

食物中的多環芳烴

Polycyclic Aromatic Hydrocarbons in Food

業界諮詢論壇

Trade Consultation Forum

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背景 Background

- 近年來，食品中多環芳烴（PAHs）的存在備受關注
 - 尤其關注這些化合物的潛在致癌性和遺傳毒性
 - 海外有對PAHs進行研究，並已採取行動監測和控制食品中PAHs的含量
 - 本地對食品中PAHs的研究有限
- There has been concern on the presence of polycyclic aromatic hydrocarbons (PAHs) in foods in the recent years
 - Carcinogenic and genotoxic potential of these compounds has caused the most concern
 - Overseas counterparts have conducted studies on PAHs and have taken action to monitor and control the level of PAHs in food
 - Local studies on PAHs in foods are limited



什麼是多環芳烴 What are PAHs?

- PAHs是一類有機化合物
- 主要是因為有機物未充分燃燒或在高溫下分解而形成，又或在各種工業工序中產生
- PAHs可藉環境污染或在食物加工或烹煮期間形成後進入食物鏈
- 對非吸煙者而言，接觸多環芳烴的主要途徑是進食
- Polycyclic aromatic hydrocarbons (PAHs) constitute a large class of organic compounds
- Primarily formed by incomplete combustion or pyrolysis of organic matter and during various industrial processes
- PAHs can enter the food chain either through environmental contamination or by formation during food processing or cooking
- For non-smokers, the major route of exposure to PAHs is consumption of food



PAHs 如何進入食物鏈？

How PAHs enter into food chain?

受環境中的 PAHs 污染

- 空氣中的 PAHs 可積聚於農作物 (特別是闊葉農作物)
- 在受污染的水中，PAHs 可沉積並轉移至魚類和海洋無脊椎動物 (例如以過濾大量水的方式進食的雙貝類)

Contamination by environmental PAHs

- Deposited on crops, esp. crops with board leaves
- Deposited and transferred to fish and marine invertebrates, e.g., bivalves that feed by filtering large quantities of water



在食物加工/烹煮期間形成

- 在食物加工期間形成 (例如製乾和煙燻)



- 高溫烹煮時形成 (例如烤、焗)



Form during processing/ cooking

- Form during processing, (e.g., drying, smoking)
- Form during cooking (e.g., grilling, roasting)

PAHs 引致的關注 Concerns on PAHs



- 有動物實驗研究顯示，某些 PAHs 有以下影響：
 - 有基因毒性
 - 抑制免疫系統
 - 可致癌
 - 影響發育
- JECFA (2005) 斷定：
 - 15種PAHs具基因毒性
 - 13種PAHs會致癌並具基因毒性
- 國際癌症研究機構(IARC) 對某些 PAHs 評估
 - 把苯並[a]芘 (BaP) 列為第1組(令人類患癌)物質
 - 把幾種PAHs列為第2A組或第2B組物質
- Some PAHs were reported to have the following effects in animal studies:
 - Genotoxicity
 - Carcinogenicity
 - Immunosuppressive effect
 - Developmental toxicity
- JECFA (2005) considered:
 - 15 individual PAHs are genotoxic,
 - 13 PAHs are both carcinogenic and genotoxic
- The International Agency for Research on Cancer (IARC) has evaluated some PAHs
 - Classified benzo[a]pyrene (BaP) as Group 1 (carcinogenic to human)
 - Some other PAHs are classified as Group 2A or 2B



風險評估研究

The Risk Assessment Study



研究目的 Study objectives

- 這項研究旨在
 - 測定本地市場選定類別食品中 PAHs 的含量
 - 估算本港成年人從這些食品攝入 PAHs 的分量，以及
 - 評估相關的健康風險
- The study aims to:
 - determine the levels of PAHs in selected food items available in local market;
 - estimate the dietary exposure to PAHs of local adult population arising from consumption of these food items; and
 - assess the associated health risk



研究方法 Methodology

- 於2022年9月至12月期間，從本港零售商和食物業處所收集了300個食物樣本(涵蓋60項食品)
- 選取樣本的主要準則包括：
 - 文獻所載該等食品的PAHs含量或其佔PAHs整體攝入量的比重
 - 有關食品在本地的受歡迎程度
 - 抽樣期內有關食品在本地市場的供應情況
- 300 food samples (included 60 food items) were collected from local retailers and food premises between Sep and Dec 2022
- The samples were chosen mainly based on
 - their PAHs levels or their contribution to overall PAHs exposure as reported in literature
 - their popularity among the local population
 - their availability in the local market during the sampling period



食物種類 Food types

涵蓋9個食品組別 Covered 9 groups of foods

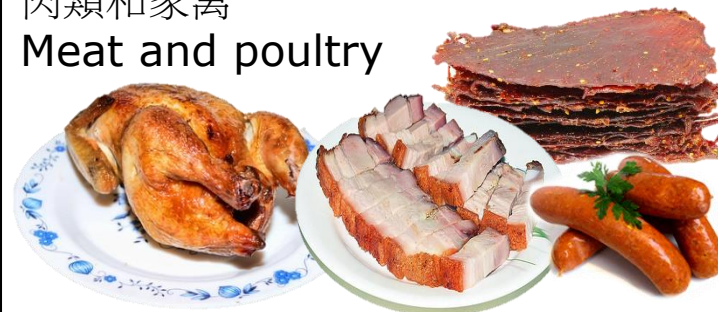
穀物和穀物製品
Cereal and cereal products



蔬菜 Vegetables



肉類和家禽
Meat and poultry



魚類和水產品
Fish and aquatic products



奶類製品和蛋
Dairy products and eggs



小食和甜點
Snacks and confection



油脂 Oils and fats



飲品 Beverages



香料 Spices



研究範圍 Scope of study

- 研究涵蓋**16種PAHs**
 - 包括 **JECFA** 在 2005年表示值得關注的多種PAHs
 - 與**EFSA**在2008年評估的PAHs清單所列者相同
- 檢測每個食物樣本中**各種PAH**的含量、**PAH4**含量，以及**PAHs 總含量**
 - PAH4 是BaP, CHR, BaA 和 BbFA的總和
- Included **16 PAHs**
 - Covered those PAHs concerned by **JECFA** in 2005
 - Same as the 16 PAHs in **EFSA** evaluation in 2008
- For each sample, the results for **individual PAHs, PAH4, and total PAHs** were obtained
 - PAH4 is the sum of BaP, CHR, BaA and BbFA



研究涵蓋的16種PAHs

16 PAHs covered in the study

	PAH	簡稱 Abbreviation		PAH	簡稱 Abbreviation
1	Benz[a]anthracene 苯並[a]蔥	BaA	9	Dibenz[a,h]anthracene 二苯並[a,h]蔥	DBahA
2	Benzo[b]fluoranthene 苯並[b]熒蔥	BbFA	10	Dibenzo[a,e]pyrene 二苯並[a,e]芘	DBaeP
3	Benzo[j]fluoranthene 苯並[j]熒蔥	BjFA	11	Dibenzo[a,h]pyrene 二苯並[a,h]芘	DBahP
4	Benzo[k]fluoranthene 苯並[k]熒蔥	BkFA	12	Dibenzo[a,i]pyrene 二苯並[a,i]芘	DBaiP
5	Benzo[ghi]perylene 苯並[g,h,i]芘	BghiP	13	Dibenzo[a,l]pyrene 二苯並[a,l]芘	DBalP
6	Benzo[a]pyrene 苯並[a]芘	BaP	14	Indeno[1,2,3-cd]pyrene 茛並[1,2,3-c,d]芘	IP
7	Chrysene 葙	CHR	15	5-methylchrysene 5-甲基葙	MCH
8	Cyclopenta[cd]pyrene 環戊並[c,d]芘	CPP	16	Benzo[c]fluorene 苯並[c]芴	BcFL

PAH4 是BaP, CHR, BaA 和 BbFA 的總和

PAH4 is the sum of BaP, CHR, BaA and BbFA



研究結果分析 Analysis of study result

- 研究主要集中在比較和分析苯並[a]芘 (BaP) 和PAH4的結果
- 在各種PAHs中，BaP較為值得關注，而PAH4往往用作食物是否含有歐盟優控PAHs的指標
- The study mainly focused on the comparison and analysis of results on BaP and PAH4
- BaP is of more concern among various PAHs, and PAH4 is often used as indicator of the occurrence of the EU priority PAHs



結果 Results



整體結果 Overall findings

- 300個樣本中有74%驗出至少一種 PAH
- 大部分驗出PAHs的樣本均只含少量 PAHs
- 檢測出的PAHs主要是CHR(16.9%)
 - 其次是CcdP (14.1%), BcF (11.2%), BaA (10.5%) 和 BbF(7.8%)
- PAHs的總含量由檢測不到至每公斤 120微克不等
- Among 300 samples collected, 74% were detected with at least 1 targeted PAHs
- Most samples only detected with small no. of PAHs
- Predominant PAH: Chrysene (CHR) (16.9%)
 - Followed by CcdP (14.1%), BcF (11.2%), BaA (10.5%) and BbF(7.8%)
- The levels of total PAHs ranged from not detected to 120 mcg/kg



不同食品組別的PAHs含量

PAHs level in food groups

- ▶ 至於不同食品組別的PAHs含量方面，以“香料”的平均含量最高，其次是“肉類和家禽”和“油脂”。
- ▶ Regarding PAHs in different food groups, “spices” contained the highest mean level, followed by “meat and poultry” and “oils and fats”.



不同食品組別的PAHs含量範圍

Range of PAHs level in food groups

食品組別 Food group	樣本數量 No. of samples	苯並[a]芘 (下限) (微克/公斤) BaP (LB) (mcg/kg)	PAH4 (下限) (微克/公斤) PAH4 (LB) (mcg/kg)	PAHs總含量(下限) (微克/公斤) Total PAH (LB) (mcg/kg)
穀物及穀物製品 Cereal and cereal products	35	0-0.090	0-0.63	0-0.99
蔬菜 Vegetables	40	0-0.060	0-0.41	0-0.97
肉類和家禽 Meat and poultry	45	0-6.0	0-36	0-63
肉類和家禽 Fish and aquatic products	50	0-0.27	0-7.3	0-11
奶類和蛋 Dairy and eggs	20	0-0.060	0-0.16	0-0.45
小食和甜點 Snacks and confection	25	0-0.40	0-2.8	0-4.8
油脂 Oils and fats	50	0-0.93	0-7.0	0-20
飲品 Beverages	25	0-0	0-0.100	0-0.37
香料 Spices	10	0.13-15	1.2-57	2.3-120
所有樣本 All samples	300	0-15	0-57	0-120

從膳食攝入多環芳烴的來源

Contributor to dietary exposure to PAHs

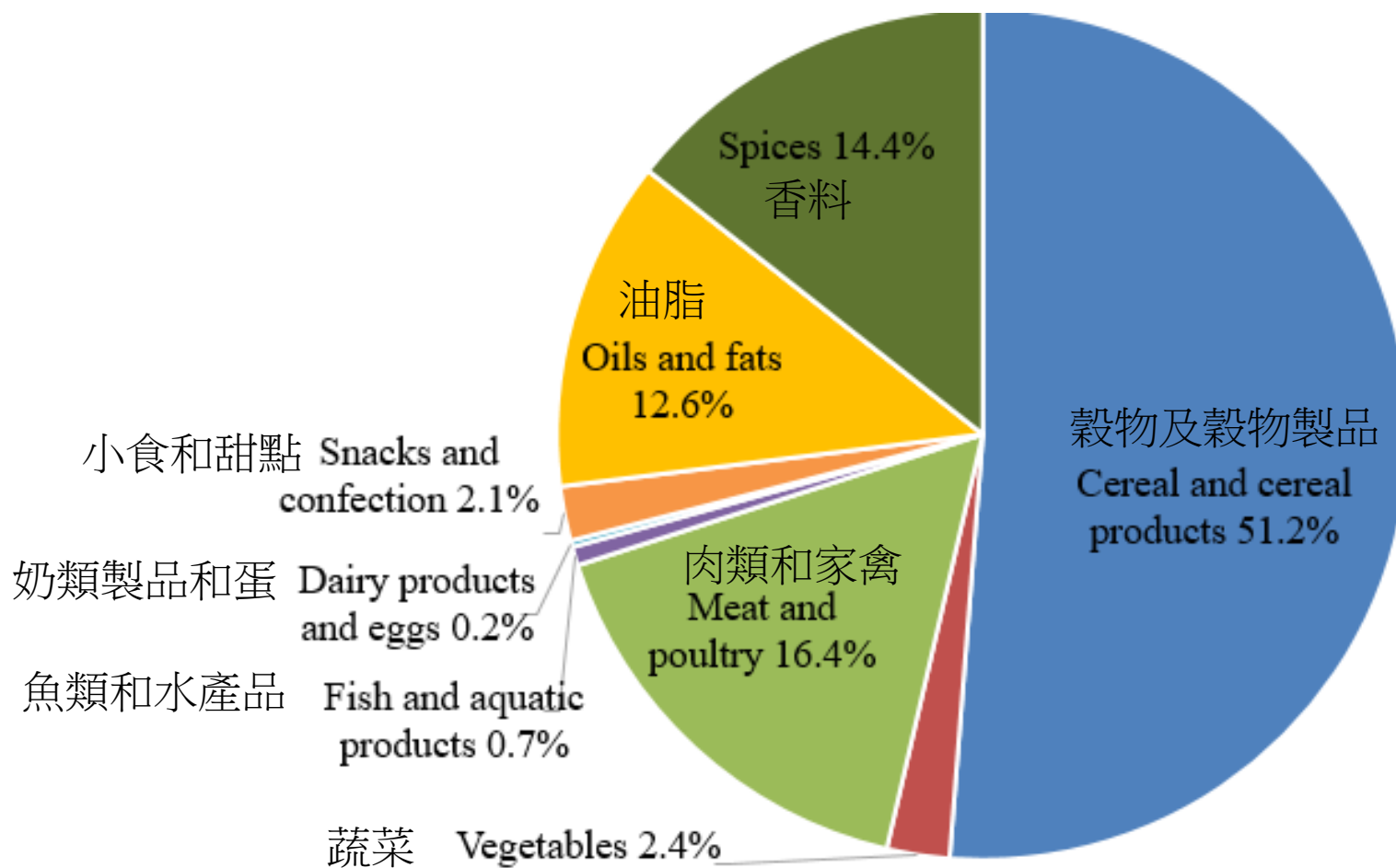
- “穀物及穀物製品”這個食品組別是香港成年人從膳食攝入PAHs的主要來源
 - 根據第二次全港性食物消費量調查的食物消費量數據作計算
- The food group “cereal and cereal products” is the major contributor to the dietary exposure to PAHs for the local adult population
 - Taking into account the food consumption data captured from the Second Hong Kong Population-based Food Consumption Survey



苯並[a]芘的攝入量 Dietary Exposure to BaP

本港成年人從各食品組別攝入BaP的平均分量佔膳食攝入量下限的百分比

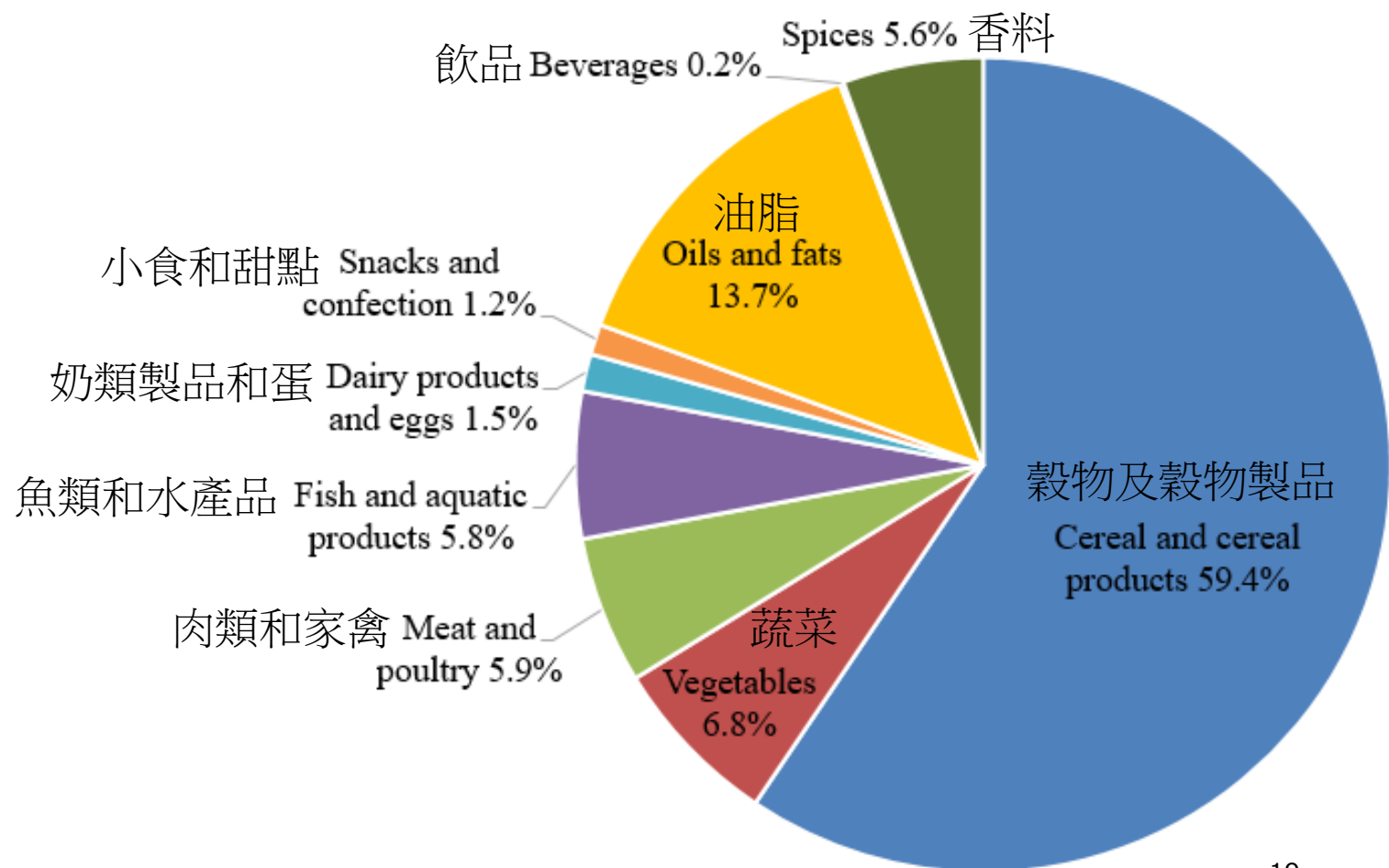
Relative contribution of food groups to LB dietary exposure to BaP among local adult population in average



PAH4的攝入量 Dietary Exposure to PAH4

本港成年人從各食品組別攝入PAH4的平均分量佔膳食攝入量下限的百分比

Relative contribution of food groups to LB dietary exposure to PAH4 among local adult population in average



PAHs對健康的影響 Health concern of PAHs

- 這項研究以暴露限值方法評估對健康可能構成的影響
 - 暴露限值越低，公眾健康可能受影響的程度越大
 - 暴露限值如高於10 000，表示對公眾健康的影響不大
- 就BaP和PAH4計算所得的暴露限值均高於10 000
 - 顯示目前香港成年人從膳食攝入PAHs的分量對健康的影響不大
- In this study, a margin of exposure (MOE) approach was adopted to assess possible health concerns
 - The lower the MOE value, the greater is the possible effect on public health
 - A MOE higher than 10 000 would indicate a low public health concern
- The calculated MOE values for both BaP and PAH4 are above 10 000
 - Indicates that the current dietary exposure to PAHs for the HK adult population is of low health concern



暴露限值 Margin of exposure

		攝入量一般的消費者 Average consumers	攝入量高的消費者 High consumers
BaP	膳食攝入量 (納克/每日每公斤體重) (下限-上限) Dietary Exposure (ng/kg bw/day) (LB-UB)	0.13- 0.90	0.21- 1.4
	暴露限值 (下限-上限) MOE (LB-UB)	540 000- 78 000	330 000- 51 000
PAH4	膳食攝入量 (納克/每日每公斤體重) (下限-上限) Dietary Exposure (ng/kg bw/day) (LB-UB)	1.4- 4.2	2.3- 6.3
	暴露限值 (下限-上限) MOE (LB-UB)	240 000- 81 000	150 000- 54 000

與其他研究比較

Comparison with other studies

- 把這項研究結果與其他地方的相關研究進行比較，本港成年市民的PAHs膳食攝入量屬低水平
- Comparing the results of the current study with that of the other places, the dietary exposure to PAHs of the local adult population is at the low end of the reported range of exposures



結論及建議

Conclusion and Recommendations



結論 Conclusion

- 目前香港成年人從膳食攝入 PAHs 的分量對健康的影響不大
- 比對這項研究與其他地方相關研究的結果，本港成年市民的 PAHs 膳食攝入量屬低水平
- The current dietary exposure to PAHs for the Hong Kong adult population is of low health concern
- Comparing the results of the current study with that of the other places, the dietary exposure to PAHs of the local adult population is low



給消費者的建議

Advice to Consumers

- 應保持均衡和多元化的飲食，以免因偏食而過量攝入某些化學污染物（包括PAHs）
- To maintain a **balanced and varied diet** so as to avoid excessive exposure to any contaminants (including PAHs)



給業界的建議

Advice to Trade

- 採取適當措施，並參考食品法典委員會在二〇〇九年採納的相關操作規範
 - 按照可合理做到盡可能低水平的原則，盡量減少食品在加工期間產生PAHs
- Follow Codex recommendations in its COP (2009) as appropriate
 - minimize introduction of PAHs in food products during processing in accordance with the principle of as low as reasonably achievable

CODE OF PRACTICE FOR THE REDUCTION OF
CONTAMINATION OF FOOD WITH POLYCYCLIC
AROMATIC HYDROCARBONS (PAH) FROM
SMOKING AND DIRECT DRYING PROCESSES

CAC/RCP 68-2009

INTRODUCTION

1. Many chemical contaminants are formed during the combustion of fuel both in the smoking and in the direct drying process. Examples include polycyclic aromatic hydrocarbons (PAH), dioxins, formaldehyde, nitrogen and sulphur oxides (relevant for formation of e.g. nitrosamines). Furthermore, heavy metals are also found in combustion gases. The types and amount of contaminants depend on the fuel used, the temperature and possible other parameters.
2. Hundreds of individual PAH may be formed and released as a result of incomplete combustion or pyrolysis of organic matter, during forest fires and volcanic eruptions as well as industrial processes or other human activities, including the processing and preparation of food. Owing to their mode of formation, PAH are ubiquitous in the environment and therefore enter the food chain, especially via air and soil. PAH can be present in the raw materials due to environmental contamination from the air by deposition on crops, from contaminated soils and transfer from water to fresh and marine invertebrates. Commercial and domestic food preparation such as smoking, drying, roasting, baking, barbecuing or frying are recognized as important sources of food contamination. Presence of PAH in vegetable oils can also originate from smoking and drying processes used to dry oil seeds prior to oil extraction.
3. Contamination of food with PAH via environmental contamination should be controlled either by source-directed measures like filtering the smoke from relevant industries (e.g. cement work, incinerator and metallurgy) and limiting the exhaust fumes of PAH from cars. Good practices, including the selection of appropriate farmland/fishing waters, could also decrease the environmental contamination of raw materials with PAH. However, this contribution to the reduction of PAH intake from the final food is not included in this Code of Practice.



~ 謝謝 Thank you ~

