.18	0.41	0.04	0.30	<0.01	0.28	0.04	<0.01	0.02	<0.1	<0.1
39	0.09	<0.18	<0.18	1.11	0.09	1.30	0.02	1.07i	0.14	<0.01	0.05	<0.1	<0.1
40	<0.17	0.17	0.47	1.39	0.08	0.49	0.03	0.48	0.08	0.12	0.04	<0.1	<0.1
41	0.12	0.23	0.39	2.28	0.13	2.45	<0.06	1.65i	0.15	0.08	0.05	<0.1	<0.1
42	<0.38	<0.25	<0.26	1.72	0.09	1.03	0.02	0.77	0.13	<0.03	0.10	<0.1	<0.1
43	<0.37	<0.24	<0.26	1.96	0.03	1.03	0.03	0.67	0.11	<0.04	0.06	<0.1	<0.1
44	<0.04	<0.12	<0.13	0.19	0.41	0.09	<0.01	0.09i	0.01	<0.01	0.01	<0.1	<0.1
45	<0.38	<0.25	<0.26	0.76	<0.03	0.26	<0.02	0.21	0.03	<0.01	0.02	<0.1	<0.1
46	<0.37	<0.24	<0.26	<0.29	<0.03	0.20	<0.01	0.17i	0.02	<0.01	0.03	<0.1	<0.1
47	0.02	<0.18	0.22	0.47	0.03	0.15	<0.01	0.18i	0.02	<0.01	0.02	<0.1	<0.1
48	0.12i	0.27i	0.57i	2.56	0.12	0.94	0.03	1.25i	0.13	0.26	0.06	<0.1	<0.1
49	<0.02	<0.05	<0.08	<0.14	<0.01	<0.04	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.1
50	<0.06	<0.1	<0.12	0.26	0.01	0.08	<0.01	0.08i	<0.01	<0.01	<0.02	<0.1	<0.1
51	<0.07	<0.13	<0.14	0.21	0.02	<0.08	<0.01	<0.08	<0.01	<0.01	<0.02	<0.1	<0.1
52	<0.03	<0.11	<0.12	0.18	0.36	0.05	<0.01	0.04i	<0.01	<0.01	<0.01	<0.1	<0.1
53	<0.1	<0.13	<0.14	0.69	0.04	0.15	<0.01	0.13i	0.01	<0.01	0.03	<0.1	<0.1
54	<0.73	0.48	1.03	3.25	<0.23	<0.32	<0.04	<0.3	<0.02	<0.03	0.04	<0.1	<0.1
55	<0.73	<0.46	<0.51	1.92	<0.22	0.44	<0.04	0.43i	0.04	<0.03	0.04	<0.1	<0.1
56	<0.11	<0.24	<0.33	0.60	0.11	0.28	<0.05	0.36i	0.12	<0.01	<0.06	<0.1	<0.1
57	7.68i	1.24i	6.47i	16.50	3.73	2.64	0.19	1.95i	0.13	<0.01	0.07	<0.1	<0.1
58	ND	2.14i	7.36i	12.33	3.02	1.47	0.11	1.11i	0.05	<0.01	0.02	<0.1	<0.1
59	3.90i	0.85i	5.43i	7.51	2.14	1.00	0.08	0.90i	0.03	<0.02	<0.01	<0.1	<0.1
60	13.69i*	2.08i	10.72i*	16.96i*	5.56	10.70i*	0.60	6.47i*	2.27	<0.21	2.51	<0.1	0.47
61	17.15i*	3.95i	6.88i*	15.99i*	8.71i	10.92i*	1.01	7.30i*	2.67	<0.28	2.02	<0.1	0.26
62	0.48i	<0.16	0.56	1.63	0.26	0.49	0.04	0.43	0.05	<0.03	<0.06	<0.1	<0.1

No	ACL	AC	FL	PHE	AN	FA	BcFL	PY	BghiF	BNTH	BeP	ATR	COR
63	4.91i	0.77i	3.21	13.19	1.92	0.75	0.02	0.70	0.02	<0.02	<0.01	<0.1	<0.1
64	2.97i	0.48i	2.13i	11.00	1.84	0.88	0.03	0.76	0.02	<0.01	<0.01	<0.1	<0.1
65	1.69i	0.34i	0.52i	1.43	<0.25	0.36	0.02	0.36	0.03	<0.01	<0.02	<0.1	<0.1
66	5.23i	0.63i	3.12	4.69	1.43	0.74	0.06	0.61	0.03	<0.01	<0.01	<0.1	<0.1
67	0.74	0.65	0.74	1.67	0.11	0.90	<0.01	0.48	0.04	<0.01	0.04	<0.1	<0.1
68	1.89i	1.08i	5.02i	4.57	1.57	0.57	0.08	0.55	0.02	<0.01	<0.03	<0.1	<0.1
69	7.97i	2.56i	12.87	45.34i	11.14	9.77	0.78	5.57i	0.55	<0.01	0.08	<0.1	<0.1
70	8.44i	1.13i	5.81i	13.67	2.55	0.91	0.04	0.70	0.02	<0.01	<0.01	<0.1	<0.1
71	ND	2.78i	11.81i	37.15i	6.58	3.42	0.12	2.10i	0.11	<0.01	0.04	<0.1	<0.1
72	9.99i*	1.23i	4.06i	5.30	1.62	0.49	0.02	0.34	0.02	<0.01	<0.01	<0.1	<0.1
73	11.87i	1.41i	5.76i	10.85	2.40	1.29	0.07	1.12i	0.09	<0.01	0.08	<0.1	<0.1
74	0.18i	<0.1	0.33i	1.36	0.12	0.50	0.02	0.15i	0.10	<0.01	0.04	<0.1	<0.1
75	<0.02	<0.1	<0.12	<0.17	<0.01	<0.03	<0.01	<0.03	<0.01	<0.01	<0.01	<0.1	<0.1
76	<0.02	<0.1	<0.12	<0.17	<0.01	<0.05	<0.01	<0.05	<0.01	<0.01	<0.01	<0.1	<0.1
77	6.62	0.81	3.49	6.01	1.60	0.87	0.04	0.71	0.03	<0.02	<0.02	<0.1	<0.1
78	1.30i	0.25i	1.67i	2.21	0.42	0.40	0.07	0.39	0.03	<0.01	0.03	<0.1	<0.1
79	3.62i	0.85i	3.92i	4.18	1.14	0.49	0.06	0.46	0.02	<0.01	<0.02	<0.1	<0.1
80	2.36i	0.33i	1.72i	5.88	1.38	0.71	0.02	0.56	0.03	<0.06	<0.03	<0.1	<0.1
81	2.25i	0.27	1.27	4.38	0.91	0.48	0.02	0.38	0.02	<0.02	<0.01	<0.1	<0.1
82	0.12	<0.58	<0.68	2.19	0.09	1.05	<0.09	1.05i	0.10	<0.07	0.05	<0.1	<0.1
83	<0.04	<0.31	<0.33	<0.41	<0.46	0.34	0.04	0.46i	0.13	<0.12	0.74	<0.1	0.13
84	0.36	<0.26	0.45	2.66	0.12	0.89	<0.07	1.05	0.22	0.10i	0.22	<0.1	<0.1
85	<0.37	<1.52	<1.68	<2.18	<2.31	<1.18	<0.09	<1.12	0.09	<0.14	<0.09	<0.1	<0.1
86	<0.04	<0.31	<0.33	<0.41	<0.46	0.19	<0.02	0.22i	0.04	<0.05	0.06	<0.1	<0.1
87	<0.04	<0.26	<0.27	<0.35	<0.02	0.16	<0.06	0.40i	0.16	<0.02	2.42	<0.1	0.11
88	<0.04	<0.26	<0.27	0.49	0.02	0.31	<0.08	0.46i	0.09	<0.02	0.15	<0.1	<0.1
89	0.79	0.64	1.46	5.61	<0.92	1.41	0.15	1.42	0.25	0.52i	0.39	<0.1	0.13
90	0.69i	0.42i	1.71	10.03	0.31	2.53	0.11	2.39i	0.28	0.14i	0.28	<0.1	<0.1
91	0.51	<0.45	0.80	3.71	0.19	1.13	<0.09	1.13i	<0.03	0.31i	0.42	<0.1	<0.1
92	<0.3	<2.28	<3.17	<3.53	<0.17	<0.54	<0.06	<0.51	<0.3	<0.14	0.24	<0.1	0.23
93	0.77i	<1.18	1.72	<1.82	0.47	0.32	<0.07	<0.26	0.21	<0.09	2.41	<0.1	<0.1

No	ACL	AC	FL	PHE	AN	FA	BcFL	PY	BghiF	BNTH	BeP	ATR	COR
94	<0.13	<0.61	<0.66	<0.81	<0.92	0.25	<0.03	0.44i	0.08	<0.09	0.21	<0.1	<0.1
95	25.53i	122.92i	16.00	33.90	1.82	6.13	0.20	4.77	0.35	0.11	0.14	<0.1	<0.1
96	39.12i	9.71i	23.32	201.51	56.39	391.23i*	9.59	259.66i	22.02	19.70	51.31i*	<0.25	6.97
97	6.05i	16.14i	7.09	10.88	1.05i	3.59	<0.17	2.27i	0.23i	0.20	0.34	<0.1	<0.1
98	<0.09	<0.61	<0.66	1.41	<0.92	0.13	<0.03	<0.1	<0.02	<0.03	<0.03	<0.1	<0.1
99	0.18i	2.56i	68.77	15.51	0.76	8.24	<0.03	6.35	0.35	<0.42	0.85	<0.1	0.11
100	<0.09	<0.6	<0.66	<0.8	<0.91	0.22	0.04	0.17i	<0.02	<0.03	<0.03	<0.1	<0.1
101	0.24	<1.18	<1.63	<1.82	<0.09	<0.28	<0.03	0.34i	<0.05	<0.07	<0.07	<0.1	<0.1
102	<0.22	<1.52	<1.65	<2.02	<2.3	<0.28	<0.07	<0.26	<0.05	<0.08	<0.08	<0.1	<0.17
103	0.64	1.29	<1.63	<1.82	0.20	2.02	<0.15	2.06i	0.40	<0.19	2.22	<0.1	0.12
104	1.81i	<1.18	2.19	13.48	0.56	6.06	<0.27	5.65i	0.82	0.47	1.70	<0.1	0.45
105	<1.68	<1.57	<1.68	<2.18	1.67	<1.03	<0.15	<1.00	<0.07	<0.11	<0.1	<0.1	<0.11
106	15.13i	3.39i	27.44i	63.01	24.84	65.94	5.83	74.16i	24.14	48.31	30.56i*	1.78	6.28
107	0.16i	<1.18	<1.33	2.64	<0.29	1.69	<0.14	1.48i	0.19	0.15	0.52	<0.1	0.21
108	0.59i	<1.12	1.81i	13.96	1.19	9.06	0.23	6.51	0.85	0.32	1.40	<0.1	0.51
109	12.89i	<2.86	14.47	169.33	9.87	97.29	3.13	80.07i	11.30	<1.48	7.72	<0.1	<1.11
110	0.21i	<1.17	<1.63	<1.81	0.14	<0.28	<0.03	<0.26	0.13	<0.1	7.49	<0.1	<0.1
111	0.51	<1.17	<1.62	6.97	0.44	2.19	<0.03	2.68i	0.16	<0.15	0.15	<0.1	<0.1
112	<0.15	<1.16	<1.61	<1.8	<0.09	0.65	<0.03	0.74i	0.13	0.33	0.12	<0.1	<0.1
113	0.32i	<1.17	3.06	22.45	0.38	14.40	0.28	7.30i	1.51	1.14	3.82	<0.1	0.37
114	2.24i	1.66i	3.67i	23.60	1.12	21.17	0.52	33.91i	7.32	<0.13	2.02	<0.1	2.71
115	3.89i	12.64i	34.59	68.56	19.60	123.14i*	1.83	104.03i*	5.59	5.62	8.13	0.40	1.49
116	<0.02	<0.06	0.08	0.22	0.01	0.10	<0.01	0.07i	<0.01	<0.01	<0.02	<0.1	<0.1
117	0.02	<0.05	<0.05	<0.07	<0.02	0.02i	<0.01	0.02	<0.01	<0.01	<0.01	<0.1	<0.1
118	5.92i	1.25i	5.28i	18.63	2.62	7.52i	0.28	3.45i	3.61	0.43	3.32	<0.1	0.18
119	9.35i	1.91i	5.58i	11.74	2.24	1.01	0.03	0.59	0.03	<0.01	0.02	<0.1	<0.1
120	0.04	<0.14	<0.14	<0.18	<0.01	0.06	<0.01	0.04i	<0.01	<0.01	0.02	<0.1	<0.1

[BaP] = benzo[a]pyrene, [BaA] = benz (a) anthracene, [CP] = cyclopenta[c,d]pyrene, CHR = chrysene, [5-MC] = 5-methylchrysene, [BbFl] = benzo[b]fluoranthene, [BjFl] = benzo[j]fluoranthene, [BkFl] = benzo[k]fluoranthene, [IP] = indeno[1,2,3-cd]pyrene, [DBaH] = dibenz[ah]anthracene, [BghiP] = benzo-[g,h,i]perylene, [DBaP] = dibenzo[a,l]pyrene, [DBaPe] = dibenzo[a,e]pyrene, [DBaPi] = dibenzo[a,i]pyrene, [DBaH] = dibenzo[a,h]pyrene, [ACL] = acenaphthylene, [AC] = acenaphthene, [FL] = fluorene, [PHE] = phenanthrene, [AN] = anthracene, [FA] = fluoranthene, [BcFL] = benzo[c]fluorene, [PY] = pyrene, [BghiF] = benzo[ghi]fluoranthene, [BNTH] = benzo[b]naphtho[2,1-d]thiophene, [BeP] = benzo[e]pyrene, [ATR] = anthanthrene, [COR] = coronene, i=indicative data only; i*=indicative due to detector overload, likely to be an underestimate; i**=indicative due to a low reference material value; <#.# indicates occurrence below Limit of Detection

Table 8 Overview of B[a]P, sum SCF-15 PAHs and sum of total 28 PAHs (upperbound µg/kg ww) in individual samples (see Table 6 for sample details)

Sample No	Category	B[a]P	Sum SCF15	Sum PAHs (n=28)	Sample No	Category	B[a]P	Sum SCF15	Sum PAHs (n=28)
upperbound µg/kg ww					upperbound µg/kg ww				
2	Chocolate	0.14	1.53	7.02	52	Infant food	0.01	0.51	1.64
3	Chocolate	0.09	1.13	4.22	53	Infant food	0.03	0.65	2.29
5	Chocolate	0.21	2.78	12.21	54	Infant food	0.07	0.77	7.44
7	Chocolate	0.17	2.17	13.01	55	Infant food	0.06	0.91	5.97
4	Chocolate	0.22	2.53	15.16	49	Infant food	0	0.52	1.15
9	Chocolate	0.22	3.07	28.92	50	Infant food	0.02	0.62	1.58
10	Chocolate	0.20	2.61	24.96	56	Infant food	0.15	1.12	3.59
11	Chocolate	0.14	2.15	23.36	116	Infant food	0.01	0.54	1.35
12	Chocolate	0.23	2.89	32.46	51	Infant food	0.02	0.57	1.55
17	Chocolate	0.11	1.48	5.24	117	Infant food	0.01	0.51	1.00
18	Chocolate	0.06	1.19	12.84	35	Smoked meats	0.02	0.59	14.94
1	Chocolate	0.08	1.16	6.94	68	Smoked meats	0.03	0.71	16.30
6	Chocolate	0.08	1.25	8.21	79	Smoked meats	0.02	0.60	15.57
8	Chocolate	0.18	2.65	20.91	30	Smoked meats	0.04	0.99	35.75
13	Chocolate	0.18	2.50	20.15	19	Smoked meats	0.04	0.76	27.80
14	Chocolate	0.23	2.35	12.45	22	Smoked meats	0.02	0.53	1.87
15	Chocolate	0.14	1.96	15.64	23	Smoked meats	0.02	0.62	15.22
16	Chocolate	0.30	3.87	30.10	29	Smoked meats	0.06	0.87	24.18
44	Dried fruit	0.02	0.54	1.85	36	Smoked meats	0.02	0.58	23.96
46	Dried fruit	0.02	0.65	2.48	37	Smoked meats	0.02	0.65	14.82
45	Dried fruit	0.02	0.67	3.10	66	Smoked meats	0.02	0.60	17.36
47	Dried fruit	0.02	0.61	2.12	77	Smoked meats	0.05	0.71	21.13
38	Dried fruit	0.02	0.70	2.43	20	Smoked meats	0.02	0.66	4.15
39	Dried fruit	0.05	1.11	5.55	27	Smoked meats	0.02	0.52	1.77
48	Dried fruit	0.03	1.86	8.37	34	Smoked meats	0.04	0.68	6.08
42	Dried fruit	0.08	1.44	6.42	78	Smoked meats	0.06	0.86	7.84
43	Dried fruit	0.03	1.17	6.17	59	Smoked meats	0.02	0.62	22.69
40	Dried fruit	0.02	1.21	4.93	62	Smoked meats	0.07	0.99	5.38
41	Dried fruit	0.03	1.13	8.92	25	Smoked meats	0.02	0.65	5.93
87	Fats/oils	0.72	8.00	12.37	26	Smoked meats	0.02	0.70	12.44
88	Fats/oils	0.09	1.53	3.92	28	Smoked meats	0.02	0.60	15.82
91	Fats/oils	0.27	3.27	12.24	65	Smoked meats	0.02	0.59	5.82
84	Fats/oils	0.08	2.03	8.63	21	Smoked meats	0.02	0.54	2.33
85	Fats/oils	0.23	1.82	12.79	76	Smoked meats	0.02	0.54	1.30
90	Fats/oils	0.14	2.59	21.68	24	Smoked meats	0.04	1.02	25.42

Table 8 continued Overview of B[a]P, sum SCF-15 PAHs and sum of total 28 PAHs (upperbound µg/kg ww) in individual samples (see Table 6 for sample details)

Sample No	Category	B[a]P	Sum SCF15	Sum PAHs (n=28)	Sample No	Category	B[a]P	Sum SCF15	Sum PAHs (n=28)
upperbound µg/kg ww					upperbound µg/kg ww				
89	Fats/oils	0.29	3.33	17.12	115	Supplements	4.40	76.57	466.08
86	Fats/oils	0.14	1.38	3.71	95	Supplements	0.18	2.10	214.17
82	Fats/oils	0.11	1.38	7.65	97	Supplements	0.18	2.68	50.89
83	Fats/oils	0.61	4.84	8.45	105	Supplements	0.21	1.73	13.18
32	Fish/Fish products	0.02	0.57	14.16	101	Supplements	0.18	1.31	7.31
64	Fish/Fish products	0.02	0.56	20.89	108	Supplements	1.10	11.32	48.97
63	Fish/Fish products	0.02	0.57	26.29	109	Supplements	5.15	75.14	486.76
70	Fish/Fish products	0.02	0.55	34.04	106	Supplements	20.29	276.21	667.02
67	Fish/Fish products	0.03	0.85	6.44	114	Supplements	1.48	15.92	116.09
33	Fish/Fish products	0.02	0.59	16.52	103	Supplements	1.27	9.67	22.51
81	Fish/Fish products	0.02	0.56	10.77	94	Supplements	0.09	1.64	6.07
71	Fish/Fish products	0.05	1.29	65.61	96	Supplements	66.68	558.45	1649.23
119	Fish/Fish products	0.02	0.87	33.58	107	Supplements	0.38	4.15	14.23
69	Fish/Fish products	0.10	3.48	100.32	113	Supplements	0.79	22.30	78.60
31	Fish/Fish products	0.40	9.02	21.13	100	Supplements	0.07	1.05	4.82
74	Fish/Fish products	0.02	0.89	4.00	110	Supplements	1.71	24.21	37.66
60	Fish/Fish products	0.57	14.08	86.42	111	Supplements	0.18	1.65	17.92
61	Fish/Fish products	0.41	13.22	90.46	104	Supplements	0.79	10.75	45.49
75	Fish/Fish products	0.02	0.54	1.26	102	Supplements	0	1.74	10.54
120	Fish/Fish products	0.02	0.55	1.41	98	Supplements	0.07	0.82	5.05
57	Fish/Fish products	0.07	1.42	42.23	92	Supplements	0.35	3.24	14.81
58	Fish/Fish products	0.03	0.77	28.59	93	Supplements	0.87	8.46	17.98
72	Fish/Fish products	0.02	0.59	23.88	99	Supplements	0.23	7.00	111.23
118	Fish/Fish products	0.67	12.89	65.48	112	Supplements	0.18	1.66	8.67
80	Fish/Fish products	0.02	0.61	13.89					
73	Fish/Fish products	0.09	1.23	36.38					

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