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食物中的金屬污染物(第II部分) — 甲基汞

Metallic Contaminants in Food Part II – Methylmercury

食物安全中心風險傳達組
科學主任游天頌先生報告

Reported by Arthur YAU, Scientific Officer,
Risk Communication Section, Centre for Food Safety

本欄上一期已討論了鉛與鎘，本文將會探討食物中的甲基汞，其對健康的影響，尤其是如何安全食用魚類。

After covering lead and cadmium in the last issue, we will look at methylmercury in food, its health implications and especially how to be safe when consuming fish.

汞(水銀)是什麼?

汞(水銀)是一種天然存在的金屬元素，可通過自然現象(例如火山活動、岩石風化等)和人類活動(例如燃煤、工業生產活動、垃圾焚化、採礦等)而逐漸散布在環境中。金屬汞(水銀)可與環境中的其他化學元素如氯、硫磺等結合，形成無機汞化合物。細菌也可以將汞轉化為無機形態的甲基汞，繼而在魚類及貝類這些生物體內積聚，令這些食物成為人體攝入甲基汞的主要來源。此外，甲基汞也可沿食物鏈向上而增加。例如，相對於體型較小、進食浮游生物的魚類，體型較大、活得較久並進食小魚的魚類甲基汞含量會較高。

What is Mercury?

Mercury is a metallic element that occurs naturally. Through natural processes (e.g. volcanic activities, rock weathering) and human activities (e.g. coal burning, industrial processes, waste incineration, mining), it can gradually spread across the environment. Metallic mercury can combine with other chemical elements like chlorine, sulphur, etc. in the environment to form inorganic mercury compounds. Bacteria can also convert mercury to its organic form methylmercury. Methylmercury can then bioaccumulate in fish and shellfish, which makes these foods a main source of human exposure. Additionally, methylmercury can also move up the food chain. For example, larger, older fish that eat smaller fish have higher methylmercury levels than smaller fish that eat planktons.

甲基汞為何引起關注?

甲基汞影響中樞及周邊神經系統和腦部發育。若孕婦在懷孕前或懷孕期間進食甲基汞含量

Why is Methylmercury a Concern?

Methylmercury affects the central and peripheral nervous systems and brain development. The intake of large predatory fish that contain high amounts of methylmercury by pregnant women before or during pregnancy can expose fetuses to methylmercury while they are still in the womb.

甲基汞含量相對較低的魚類例子 Examples of fish that are of relatively lower levels of methylmercury



甲基汞含量相對較高的魚類例子 Examples of Fish that are of relatively higher levels of methylmercury

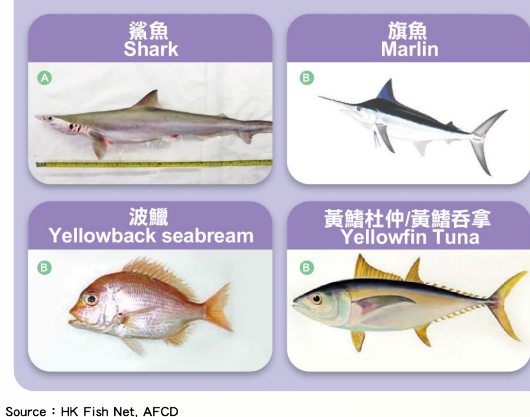


圖1: 甲基汞含量相對較低的魚類(左)與甲基汞含量相對較高的魚類(右)的例子(相片來源: 漁農自然護理署(漁護署))
Figure 1: Examples of fish that are of relatively lower levels of methylmercury (left) and fish that are of relatively higher levels of methylmercury (right) (Photo source: Agriculture, Fisheries and Conservation Department (AFCD))

較高的大型捕攝性魚類，仍在腹中的胎兒便會攝入甲基汞。此問題值得重視，因為甲基汞會通過胎盤從母體有效地轉移至胎兒。進食後的吸收率由金屬汞的近乎完全沒有、無機汞的10%至30%至甲基汞的95%左右不等。

兒童的認知思維能力、記憶力、專注力、語言能力、精細運動能力和視覺空間能力或會受攝入甲基汞的影響。世界衛生組織（世衛）建議某些特定羣體，特別是正值生育年齡的婦女及幼兒限制甲基汞含量高魚類的進食量。

吃魚有益健康

進食魚類是均衡飲食的一部分，對健康有莫大益處。魚類含豐富蛋白質、人體必需的奧米加-3脂肪酸及多種維他命和礦物質。更重要的是，魚類含有DHA（二十二碳六烯酸）及EPA（二十碳五烯酸），有助預防冠心病，並對胎兒腦部發育至關重要。婦女和幼兒的膳食尤其應該加入魚類。

孕婦和正值生育年齡婦女有甲基汞的安全攝入量嗎？

世衛轄下的糧食及農業組織 / 世界衛生組織聯合食物添加劑專家委員會（專家委員會）已在2007年根據發育中的神經毒性訂定安全攝入量，即暫定每周可容忍攝入量為每公斤體重 1.6 微克，以保障發育中的胎兒。對於生育年齡婦女外的其他成年人，其攝入最多高於每周可容忍攝入量兩倍，仍不會構成神經毒性的風險。如果女性經常食用甲基汞含量高的魚類，甲基汞會在其體內逐漸積聚。儘管甲基汞大致可經糞便自然排出體外，成人體內的甲基汞水平要降低一半，一般需時45至70天。因此，婦女在懷孕前身體內可能已含有甲基汞。正因如此，計劃懷孕的婦女應該關注食物中的汞。

作出精明選擇，獲得吃魚益處又避免風險

一般而言，體型較小 [即（1斤（約605克）以下）] 的魚類、養殖魚和淡水魚的甲基汞含量較低。食物安全中心（食安中心）進行的總膳食研究顯示，大頭魚、鯧魚（鯇魚）、絞鯪魚肉、三文魚、烏頭、龍脷柳和鮫魚的甲基汞含量相對較低。不過，由於甲基汞會在生物體內積聚，體型較大（大多壽命較長）的魚類，以及劍魚和鯊魚等捕獵性魚類所積聚的甲基汞會較多。市民應進食多種甲基汞含量較低的魚類。每星期進食一至二份（一份等於150克）魚類作為均衡飲食的一部分，能為健康帶來益處，同時也要限制甲基汞含量高魚類的進食量。此外，罐頭吞拿魚的甲基汞含量通常低於新鮮吞拿魚，主要因為魚類的品種不同，或用於罐頭的吞拿魚體型較小 [如鯉魚（skipjack tuna）]。每周不應進食多於5罐（每罐約140克）鯉魚罐頭，而長鰭吞拿魚（albacore tuna）罐頭則不應多於每周3罐。在本港，產後或授乳婦女經常會飲用魚湯。食安中心曾經就飲用魚湯的風險和益處進行評估，研究結果顯示，飲用魚湯是安全的。雖然如此，還應避免進食體型較大的捕獵性魚類，包括飲用這些魚烹調的魚湯。

This is a significant issue since methylmercury is effectively transferred from the mother to the foetus through the placenta. The rate of absorption through ingestion varies from almost none for metallic mercury, 10 to 30% for inorganic mercury and around 95% for methylmercury.

The cognitive thinking, memory, attention, language and fine motor and visual spatial skills of children may be affected by exposure to methylmercury. Certain groups, particularly women of childbearing age and small children, are recommended by the World Health Organization (WHO) to limit their intake of fish that are known to have high amounts of methylmercury.

Eating Fish is Beneficial to Health

Eating fish as part of a balanced diet offers significant health benefits. Fish is an excellent source of protein, essential omega-3 fatty acids, and various vitamins and minerals. More importantly, fish contains docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), which can reduce the risk of coronary heart disease and are vital for foetal brain development. Women and young children in particular should include fish in their diets.

Is there a Safe Level for Methylmercury in Pregnant Women or Women of Childbearing Age?

The WHO's Joint FAO/WHO Expert Committee on Food Additives (JECFA) has established a safety reference value (Provisional Tolerable Weekly Intake, PTWI) of 1.6 micrograms per kilogram of body weight per week in 2007 based on developmental neurotoxicity in order to safeguard the developing foetus. For adults other than women of childbearing age, methylmercury intake of up to two times higher than the PTWI would not pose any risk of neurotoxicity. If a woman regularly consumes fish that contain high amounts of methylmercury, it can accumulate in her body gradually. While mercury can be excreted from the body naturally mainly through faeces, it usually takes 45 to 70 days for the methylmercury levels to reduce to half in adults. Consequently, it may be present in a woman even before she becomes pregnant. Therefore, women planning for pregnancy should also be aware of mercury in food.

Choose Wisely to Reap the Benefits of Fish Consumption and to Reduce the Risk

In general, smaller fish [i.e. less than one catty (about 605 g)], farmed fish and freshwater fish have lower levels of mercury. According to the results of the Total Diet Study conducted by the Centre for Food Safety (CFS), bighead carp, pomfret, dace (minced), salmon, grey mullet, sole fillet and grass carp were found to contain relatively low levels of methylmercury. However, larger fish (often with longer lifespans), as well as predatory species like swordfish and shark, tend to have higher methylmercury concentrations due to bioaccumulation. Consume a variety of fish that are lower in methylmercury. Eat one to two servings of fish per week (1 serving = 150g) within a balanced diet to reap the health benefits, and limits the consumption of fish that contain high amounts of methylmercury at the same time. Furthermore, methylmercury levels in canned tuna are lower than in fresh tuna mainly because different species or smaller tuna (e.g. skipjack tuna) are used. It is recommended to consume no more than 5 cans (about 140g/can) of skipjack tuna a week, while the limit for albacore tuna should be no more than 3 cans per week. It is common for women in Hong Kong to consume fish soup after childbirth or when lactating. A study on the risks and benefits of fish soup consumption conducted by the CFS suggested that it is safe to drink fish soup. Nevertheless, eating large predatory fish, including drinking soup prepared with those predatory fish, should be avoided.

非營養性甜味劑的增甜之旅

The Sweet Journey of Non-nutritive Sweeteners

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

我們對甜味都有一種與生俱來的渴望，這種偏好跨越了年齡和文化。從歷史上看，我們的祖先依靠存在於水果、蜜糖和其他植物中的天然糖的甜味得到能量及重要營養素。由於我們的飲食現況已改變，部分人轉為食用低熱量或不含熱量甜味劑（即非營養性甜味劑）作為糖的代產品，以期減少熱量攝取量或控制血糖水平。讓我們在本文中一嘗部分非營養性甜味劑的甜味。

非營養性甜味劑的興起

糖精是世界上第一種人造甜味劑，是在十九世紀偶然發現的。糖精的甜度比蔗糖（砂糖）高約200至700倍。糖精不含熱量，它為希望滿足對甜食的喜愛而不想有糖帶來的熱量負擔的人士提供了代替品。糖精迅速大受歡迎，特別是在第一次和第二次世界大戰糖供應短缺的時候。然而，糖精以其苦澀的餘味而聞名，這限制了其在食物中的應用。

繼糖精面世後，另一種不含熱量甜味劑環己基氨基磺酸在1937年被發現。環己基氨基磺酸的甜度比蔗糖高約30倍。雖然環己基氨基磺酸的甜度不及糖精，但卻能與糖精配搭得宜。環己基氨基磺酸與糖精混和後，可中和糖精帶來的相關苦澀餘味，使該混合物比兩者各自單獨使用更可口。

天冬酰胺是另一種經典甜味劑，於1965年發現。天冬酰胺由兩個氨基酸—天冬氨酸和苯丙氨酸—組成，每克含4千卡的熱量，與蔗糖相同。不過，由於天冬酰胺的甜度比蔗糖高約200倍，只需在食物內加入少量便可代替砂糖達到預期的甜度，因此實際上是非營養性甜味劑。天冬酰胺的缺點之一是不耐熱，加熱後會失去甜度，因而在烘培食品中的使用受到限制。此外，天冬酰胺會對苯丙酮酸尿症患者造成風險。苯丙酮酸尿症是一種遺傳病，由於患者體內不能正常分解苯丙氨酸氨基酸，以致在體內積聚，達到可能影響健康的水平，並會令腦部嚴重受損。因此，有關人士應細閱配料表，查看是否有天冬酰胺並避免攝入。

最新發明：愛得萬甜

天冬酰胺面世後，食物業紛紛要求研製第二代具有較佳特性（包括耐熱度較高和甜度較高）的“以氨基酸為原料的”甜味劑。1980年代研製出的紐甜和2008年研製出的愛得萬甜是兩種不含熱量的天冬酰胺類似物。

紐甜由天冬酰胺衍生，甜度比蔗糖高約7,000至13,000倍。紐甜耐熱，因此適用於烘培食品。

愛得萬甜是天冬酰胺的衍生物，以天冬酰胺和香蘭素（一種香草豆莢的提取物）生產，但一般來說比天冬酰胺耐熱。愛得萬甜已通過聯合國糧食及農業組織/世界衛生組織聯合食品添加劑聯合專家委員會（專家委員會）的安全評估，是最新列入《食物添加劑通用標準》內的非營養性甜味劑。

雖然紐甜和愛得萬甜是天冬酰胺的衍生物，但專家委員會得出結論，認為正常使用紐甜和愛得萬甜而產生的苯丙氨酸不會對苯丙酮酸尿症患者造成明顯影響。

愛得萬甜小檔案

食物添加劑國際編碼系統編號：969

技術用途：甜味劑、增味劑

甜味強度：比砂糖甜大約20,000倍

能量值：0千卡

專家委員會訂定的每日可攝入量：每日每公斤體重0-5毫克

應用：糖果、甜品、不含酒精飲品

The Rise of Non-nutritive Sweeteners

Saccharin is recognised as the world's first artificial sweetener, accidentally discovered in the late 19th century. Saccharin is approximately 200 to 700 times sweeter than sucrose (table sugar). Containing no calories, it provided an alternative to those looking to satisfy their sweet tooth without the caloric baggage of sugar. Saccharin quickly gained popularity, especially during World War I and II when sugar was in short supply. However, saccharin is known for its bitter aftertaste, which limits its applications in food.

Following the introduction of saccharin, cyclamate was discovered in 1937 as another no-calorie sweetener. Cyclamate is about 30 times sweeter than sucrose. Whilst it is not as sweet as saccharin, cyclamate complements saccharin well. When blended with saccharin, cyclamate can help to mitigate the bitter aftertaste associated with saccharin, making the combination more palatable than either one alone.

Aspartame is another classic sweetener. It was discovered in 1965. Composed of two amino acids — aspartic acid and phenylalanine, aspartame has a caloric value of 4 kcal/g, which equals that of sucrose. However, since aspartame is approximately 200 times sweeter than sucrose, adding only a small amount to food can replace sugar to give the desired sweetness, rendering it practically a non-nutritive sweetener. One of the drawbacks of aspartame is that it is not heat stable and loses its sweetness when heated, limiting its use in baked goods. Additionally, aspartame poses specific risks to individuals with phenylketonuria (PKU), an inherited disease that prevents proper metabolism of the amino acid phenylalanine, leading to accumulation of potentially harmful levels of phenylalanine and serious brain damage. Therefore, individuals concerned are advised to check the ingredient list to identify the presence of aspartame and avoid it.

The Latest Invention: Advantame

After the creation of aspartame, there were calls for developing second generation 'amino-acid-based' sweeteners with more desirable characteristics, including higher heat stability and higher sweetness potency. Neotame developed in the 1980s and advantame developed in 2008 are two such aspartame analogues but with no calorie value.

Neotame is derived from aspartame that is approximately 7,000 to 13,000 times sweeter than sucrose. Neotame is heat stable, making it suitable for use in baked goods.

Advantame is a derivative of aspartame made from aspartame and vanillin (an extract of the vanilla bean) but is generally more heat stable than aspartame. Advantame has undergone safety evaluation by the Joint FAO/WHO Expert Committee on Food Additives (JECFA), and it is the most recent non-nutritive sweetener included in the Codex General Standard for Food Additives.

Profile of Advantame

International Numbering System (INS) number: 969

Technological functions: Sweetener, flavour enhancer

Sweetness intensity: Approximately 20,000 times sweeter than table sugar

Energy value: 0 kcal/g

Acceptable Daily Intake (ADI) established by JECFA: 0-5 mg/kg body weight per day

Applications in food: Confectioneries, desserts, non-alcoholic drinks

其他非營養性甜味劑

此外，非營養性甜味劑也包括醋磺內酯鉀、縮二氨酸基胺、

Despite being derivatives of aspartame, JECFA concluded that the formation of phenylalanine from the normal use of neotame and advantame would not be significant to individuals with PKU.

Other Non-nutritive Sweeteners

Besides, non-nutritive sweeteners also encompass acesulfame potassium, alitame, aspartame-acesulfame salt and sucralose, along with certain plant-derived options such as steviol glycosides and thaumatin. All these sweeteners have been evaluated by JECFA and are determined safe for food use.

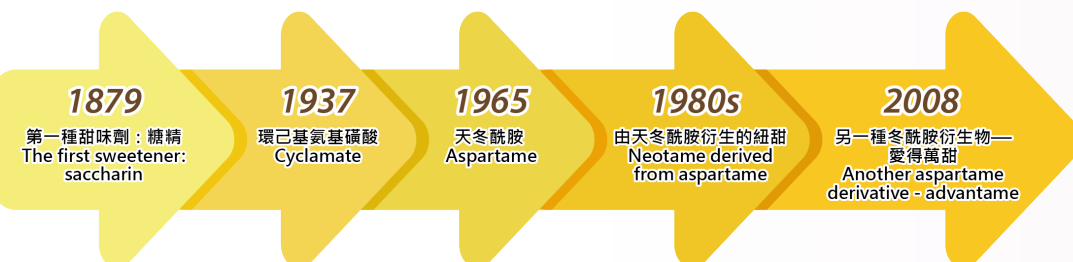


圖2：部分非營養性甜味劑多年來的歷史（不按比例）

Figure 2: The history of some non-nutritive sweeteners over the years (not to scale)

天冬酰胺—醋磺內酯鹽和三氯半乳糖，以及部分植物提煉的選擇如甜菊醇糖苷及索馬甜。這些甜味劑均已經過專家委員會評估，評定為可在食物中安全使用。

非營養性甜味劑有助控制體重嗎？

儘管非營養性甜味劑有其好處，並且其安全使用有著悠久的歷史，但對於健康及體重控制的影響仍然存在爭論。世界衛生組織（世衛）就非糖甜味劑的使用發布的最新指引建議，不要使用非糖甜味劑作為控制體重或減低非傳染病風險的方法。這點正凸顯了全面審視飲食習慣和生活習慣的重要性。

減低甜度較為平衡的做法，是選擇含有較少或沒有添加糖或甜味劑的食物和飲品。消費者應仔細參閱食物標籤，以作出符合健康目標而又有依據的選擇。

下期我們將繼續甜味之旅，認識營養性甜味劑—多元醇。

Do Non-nutritive Sweeteners Help to Control Body Weight?

Despite the appeal of non-nutritive sweeteners and the long history of their safe use, there are ongoing debates about their impact on health and weight management. The latest World Health Organization (WHO) guideline on the use of non-sugar sweeteners recommends that non-sugar sweeteners not be used as a means of achieving weight control or reducing the risk of non-communicable diseases. This highlights the importance of considering the broader context of dietary habits and lifestyle choices.

A more balanced approach to reducing sweetness involves choosing foods and beverages with less or no added sugars or sweeteners. Consumers are encouraged to scrutinize food labels to make informed choices that align with their health goals.

In the next article, we will continue our sweet journey with nutritive sweeteners – polyols.

學校膳食與食物安全 School Meals and Food Safety

九月發生了一宗與進食學校食堂提供的牛肉千層麵有關的懷疑食物中毒事故。有關學校食堂的廚房需要暫停運作，以進行徹底清潔和消毒。經調查後，長時間存放大量備餐，以及衛生情況欠佳引發食物安全疑慮。

大量配製食物時，由於難以監察和確保食物的各部分均已徹底煮熟並冷卻至正確貯存溫度，因此應格外謹慎。煮熟的食物若貯存溫度不正確，能導致產氣莢膜梭狀芽孢桿菌和蠟樣芽孢桿菌等能產生孢子的細菌萌發孢子。食物貯存不當，也可能引致細菌繁殖。

要減低食物中毒的風險，學校食堂和業界應確保有充足設施（包括煮食電器和雪櫃）以供食物配製、貯存、冷卻及分發之用。食物處理人員應保持良好個人衛生，並制定有效的廚房清潔程序。市民應在餐點送達後盡快進食。

In September, there was a suspected case of food poisoning related to the consumption of beef lasagna prepared by a school canteen. The kitchen operation of the school canteen was suspended for thorough cleaning and disinfection. Upon investigation, prolonged storage of a large number of dishes and unhygienic conditions raised food safety concerns.

One should exercise caution in large scale food preparations as it is difficult to monitor and ensure all parts of food are thoroughly cooked and cooled to proper holding temperatures. Storing cooked food at improper holding temperatures can result in spore germination from spore forming bacteria such as *Clostridium perfringens* and *Bacillus cereus*. Improper food storage can also lead to bacterial proliferation.

To minimise the risk of food poisoning, school canteens and the trade should ensure there are adequate facilities including cooking appliances and refrigerators for food preparation, storage, cooling and distribution. Food handlers should observe good personal hygiene and establish effective cleaning procedures for kitchens. The public should consume meals served as soon as possible.

肉類和家禽食品中的李斯特菌 *Listeria monocytogenes* in Meat and Poultry Products

最近有新聞報導，美國回收約一千萬磅可能受李斯特菌污染的就食肉類和家禽產品。在監管當局進行的日常食品測試中有樣本被驗出對李斯特菌呈陽性反應。回收的食品包括預先包裝的三文治、沙律和麵食製品。

李斯特菌是散布於不同環境和食物中的病原體。保質期較長的冷凍即食食物如即食肉類或家禽風險較高，如果給予足夠的時間，李斯特菌可在這些受污染的食物中於冷凍溫度下大量繁殖。烹煮可殺死這些細菌。感染李斯特菌可令人患上李斯特菌病，症狀包括發燒、嘔吐及腹瀉。孕婦感染此病可引致流產及死胎。長者和免疫能力較弱的人士有可能出現嚴重感染或致命個案。

市民應檢查食品的包裝是否完好。冷凍食物應在徹底煮熟或翻熱後才進食。業界應在食物生產過程中保持良好衛生規範，正確處理食物。

Recent news reported that about 10 million pounds of ready-to-eat (RTE) meat and poultry products were recalled in the United States due to possible *Listeria monocytogenes* contamination. Samples were found positive for *Listeria monocytogenes* in routine product testings by the regulatory authority. The products recalled include prepackaged sandwiches, salads and pastas.

Listeria monocytogenes is a pathogen widely dispersed in the environment and food. RTE foods with long shelf lives under refrigeration such as RTE meat or poultry are of higher risk since *Listeria monocytogenes* may proliferate after contamination of these RTE foods to significant numbers at refrigeration temperatures when given sufficient time. The bacteria can be killed by cooking. *Listeria monocytogenes* infection can cause listeriosis with symptoms like fever, vomiting and diarrhoea. In pregnant women, the infection can result in miscarriages and stillbirths. Serious or fatal infections can occur in the elderly and individuals with weakened immune systems.

The public should check if food packages are intact. Chilled food should be cooked or reheated thoroughly before consumption. The trade should maintain good hygienic and food handling practices along food manufacturing processes.



風險傳達工作一覽（二零二四年十月）

Summary of Risk Communication Work (October 2024)

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給消費者的食物警報 Food Alerts to Consumers: 2	懷疑食物中毒個案通報 Suspected Food Poisoning Alerts: 1	教育研討會/ 演講/ 講座/ 輔導 Educational Seminars/ Lectures/ Talks/ Counselling: 31	上載到食物安全中心網頁的新訊息 New Messages Put on the CFS Website: 53	