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食物加工過程中的污染物 – 該擔心嗎？

Process Contaminants in Food – Should I be Concerned?

食物安全中心風險評估組
科學主任張鳳文女士報告

Reported by Ms. Iris CHEUNG, Scientific Officer,
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烹煮食物是為了使食物既可安全食用，也更美味可口。然而，在家烹調時或在食物製造過程中，都可能無意中產生有害的化學副產物，即加工過程污染物。最近有報告討論了三種加工過程污染物，分別是丙烯酰胺、縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯。雖然這些污染物可能對健康有潛在影響，但市民及業界可以採取方法降低這些物質在食物中的含量。

丙烯酰胺

丙烯酰胺主要在經高溫烹煮的澱粉類食物中(例如馬鈴薯及麵包)因褐化反應而產生。褐化反應而食物在攝氏120度或更高的溫度下烹煮或處理時，食物內天然存在的游離氨基酸天門冬酰胺與還原糖(例如葡萄糖及果糖)發生的化學反應。一般來說，烹煮溫度越高、時間越長，所產生的丙烯酰胺便越多。很多烘焙及煎炸食物，例如餅乾、薯片、薯條及多士，丙烯酰胺的含量都偏高，而水煮和蒸煮通常不會產生丙烯酰胺。

當進食後，丙烯酰胺會被吸收並分送到體內所有器官進行新陳代謝。動物實驗顯示，丙烯酰胺可導致生殖及發育問題，並增加患上癌症的風險。因此，我們應盡可能減少從飲食中攝入丙烯酰胺。

一般而言，要減少食物中的丙烯酰胺，不宜以過高的溫度烹煮過長時間。消費者在家中煎炸、烘焙、烤烘或燒烤馬鈴薯及麵包等澱粉類食物時，應把食物煮至呈金黃色或淺黃色即可。供煎炸、烘焙等的馬鈴薯不宜存放在雪櫃內，因為會形成更多的還原糖，導致隨後烹煮

We cook foods to make them safe, likewise tastier, to eat. However, undesirable chemical by-products, known as process contaminants, can be formed unintentionally during home cooking or manufacturing. Acrylamide, glycidyl esters (GE) and 3-monochloropropane-1,2-diol esters (3-MCPDE) are the process contaminants that have recently been discussed in a report. While these substances may have potential health effects, there are ways that members of the public and the trade can reduce their content in food.

Acrylamide

Acrylamide is mainly formed in starchy foods, such as potatoes and bread, cooked under high temperatures as a result of the Maillard reaction. It is a chemical reaction between the naturally present free amino acid asparagine and reducing sugars, such as glucose and fructose, in food when they are cooked or processed at 120°C or above. In general, more acrylamide will be formed under higher cooking temperature and longer cooking time. Many baked and fried foods like biscuits, chips, French fries and toast contain relatively high levels of acrylamide, whereas boiling and steaming do not typically form acrylamide.

Following ingestion, acrylamide is absorbed and distributed to all organs for metabolism. Animal experiments revealed that acrylamide may cause reproductive and developmental problems, and is associated with increased risk of developing cancers. As such, intake of acrylamide from our diet should be maintained as low as possible.

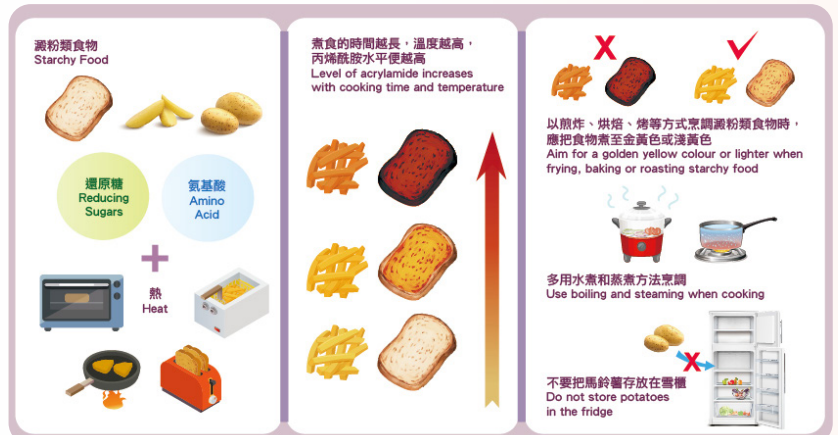


圖1: 左: 丙烯酰胺如何產生; 中: 烹煮時間越長、溫度越高, 丙烯酰胺含量便越多; 右: 減少產生丙烯酰胺的方法

Figure 1: Left: Formation of acrylamide; Middle: Level of acrylamide increases with increasing cooking time and temperature; Right: Ways to reduce acrylamide formation

時更容易產生丙烯酰胺。此外，烹煮蔬菜時先焯後炒，或者使用水煮或蒸煮的方法，也有助減少所產生的丙烯酰胺。由於我們的日常飲食少不了澱粉類食物，要完全避免從食物中攝入丙烯酰胺是不切實際的。消費者應有健康均衡的飲食，並進食大量蔬果。

業界應持續探討如何降低食物中丙烯酰胺的含量，並參考食物安全中心(食安中心)的《[減低食品中丙烯酰胺的業界指引](#)》及食品法典委員會的《[減低食品中丙烯酰胺的操作規範](#)》，在選擇原材料和制定配方及食物加工方法時減少丙烯酰胺的產生。

縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯

縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯是在工業提煉油脂過程中，以大約攝氏160度或更高溫度把油加熱以進行脫臭時形成的污染物，主要在食油(例如植物油)及含有這些油的食物(例如餅乾、薯條及人造牛油)中找到，當中尤以棕櫚油及相關食品含有較多的縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯。

在消化後，縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯會釋出縮水甘油及氯丙二醇，帶來潛在健康問題。實驗動物研究顯示，縮水甘油會破壞基因，而氯丙二醇則可能會影響老鼠的腎臟及雄性生殖系統。我們亦應盡可能減少從飲食中攝入這兩種污染物。

業界宜採取措施，例如選擇縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯含量較低的原材料，以及在生產食品時減少食油的用量，都可降低食物中的縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯含量。業界應參考食品法典委員會的《[減少精煉油及其製品中氯丙二醇脂肪酸酯和縮水甘油脂肪酸酯操作規範](#)》，並選用適合其加工方法及產品的技術。

注意事項

1. 丙烯酰胺、縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯是以高溫烹煮某些食物時無意中產生的加工過程污染物。
2. 消費者及業界均應努力，把食物中加工過程污染物的含量降至越低越好。

給市民的建議

- 食物不應以過高的溫度烹煮過長時間。用水煮和蒸煮的方法烹煮食物，有助減少丙烯酰胺的形成。依照生產商的烹調指示處理預先包裝的食物，以免過度烹煮。
- 減少食用精煉油脂及相關產品(例如人造牛油)，以降低縮水甘油脂肪酸酯及氯丙二醇脂肪酸酯的攝入量。
- 保持均衡及多元化的飲食，以減低因偏吃而攝入某些污染物的風險。

給業界的建議

- 業界應努力盡可能降低加工過程污染物在食品中的含量。
- 參考食安中心的業界指引及食品法典委員會制定的相關操作規範，採取適當的措施。

In general, acrylamide can be reduced by not cooking food at high temperatures for too long. When frying, baking, toasting or roasting starchy foods like potato and bread at home, consumers should aim for a golden yellow colour or lighter. Storing potatoes intended for frying and baking, etc. in fridge is not advisable as more reducing sugars will be formed, facilitating acrylamide formation during subsequent cooking. Furthermore, blanching vegetables before stir-frying or cooking them by boiling or steaming can also help reduce the formation of acrylamide. As starchy foods are key to our everyday diet, it is probably impractical to completely avoid acrylamide in food. Consumers should have a healthy and balanced diet and eat plenty of fruits and vegetables.

All along the trade is advised to seek ways to reduce the level of acrylamide in food. The trade may refer to the CFS' "[Trade Guidelines on Reducing Acrylamide in Food](#)" and the Codex's "[Code of Practice for the Reduction of Acrylamide in Foods](#)" on reduction in acrylamide level during the selection of raw materials and the formulation of recipes and food processing conditions.

GE and 3-MCPDE

GE and 3-MCPDE are process contaminants that are formed when oils are heated at temperatures of about 160°C or higher to remove undesirable taste and odour during industrial refining. They are found in edible oils (e.g. vegetable oils) and foods containing these oils (e.g. biscuits, French fries and margarine). In particular, palm oil and its related food products are found to contain higher levels of GE and 3-MCPDE.

The potential health concern about GE and 3-MCPDE involves the release of glycidol and 3-monochloropropane-1,2-diol (3-MCPD) upon digestion. Research animal studies showed that glycidol is gene-damaging, whereas 3-MCPD may affect kidney and male reproductive system of rats. Their intake from our diet should also be maintained as low as possible.

Measures such as selection of raw materials with lower levels of GE and 3-MCPDE and reducing the amount of edible oil used in food production can reduce the level of GE and 3-MCPDE in food. The trade should make reference to the Codex's "[Code of Practices for the Reduction of 3-MCPDEs and GEs in Refined Oils and Food Products Made with Refined Oils](#)" and select the techniques that are appropriate to their processes and products.

Key Points to Note

1. Acrylamide, GE and 3-MCPDE are process contaminants formed unintentionally in some foods that are cooked at high temperatures.
2. The level of process contaminants should be kept as low as possible. Both consumers and the trade should make effort to reduce their levels in food.

Advice to the Public

- Do not cook food at high temperatures for too long. Cook by boiling or steaming can help reduce the formation of acrylamide. When handling prepackaged food, follow the manufacturer's cooking instructions to avoid overcooking.
- Reduce the consumption of refined fats and oils and related products (e.g. margarine) to reduce the exposure to GE and 3-MCPDE.
- Maintain a balanced and varied diet to minimise the risk from exposure to contaminants from a limited range of food items.

Advice to the Trade

- Effort should be made to reduce the level of process contaminants in food products as low as practically possible.
- Adopt appropriate measures with reference to the CFS' trade guidelines and relevant Code of Practices developed by the Codex.

硝酸鹽及亞硝酸鹽 – 該添加嗎？

Nitrate and Nitrite – To Add or Not to Add?

食物安全中心風險評估組
科學主任黃詩雯女士報告

Reported by Ms. Sosanna WONG, Scientific Officer,
Risk Assessment Section, Centre for Food Safety

有什麼比得上以豐富的早餐來開始新的一天？火腿三文治、腸仔包、午餐肉即食麵等，任君選擇。在我們的日常飲食中，加工肉類頗為常見，這些肉類經過鹽醃、醃製、發酵和煙燻等過程，有人喜歡其特有的醃製風味，但亦有人會對這些食品中使用了硝酸鹽及亞硝酸鹽表示擔心。現在讓我們了解一下，硝酸鹽及亞硝酸鹽如何應用於食品中及其安全性。

為什麼硝酸鹽及亞硝酸鹽存在於食物中？

硝酸鹽及亞硝酸鹽是氮循環所產生天然存在的物質，可在土壤、水及食物中找到。硝酸鹽是植物生長所需的必要營養素，容易轉化為亞硝酸鹽，反之亦然。硝酸鹽存在於大多數蔬菜中，其中綠葉蔬菜的硝酸鹽含量最高。硝酸鹽及亞硝酸鹽亦可天然存在於其他食物中，例如肉類，但含量較少。

人類使用硝酸鹽及亞硝酸鹽作為醃製肉類的防腐劑已有悠久歷史。亞硝酸鹽是食物防腐的有效成分，而硝酸鹽則在食物中細菌的還原作用下轉化為亞硝酸鹽，然後發揮防腐功能。在加工肉類中應用硝酸鹽及亞硝酸鹽主要是為了抑制細菌生長，特別是肉毒桿菌。這種細菌可在生的食物中找到，能夠產生神經毒素，即使含量很低也會危及生命。因此，硝酸鹽及亞硝酸鹽對於保持加工肉類的食用安全十分重要。目前，尚未有具成本效益的替代品。

硝酸鹽及亞硝酸鹽亦可增強加工肉類的色澤。亞硝酸鹽首先產生一氧化氮，與名為肌紅蛋白的肌肉色素發生反應。這種化合物經加熱後會轉化為穩定的色素，呈現特有的粉紅色。硝酸鹽及亞硝酸鹽還有助於形成特有的醃製風味，並防止在貯存期間因氧化而產生異味。

硝酸鹽及亞硝酸鹽可安全使用嗎？

硝酸鹽在化學上狀態穩定，但可在人體腸道內轉化為亞硝酸鹽，然後產生內源性硝化作用，形成N-亞硝基化合物，令人擔心可能對健康造成不良影響。

國際癌症研究機構已把加工肉類歸類為「令人類患癌」的食物。食用加工肉類會增加患癌的風險，有人或會將之歸咎於硝酸鹽及亞硝酸鹽。國際癌症研究機構對攝入硝酸鹽及亞硝酸鹽的致癌性進行了評估，把其歸類為「可能令人類患癌」的物質，這是因為考慮到硝酸鹽及亞硝酸鹽在若干條件下可能會產生一些N-亞硝基化合物，例如亞硝胺，可令實驗動物患上癌症。然而，食物中的硝酸鹽或亞硝酸鹽本身是否可令人類患癌，相關的證據並不完全充分或只屬有限。此外，還值得注意的是，其他因素也可能增加因食用加工肉類而患癌的風險。舉例來說，高溫烹調(包括以火燒烤加工肉類)可產生多環芳族碳氫化合物及雜環芳族胺等化學物，其中一些是已知或懷疑致癌物。到目前為止，當中的確實原理尚待完全了解。不過，加工肉類的鈉(鹽)及飽和脂肪含量通常偏高。消費者應避免進食過量加工肉類。

聯合國糧食及農業組織/世界衛生組織食品添加劑聯合專家委員會已評估硝酸鹽及亞硝酸鹽的安全性，並根據對健康沒有造成不良影響(例如引致正鐵血紅蛋白血症)的分量，分別訂定了健康參考值。歐洲食物安全局對使用亞硝酸鹽作為食物添加

What could be more satisfying than starting a day with a big breakfast? Ham sandwiches, hot dog buns, instant noodles with luncheon meat, you name it. Processed meat, which refers to meat that has undergone processes such as salting, curing, fermentation and smoking, is rather common in our daily meals, and some people might enjoy the distinctive cured flavour. However, some might have concerns over the use of nitrate and nitrite in these food products. Now, let us dip into how nitrate and nitrite are applied in foods and their safety.

Why are Nitrate and Nitrite Present in Food?

Nitrate and nitrite occur naturally as part of the nitrogen cycle and can be found in soil, water and food. Nitrate is an essential nutrient utilised by plants for growth, and is readily converted to nitrite and back. Nitrate is present in most vegetables, among which green leafy vegetables have the highest nitrate content. Nitrate and nitrite can also naturally exist in other foods like meat in smaller quantities.

Humans have a long history of using nitrate and nitrite as preservatives in curing meat. Nitrite is the active ingredient responsible for food preservation, whereas nitrate is converted to nitrite through bacterial reduction in food before exerting preservative functions. Nitrate and nitrite are applied in processed meat primarily to suppress the growth of bacteria, *Clostridium botulinum* in particular. The bacteria, which can be found in raw foods, is capable of producing a neurotoxin that is life-threatening even at very low levels. Therefore, nitrite and nitrate are important in keeping processed meat safe. Currently, no cost-effective alternatives are available.

Nitrate and nitrite can also enhance the colour of processed meat. Nitrite first forms nitric oxide that reacts with myoglobin, a muscle pigment. Upon heating, the compound is then converted into a stable pigment, contributing to the characteristic pink colour. Nitrate and nitrite also aid the development of the characteristic cured flavour and prevent the formation of off-flavours from oxidation during storage.

Are Nitrate and Nitrite Safe?

Nitrate is chemically stable, but it can be converted to nitrite in the human gut and can subsequently result in endogenous nitrosation, raising concerns over potential adverse health effects from the N-nitroso compounds formed.

Processed meat has been classified by the International Agency for Research on Cancer (IARC) as “[carcinogenic to humans](#)”. Some may blame nitrate and nitrite for the link between consumption of processed meat and increased cancer risks. The IARC has evaluated the carcinogenicity of ingested nitrate and nitrite, and classified them as “[probably carcinogenic to humans](#)” based on considerations that nitrate and nitrite

under certain conditions may result in the production of some N-nitroso compounds, such as nitrosamines, that can cause cancer in experimental animals. However, evidence with respect to whether nitrate or nitrite per se in food can cause cancer in humans is inadequate or limited. Furthermore, it is also worth noting that other factors may contribute to the link between consuming processed meat and increased cancer risks. For example, high-temperature cooking including cooking processed meat over a flame as in barbecuing and grilling can produce chemicals like polycyclic aromatic hydrocarbons and heterocyclic aromatic amines, some of which are known or suspected carcinogens. To date, the exact mechanisms underlying this link are not yet fully understood. Nevertheless, processed meat is often high in sodium (salt) and saturated fat. Consumers should avoid excessive consumption of processed meat.

The Joint Food and Agriculture Organization / World Health Organization Expert Committee on Food Additives has evaluated the safety of nitrate and nitrite,

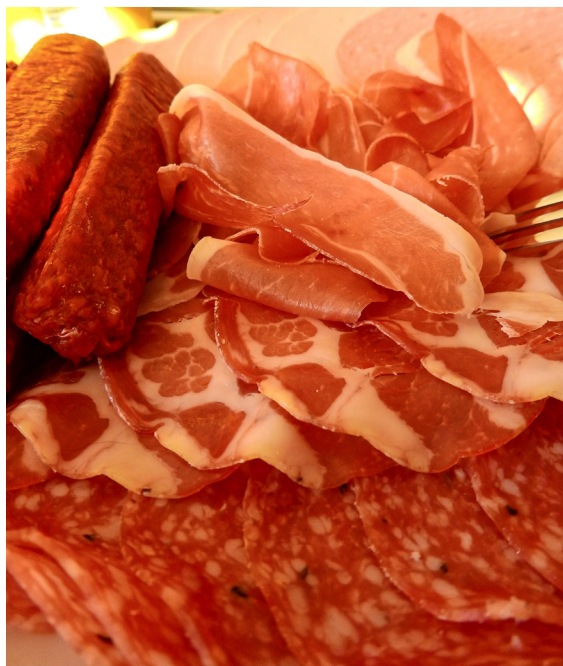


圖2：在加工肉類中使用硝酸鹽及亞硝酸鹽已有多年歷史
Figure 2: Nitrate and nitrite have been used in processed meat for many years

劑導致人體內形成亞硝胺進行了評估，得出結論認為，在食品中添加准許分量的亞硝酸鹽及硝酸鹽是安全的。

香港如何規管硝酸鹽及亞硝酸鹽

中國大陸、美國、歐洲聯盟成員國、加拿大、澳洲及新西蘭等多地都准許在食物中使用硝酸鹽及亞硝酸鹽。

在本港，使用硝酸鹽及亞硝酸鹽作為防腐劑受《食物內防腐劑規例》所規管。該規例訂明，只可在指明食物(包括醃製肉類)中使用指明分量的硝酸鹽及亞硝酸鹽。如果在預先包裝食品中使用了硝酸鹽或亞硝酸鹽，必須按照《食物及藥物(成分組合及標籤)規例》的規定，在配料表中加以標明。

and allocated health-based guidance values to them respectively based on levels that showed no adverse health effects such as methaemoglobinaemia. The European Food Safety Authority estimated the formation of nitrosamines inside the body following the use of nitrite as food additives, and concluded that nitrite and nitrate added to food are safe when using at permitted levels.

Regulatory Control of Nitrate and Nitrite in Hong Kong

Nitrate and nitrite are permitted for use in foods in many places such as Mainland China, the United States, the European Union, Canada, Australia and New Zealand.

In Hong Kong, the use of nitrate and nitrite as preservatives is regulated under the Preservatives in Food Regulation. Under the Regulation, nitrate and nitrite are only permitted within specified levels in specified foods including cured meat. If nitrate or nitrite is used in a prepackaged food, it must be labelled in the ingredient list in accordance with the requirements under the Food and Drugs (Composition and Labelling) Regulations.

食物中的麥角生物鹼 Ergot Alkaloids in Food

食物安全中心(食安中心)最近就本港穀類及穀類產品中的麥角生物鹼發表了研究報告。麥角生物鹼是真菌毒素，可在黑麥、高粱、珍珠粟/御穀、小麥、大麥等穀類農作物中找到。含有麥角生物鹼的麥角由穀類上的真菌形成，如果收割時穀物帶有麥角，便有可能污染穀物。與其他真菌毒素不同，麥角生物鹼只會在收割前形成，而且在貯存期間含量變化不大。

根據歷史記錄的記載，麥角生物鹼可導致血管收縮，情況嚴重時可引致劇痛，患者其後會因壞疽以致失去手指、手、腳，甚至四肢。這類中毒事件現今已少見，因為在篩選及磨穀過程中，大部分影響穀物的麥角已被清除。

食安中心的研究發現，79%的樣本沒有驗出麥角生物鹼，而樣本中驗出的麥角生物鹼平均含量大致低於二零一七年歐洲一項研究的水平。食安中心的研究顯示，本港市民無須擔心攝入麥角生物鹼的問題。

The Centre for Food Safety (CFS) had recently released the report of a study on ergot alkaloids (EAs) in cereal and cereal-containing products in Hong Kong. EAs are fungal toxins that can be found in cereal grains like rye, sorghum, pearl millet, wheat, barley, etc. The EA-containing ergots, which are formed by the fungi on the cereals, can contaminate the grains if the ergots are harvested together with the grains. Unlike other fungal toxins, EAs only form before harvest and the level remains relatively constant during storage.

EAs can cause blood-vessel constriction and in severe cases intense pain, and subsequent gangrene with loss of fingers, hands, feet and even entire limbs as reported in historic records. The conditions are now rare, as sorting and milling processes have removed most of the ergots that affect the grains.

The CFS study found that 79% of the samples were not detected with EAs, and the mean levels of EAs detected in samples were generally lower than those of a European study in 2017. The CFS study revealed that the exposure to EAs causes no concern to the local population.

減少廚餘以支持邁向碳中和

Reduce Food Waste to Help Move Towards Carbon Neutrality

減少廚餘對於減少溫室氣體排放和實現碳中和十分重要，但並非要與食物安全背道而馳。正確處理食物可以延長食物的保質期，避免變壞。人人都可以支持減少廚餘，同時加強食物安全。

為了避免食物變壞，減少廚餘，在購買前應檢查已有的食物，列出購物清單。採用「先入先出」的原則，先食用較早過期的食物。過了「最佳食用日期」的食物儘管品質並非最佳，但若按照生產商的指示保存，仍可安全食用。檢查雪櫃的溫度，確保在適當的溫度下貯存冷凍及冷藏食物。剩餘的食物應存放於清潔的密封容器內，並在烹製好後兩小時內放進雪櫃。

為了善用剩餘的食物資源，有團體為有需要人士推行食物回收計劃，食物安全中心為此編製了指引，以協助這些團體在回收食物時確保食物安全。

While minimising food waste is central to reducing greenhouse gas emissions and achieving carbon neutrality, it does not have to go against practising food safety. Proper handling of food can maximise its shelf-life and avoid spoilage, and everyone can help reduce food waste and at the same time enhance food safety.

To reduce food spoilage and waste, check what you already have and make a shopping list before purchase. Follow the "first-in-first-out" principle and consume food approaching its "use by" date first. Food after its "best before" date may still be safe to eat with some quality loss if kept in accordance with the manufacturer's instructions. To store refrigerated food and frozen food at a proper temperature, the fridge temperature should be checked. Leftovers should be kept in clean and airtight containers, and refrigerated within two hours of finishing preparation.

To make better use of surplus food resources for organisations that conduct food recovery programmes, the Centre for Food Safety has issued a set of guidelines to assist these organisations in ensuring food safety while recovering food for the people in need.



風險傳達工作一覽 (二零二一年十一月)

Summary of Risk Communication Work (November 2021)

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