# 食物安全焦點
# Food Safety Focus

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Centre for Food Safety

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## 編輯委員會 EDITORIAL BOARD



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*Incident in Focus*

# 馬鈴薯中的有毒配糖生物鹼
# Toxic Glycoalkaloids in Potatoes


食物安全中心
風險評估組
科學主任朱源强先生報告

*Reported by Mr. Johnny CHU, Scientific Officer,*
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二零一五年九月，食物安全中心(中心)接獲一宗食物中毒個案，涉及來自同一家庭的兩名患者。他們在二零一五年九月十七日晚食用了煮好的馬鈴薯後隨即舌頭麻痺，而且口腔感到灼熱。兩人求醫後情況穩定，無須送院診治，症狀其後亦逐漸減退。調查人員在患者家人提供的生馬鈴薯和其中一名患者的尿液樣本中檢出茄鹼，調查結果與茄鹼中毒的情況吻合。馬鈴薯含有配糖生物鹼(又稱糖苷生物鹼或苷生物鹼)，若攝入過量配糖生物鹼可引致腸胃和身體不適。雖然本港市民因攝入過量配糖生物鹼而對健康造成嚴重影響的機會很微，但亦偶有市民因進食配糖生物鹼含量偏高的馬鈴薯而出現短暫不適的報告。

## 馬鈴薯中的配糖生物鹼

馬鈴薯植株會自然產生多種配糖生物鹼，其中最主要是α-茄鹼與α-卡茄鹼，佔馬鈴薯中總配糖生物鹼含量的95%。

配糖生物鹼遍布馬鈴薯植株的各個部分，其中以花和芽的含量最高，塊莖的含量最低。據文獻記載，商業品種的馬鈴薯塊莖的總配糖生物鹼含量由每公斤10至150毫克不等(見圖1)。

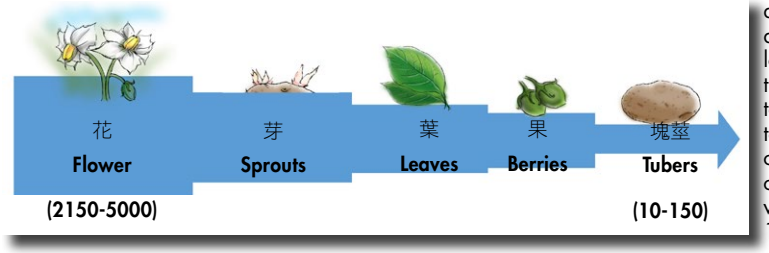


圖1. 馬鈴薯植株各部分由高至低的配糖生物鹼含量(毫克／公斤，非按比例繪製)
Figure 1. Glycoalkaloid contents in different parts of a potato plant, in order from highest to lowest concentration (mg/kg, not drawn to scale)

雖然整個馬鈴薯塊莖都含有配糖生物鹼，但以芽、皮和芽眼周圍的含量最高(見圖2)。在正常的塊莖，配糖生物鹼主要集中在薯皮下只有1.5毫米薄的一層(外皮含有30至80%的配糖生物鹼)。中心於二零零七年的研究中檢測了本港市面上有售的五種馬鈴薯，發現其配糖生物鹼含量(α-茄鹼和α-卡茄鹼的總和)以新鮮重量計每公斤由26至88毫克不等，其中薯肉的配糖生物鹼含量低於每公斤10毫克，而薯皮則為每公斤90至400毫克不等。由此可見，只要削去外皮便可大大減少馬鈴薯的配糖生物鹼含量。

## 配糖生物鹼含量在貯存期間增加

馬鈴薯塊莖在店鋪架上或家中如長時間受到光照，表層會分別出現兩種互不關連的反應：表皮變綠和產生配糖生物鹼。表皮呈綠色的現象稱為“綠變”，表示塊莖正產生葉綠素。由於葉綠素和配糖生物鹼同時在表皮產生，因此表皮變

In September 2015, the Centre for Food Safety (CFS) was notified of a food poisoning case involving two persons from the same household. They developed tongue numbness and a burning sensation in their mouths immediately after eating cooked potatoes prepared at home on the evening of 17 September 2015. Both sought medical treatment but did not require hospitalisation. They were in stable condition and their symptoms gradually resolved. Solanine was detected in the raw potato sample provided by the household and in a urine sample of one of the victims. The findings were compatible with solanine poisoning. Potatoes are known to contain glycoalkaloids which may induce gastrointestinal and systemic effects if consumed in high amounts. Local consumers are seldomly exposed to levels of glycoalkaloids that cause serious health effects. However, there have been in the past occasional reports of short-term adverse symptoms, usually from eating potatoes that contain elevated amount of glycoalkaloids.

## Glycoalkaloids in Potatoes

Glycoalkaloids are naturally produced in potatoes (*Solanum tuberosum*) and the main glycoalkaloids are alpha-solanine and alpha-chaconine which together account for 95% of the total glycoalkaloid content.

Glycoalkaloids occur in all parts of a potato plant. The highest glycoalkaloid levels are found in flowers and sprouts while the lowest is in potato tubers. According to literature, the total glycoalkaloid content of commercial cultivars of tubers may vary between 10 and 150 mg/kg fresh weight (Figure 1).

Glycoalkaloids are found throughout the potato tubers, but concentrate in the sprouts, peel and the area around the potato 'eyes' (Figure 2). In normal tubers, glycoalkaloids are concentrated in a small 1.5 mm layer immediately under the skin (i.e. 30 to 80% of the glycoalkaloids are found in the outer peel). According to a study conducted by the CFS in 2007, the glycoalkaloid content (alpha-solanine and alpha-chaconine) of five cultivars of tubers available in the Hong Kong market ranged from 26 to 88 mg/kg fresh weight. While glycoalkaloids were below 10 mg/kg in the flesh of these potatoes, glycoalkaloids in the peel varied between 90 and 400 mg/kg. Hence, with normal tubers, peeling of potatoes will greatly reduce the levels of glycoalkaloids present.

## Increase of Glycoalkaloids During Storage

Prolonged exposure of potato tubers to light on the store shelf or at home will stimulate the occurrence of two independent reactions near the surface of the potato tuber: the formation of green colour and glycoalkaloids. The appearance of green colour is called "greening" and it indicates the formation of chlorophyll. Since the formation of chlorophyll and glycoalkaloids occurs side by side, "greening" is considered to be an indication for an increase in the level of glycoalkaloids.


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綠亦代表了配糖生物鹼的含量有所增加。

此外，塊莖受損後亦會大量合成配糖生物鹼，因此，店鋪架上有損傷的馬鈴薯一般含較多配糖生物鹼。

## 對健康的影響

攝入過量的配糖生物鹼對人體有害。急性症狀一般於食用後30分鐘至12小時內出現，包括噁心、嘔吐、胃痙攣、腹痛和腹瀉；嚴重者更會出現多項神經系統病徵(包括嗜睡、煩躁、顫抖、神志不清、乏力和視力模糊)。不過，我們因食用含過量配糖生物鹼的馬鈴薯而致命的可能性不大，因為馬鈴薯的配糖生物鹼含量如超過每公斤200毫克，味道會變苦，而且會令喉嚨和口腔有灼熱感(見圖3)。

## 規管情況

食品法典委員會未有就食物中的配糖生物鹼設立食物安全標準，但普遍以每公斤新鮮馬鈴薯含200毫克配糖生物鹼為安全上限。本港法例對食物中的配糖生物鹼並無明文規定，不過，所有在香港出售的食物必須適宜供人食用。

## 中心採取的行動

中心在接報該食物中毒個案後，已指示有關零售商把問題馬鈴薯下架。

## 預防措施

雖然商業品種的馬鈴薯所含的配糖生物鹼分量不高，不大可能影響健康，但如貯存不當(如受光照)或塊莖受損，馬鈴薯中的配糖生物鹼會快速增加。配糖生物鹼十分耐熱，在高達230°C至280°C的溫度下才會開始分解，焗、煮、煎炸及微波煮食等烹煮過程均不能大幅減少其含量。因此，市民應把馬鈴薯存放在陰涼乾爽的地方。此外，為了減少馬鈴薯中的配糖生物鹼，煮食前應削去外皮，以及有損傷、腐爛、發綠和發芽的地方。如情況嚴重，應把整個馬鈴薯丟棄不用。

### 注意要點：

1. 馬鈴薯天然含有配糖生物鹼，攝入過量配糖生物鹼對人體有害。
2. 配糖生物鹼集中在薯皮部分。馬鈴薯長期受光照刺激，會在塊莖表層產生配糖生物鹼。
3. 煮或煎炸都不能消除配糖生物鹼。

## 給業界的建議

- 把馬鈴薯塊莖陳列在光照度較低的位置，晚間把馬鈴薯上方的照明關掉，或用棕色厚紙袋把馬鈴薯蓋好。
- 保持馬鈴薯乾爽。

## 給市民的建議

- 有需要時才購買，以避免長時間貯存。
- 把馬鈴薯存放在陰涼乾爽的地方。
- 烹煮前先削皮可減少馬鈴薯的配糖生物鹼含量。
- 煮食前先削去有損傷(切口和瘀痕)、腐爛、發綠、發芽的地方。如情況嚴重，應把整個馬鈴薯丟棄不用。
- 切勿食用有苦味或令口腔有灼熱感的馬鈴薯。

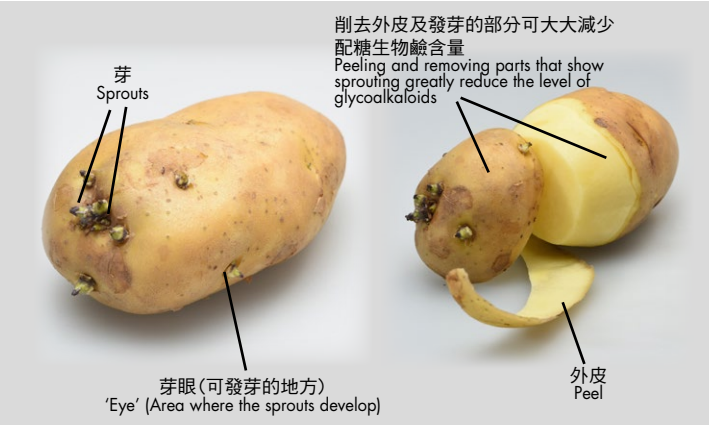


圖2. 塊莖中配糖生物鹼含量最高的部分
Figure 2. Parts of a tuber with the greatest concentrations of glycoalkaloids

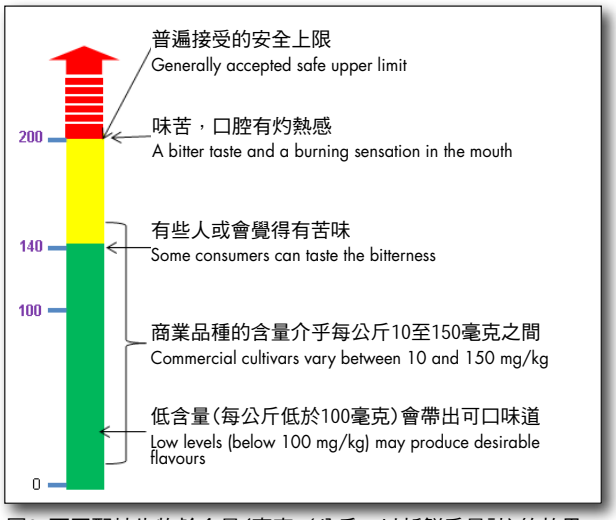


圖3. 不同配糖生物鹼含量(毫克／公斤，以新鮮重量計)的效果
Figure 3. Effects of different concentrations (mg/kg fresh weight) of glycoalkaloids

Damage to tubers also causes increased synthesis of glycoalkaloids; hence, damaged potatoes on the store shelf generally contain elevated levels of glycoalkaloids.

## Public Health Significance

High levels of glycoalkaloid are toxic to humans. Acute symptoms, which generally occur 30 minutes to 12 hours after ingestion, include nausea, vomiting, stomach and abdominal cramps, and diarrhoea. More severe cases of glycoalkaloid poisoning may be accompanied by a variety of neurological effects (i.e. drowsiness, restlessness, shaking, confusion, weakness, and disturbed vision). However, it is unlikely that humans would eat potatoes containing high, fatal glycoalkaloid doses because glycoalkaloid concentrations above 200 mg/kg are associated with a bitter taste and a burning sensation in the throat and mouth (Figure 3).

## Regulatory Control

Codex has not established any food safety standard for glycoalkaloid levels in food; however, the generally accepted safe upper limit is considered to be 200 mg glycoalkaloids per kg of fresh potato. There is no specific regulation on glycoalkaloids in food stipulated in the laws of Hong Kong. Nevertheless, all foods for sale in Hong Kong must be fit for human consumption.

## Actions Taken

Upon the notification of the food poisoning case, the retailer was instructed to withdraw the potatoes concerned off the shelves.

## Preventive Measures

While levels of glycoalkaloids in commercial potato varieties are unlikely to cause adverse health effects, improper storage (e.g. exposure to light) or damage to the tubers can lead to rapid production of glycoalkaloids. The increased glycoalkaloid content cannot be significantly reduced by cooking (i.e. baking, boiling, frying, and microwaving) because glycoalkaloids are heat stable and only begin to break down between 230°C and 280°C. Hence, the public is advised to store potatoes properly (i.e. in a cool, dry, dark place). To reduce the amount of glycoalkaloids in potatoes, the public is also advised to peel the skin and to remove the parts of the tuber that show damage, rotting, green colouring and sprouting before cooking. In more severe cases, discard the entire potato.

### Key Points to Note:

1. Glycoalkaloids occur naturally in potatoes and are toxic to humans at high levels.
2. Glycoalkaloids are concentrated in the peel and prolonged exposure of tubers to light will stimulate the formation of glycoalkaloids near the surface of the potato tuber.
3. Glycoalkaloids are not broken down by cooking or frying.

## Advice to the Trade

- Display potato tubers in areas with low light intensity. Shut lights off at night over the potatoes, or cover the potatoes with brown paper sacks.
- Keep potatoes cool and dry.

## Advice to the Public

- Buy on an "as needed" basis to avoid the need for long-term storage.
- Store potatoes in a cool, dry, dark place.
- Peel the potatoes before cooking can reduce the amount of glycoalkaloids.
- Cut away any parts that show damage (cuts and bruises), rotting, green colouring and sprouting before cooking. In severe cases, discard the entire potato.
- Do not eat potatoes that taste bitter or cause a burning sensation in the mouth.

食物安全平台
Food Safety Platform

# 油脂中的致癌化學物
# Cancer-causing Chemicals in Fats and Oils

食物安全中心
風險評估組
莊富傑獸醫及科學主任馬嘉明女士聯合報告

*Reported by Dr. Ivan CHONG, Veterinarian and Ms. Janny MA, Scientific Officer, Risk Assessment Section, Centre for Food Safety*

本文是油脂系列的最後一篇，將集中介紹油脂中可能存在的致癌化學物——黃曲霉毒素和苯並[a]芘。

## 黃曲霉毒素

黃曲霉毒素是由黃曲霉菌屬（*Aspergillus*）的一些霉菌（包括黃曲霉、寄生曲霉及*A. nomius*等）產生的一組毒性強烈的霉菌毒素。受污染的植物產品中最常見的黃曲霉毒素是B1、B2、G1及G2四類。

世界衛生組織的國際癌症研究機構把黃曲霉毒素列為令人類患癌的物質（第1組），而肝臟是首當其衝受其影響的器官。

最容易受黃曲霉毒素污染的食物包括玉米、花生、木本堅果和其他油籽。因此，植物毛油(如花生油)含有黃曲霉毒素並不足為奇。油料作物如受到黃曲霉毒素污染，從這些油料作物壓榨取得的植物油也可能含有黃曲霉毒素。

食油在精煉過程中可移除大部分黃曲霉毒素。不過，為了把風險減到最低，特別是對於一些不會經過任何精煉過程的食用油，妥善貯存和處理油料作物仍然是非常重要的。舉例來說，油料作物應保持乾燥，以防霉菌滋生，從而產生黃曲霉毒素。

## 苯並[a]芘

苯並[a]芘是一種多環芳香族碳氫化合物（polycyclic aromatic hydrocarbons，簡稱PAHs），在環境中無處不在。食物中的PAHs主要來自某些加工處理過程和烹調方式(如燒烤、煙熏、乾燥、烘焗、煎炸等)。苯並[a]芘與黃曲霉毒素一樣，同被國際癌症研究機構列為令人類患癌的物質(第1組)。

除了來自環境的污染外，食用油含有PAHs大多是因為這些油籽在乾燥過程中接觸到燃燒產生的氣體。本港和海外的檢測結果均顯示某些食用油如花生油、粟米油、葡萄籽油、葵花籽油和橄欖渣油等的苯並[a]芘含量相對偏高。聯合國糧食及農業組織／世界衛生組織聯合食物添加劑專家委員會指出，植物油脂(由於該食物類別含較高濃度的PAHs)，以及穀物及穀類食物(由於在多國屬消費量高的食物)是攝入PAHs的主要膳食來源。

鑑於在加工過程中產生的PAHs對人類健康的風險，食品法典委員會制定了《降低熏製和直接乾燥工藝過程中多環芳香族碳氫化合物污染食品的操作規範》，明確指出應避免在乾燥過程中讓油籽直接接觸到燃燒所產生的物質。此外，在食用油精煉過程中，

食用油脂中的苯並[a]芘和黃曲霉毒素含量可通過各種方法減低

Measures are available to lower the levels of B[a]P and aflatoxins in edible fats and oils

In this last article of the series, we will mainly focus on the carcinogenic chemicals, i.e. aflatoxins and benzo(a)pyrene (B[a]P), that may be present in fats and oils.

## Aflatoxins

Aflatoxins are a group of highly toxic mycotoxins produced by fungi of the genus *Aspergillus*, including *A. flavus*, *A. parasiticus* and *A. nomius*. The four main aflatoxins found in contaminated plant products are aflatoxins B1, B2, G1 and G2.

The International Agency for Research on Cancer (IARC) of the World Health Organization classifies aflatoxins as human carcinogens (Group 1); with the liver being the primary target organ.

Major foods commonly associated with aflatoxin contamination include corn (maize), peanuts (groundnuts), tree nuts as well as other oilseeds. Therefore, it is not surprising that crude vegetable oils, e.g. peanut oil, may contain aflatoxins. As a result, pressing of oil-bearing crops contaminated with aflatoxins may result in their presence in the oil.

Aflatoxins are nearly completely removed by the process of oil refinement. However, proper storage and handling of these oil-bearing crops (e.g. maintaining low moisture levels to prevent the growth of aflatoxigenic fungi and aflatoxins production) are still important in order to minimise the risk, especially for those oils which do not undergo any refining process.

## Benzo(a)pyrene

B[a]P is a kind of polycyclic aromatic hydrocarbons (PAHs) and is ubiquitous in the environment. In food, PAHs may be formed via certain processing and cooking methods, e.g. barbecuing, smoking, drying, roasting, frying or grilling. Like aflatoxins, B[a]P has also been classified as carcinogenic to humans (Group 1) by IARC.

Apart from environmental contamination, the occurrence of PAHs in oils is mostly related to the drying processes of the oilseeds where combustion gases may come into contact with them. Both local and overseas surveillance have shown that certain types of oils including peanut oil, corn oil, grapeseed oil, sunflower oil and olive pomace oil, etc. may contain higher levels of B[a]P. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has also concluded that vegetable fats and oils (owing to higher concentrations of PAHs in this food group) as well as cereals and cereal products (owing to high consumption in the diets of many countries) are the major contributors of PAHs intake.

In view of the risks to human health from PAHs formed in foods during processing, Codex has established a Code of Practice for the Reduction of Contamination of Food with Polycyclic Aromatic Hydrocarbons (PAH) from Smoking and Direct Drying Processes. It specifies that direct contact of oilseeds with combustion products during drying processes should be avoided. In addition, the use of active carbon during refining of the oil is a way to reduce the PAHs content after direct drying. The level of B[a]P in oils can be much reduced after oil refining processes while the ultimate

可使用活性碳去除在直接乾燥工序中產生的PAHs。食用油的精煉過程能把苯並[a]芘含量大大降低，而苯並[a]芘最終的含量則取決於精煉的條件及質量控制。

## 結語

油脂是我們的煮食好幫手，不但是導熱媒介，而且能提高食物的味道和口感。只要經過適當的處理和精煉過程，油脂產品中的黃曲霉毒素和苯並[a]芘均可有效地減低至可食用的水平。

level of B[a]P would depend on the conditions under which refining takes place and quality control.

## Conclusion

Fats and oils are indeed our good partners in cooking. They not only function as a heat medium but also contribute flavour and texture to our food. With proper treatment and refinement, aflatoxins and B[a]P in these products can be effectively reduced to a low level for human consumption.

食物事故點滴
Food Incident Highlight

## 常見中式飲品的糖含量

本港成年人所攝入的糖分主要來自不含酒精飲品。食物安全中心與消費者委員會合作研究餐飲中部分常見中式飲品的糖含量，研究結果近日出爐。在101個非預先包裝飲品樣本中，約有29%的樣本(主要是柑桔／柚子蜜、山楂飲品、酸梅湯和西洋菜蜜)被視為含高糖分(每100毫升含多於7.5克糖)。個別同類飲品樣本中的糖含量差異很大；在七種預先包裝飲品樣本中，有五種的平均糖含量高於同類非預先包裝飲品樣本的平均糖含量。由此可見，飲品(尤其是預先包裝飲品)仍有很多空間改變配方，以降低產品的糖含量。

業界應參考中心的《降低食物中糖和脂肪含量的業界指引》減低飲品的糖含量，並為顧客提供“少糖”或“無添加糖”的選擇。消費者在點飲品時，可要求食肆提供“少糖”或“無添加糖”的飲品；或者要求把糖或糖水分開送上；並盡量少喝添加了大量糖分的飲品。為健康著想，業界和市民須共同努力，減低糖的攝入量。

## Sugar in Popular Chinese-style Beverages

Non-alcoholic beverages are the major contributor of total sugar intake for adults locally. Recently, the Centre for Food Safety has released the result of a joint study with the Consumer Council on sugar contents in certain popular Chinese-style non-alcoholic beverages consumed with meals. About 29% of the 101 non-prepackaged samples, mainly kumquat/citron honey, hawthorn drink, sour plum drink and watercress honey samples, are considered high in sugar, i.e. >7.5g per 100 mL. Large variations in sugar contents within beverage types were observed, and comparing with non-prepackaged counterparts, a higher mean sugar content in prepackaged drinks were noted in five out of seven types of beverages. There is much room for product reformulation in lowering the sugar contents, especially for prepackaged beverages.

The trade is encouraged to reduce sugar in beverages according to the Trade Guidelines for Reducing Sugars and Fats in Foods and offer “less sugar” or “no added sugar” options. Consumers can request “less sugar” or “no added sugar” versions when ordering, ask for syrup/sugar to be served separately, and limit the consumption of drinks with high amounts of added sugars. A concerted effort of the trade and the public is needed if we want to reduce sugar consumption for the sake of better health.

## 嬰兒不可吃隔夜菜

隔夜菜放在雪櫃裡會積聚亞硝酸鹽，多吃會致癌？對大部分人來說，吃隔夜蔬菜不會顯著增加患癌的風險。但如果是餵嬰兒吃蔬菜的話，就要多加小心了。

蔬菜天然含有硝酸鹽和亞硝酸鹽，一些加工食品(如醃製肉類)亦使用了硝酸鹽和亞硝酸鹽作為食物添加劑。硝酸鹽和亞硝酸鹽本身不會令人類患癌。不過，亞硝酸鹽在胃部可能與胺產生作用，形成致癌的亞硝胺。另一方面，蔬菜已知有預防癌症的作用。

吃剩的蔬菜如受細菌污染而產生亞硝酸鹽，嬰兒吃了會有危險。原因是嬰兒的消化系統及正鐵血紅蛋白還原酶系統尚未成熟，較易患上亞硝酸鹽引致的正鐵血紅蛋白血症(亦稱為藍嬰綜合症，指血紅蛋白未能把氧氣帶到各身體組織，令皮膚和嘴唇發紫的一種罕見症狀)。因此，餵給嬰兒的食物，特別是蔬菜最好在吃前才新鮮配製。

## Leftover Vegetables Not For Infants

Does food especially vegetables left overnight in the fridge cause cancer due to the accumulation of nitrite? For most people, eating leftover vegetables would not significantly increase the risk of cancer. Yet, caution should be taken when feeding infants with vegetables.

Vegetables naturally contain nitrate and nitrite. Some processed foods such as cured meats also contain nitrate and nitrite as food additives. Nitrate and nitrite themselves are not carcinogenic to humans. However, nitrite might react with amines to form carcinogenic nitrosamines in the stomach. On the other hand, vegetables are known to have protective effects against the risk of cancer.

Infants are at risk because nitrite might accumulate in leftover vegetables due to bacteria contamination. High level of nitrite may cause methaemoglobinaemia (commonly known as blue baby syndrome, a rare condition under which haemoglobin is unable to carry oxygen to body tissues) in infants due to the immaturity of their digestive systems and methaemoglobin reductase systems. It is most desirable to prepare infant food especially vegetables just before consumption.

## 風險傳達工作一覽
Summary of Risk Communication Work

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