食物安全焦點
Food Safety Focus

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認清蔬菜中的硝酸鹽及亞硝酸鹽
The Truth about Nitrate and Nitrite in Vegetables

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, Risk Assessment Section, Centre for Food Safety

背景

蔬菜含有豐富的膳食纖維、維他命及礦物質，具有預防慢性疾病及癌症的功效，是健康飲食的重要一環。然而，有人或會關注蔬菜中的硝酸鹽及亞硝酸鹽對健康有何影響。我們到底需要為此而擔心嗎？讓我們來深入了解一下蔬菜中的硝酸鹽及亞硝酸鹽。

蔬菜中的硝酸鹽及亞硝酸鹽

硝酸鹽廣泛存在於大自然中，可在土壤、水及食物中找到，是植物生長發育的重要營養素。硝酸鹽可自然地和在細菌促進下被轉化為亞硝酸鹽。在人體腸道內，硝酸鹽亦會被代謝為亞硝酸鹽。除了蔬菜之外，人體還會通過許多其他食物攝入硝酸鹽及亞硝酸鹽，例如水及火腿、香腸等加工肉類(用作食物添加劑)。

蔬菜的硝酸鹽含量因種類而異。一般來說，葉菜類蔬菜(例如椰菜及菠菜)的硝酸鹽含量較高，而根莖類蔬菜(例如馬鈴薯及甘筍)及球莖類蔬菜(例如洋蔥及蒜頭)的硝酸鹽含量則相對較低。至於蔬菜的亞硝酸鹽平均含量通常很低。

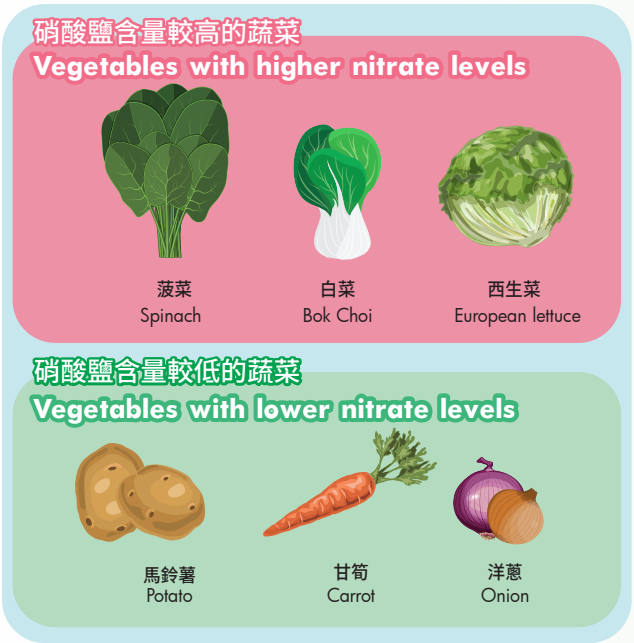

圖1：不同硝酸鹽含量的蔬菜例子
Figure 1: Examples of vegetables with different nitrate levels

硝酸鹽及亞硝酸鹽對健康的影響

硝酸鹽本身可說是沒有毒性的，但其代謝物亞硝酸鹽卻可令血液中的血紅蛋白氧化，因而無法在人體內運送氧氣，令患者的嘴唇和皮膚發紫，引致正鐵血紅蛋白血症。健康人士很少患上正鐵血紅蛋白血症，而嬰兒卻較容易出現此症，原因是嬰兒的消化系統尚未成熟，導

Background

Vegetables are essential components of a healthy diet since they are good sources of dietary fibres, vitamins and minerals, and have beneficial health effects against chronic diseases and cancers. However, some people may have concern on the health effects caused by the nitrate and nitrite in vegetables. Do people really have to worry about that? Let's take a closer look into the nitrate and nitrite in vegetables.

Nitrate and Nitrite in Vegetables

Nitrate is widely distributed in the nature and can be found in soil, water and food, and is a crucial nutrient for the growth and development of plants. Nitrate can be converted into nitrite naturally and the process is accelerated in the presence of bacteria. Inside the human gut, nitrate can also be metabolised into nitrite. Apart from vegetables, humans are exposed to nitrate and nitrite in many other ways such as from water and processed meats (e.g. ham and sausages) where they are used as food additives.

Nitrate concentration varies among different vegetable types. In general, leafy vegetables (e.g. cabbage and spinach) have higher nitrate concentrations, whereas root vegetables (e.g. potato and carrot) and bulb vegetables (e.g. onion and garlic) have relatively lower levels. For nitrite, its average concentration in vegetables is generally low.

Health Implications of Nitrate and Nitrite

Nitrate itself is relatively non-toxic but its metabolite, nitrite, can oxidise haemoglobin in blood and render it unable to carry oxygen inside the human body. This medical condition is known as methaemoglobinaemia and affected persons will have their lips and skin turned blue. While methaemoglobinaemia are rarely seen in healthy individuals, young infants are more susceptible to it because of the immaturity of the digestive system, resulting in proliferation of bacteria and conversion of nitrate to nitrite. Also, fetal haemoglobin in young infants are more easily affected by nitrite and on the other hand they are less capable to convert the methaemoglobin back to normal state. This condition in babies is called 'blue baby syndrome'.

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Incident in Focus

致硝酸鹽在細菌增生下轉化為亞硝酸鹽。此外，嬰兒體內的胎兒血紅蛋白較易受到亞硝酸鹽影響，同時亦較難把正鐵血紅蛋白還原至正常狀態。嬰兒的這種症狀被稱為「藍嬰綜合症」。

亞硝酸鹽亦可在體內與胺產生內源性硝化作用，形成亞硝胺。亞硝胺可能令實驗動物患癌，但流行病學研究未能證明從膳食攝入硝酸鹽會增加患癌的風險。從正常膳食中的蔬菜攝入硝酸鹽同時，也攝入其他生物活性物質(例如維他命C)或有助抑制內源形成亞硝胺。歐洲食物安全局亦認為，進食蔬果的益處大於透過蔬菜攝入硝酸鹽對人體健康可能產生的風險。

影響蔬菜中硝酸鹽及亞硝酸鹽含量的因素

(一) 食物加工程序

硝酸鹽可溶於水。研究顯示，蔬菜經清洗和沸水烹煮後，由於硝酸鹽流失於水中，硝酸鹽含量會相對減少。研究也發現，去除硝酸鹽含量較高的部分，例如把馬鈴薯去皮，亦會降低硝酸鹽含量。

若把蔬菜切碎或磨碎，植物細胞會釋出可把硝酸鹽轉化為亞硝酸鹽的酶，可能導致大量亞硝酸鹽形成。因此，蔬菜切碎或磨碎後最好盡快烹煮，而嬰兒食物(例如菜泥)亦應即煮即食。

(二) 貯存環境

新鮮完好的蔬菜只要貯存妥當，亞硝酸鹽含量通常很低。研究顯示，在冷凍的情況下，由於酶及細菌並不活躍，可抑制亞硝酸鹽形成。因此，蔬菜如非即時烹煮，最好存放於攝氏4度或以下的雪櫃內。

烹煮可破壞蔬菜中酶的活性，但蔬菜其後如受細菌污染，細菌可把硝酸鹽轉化為亞硝酸鹽，造成亞硝酸鹽累積。因此，如打算隔夜貯存包括蔬菜在內的熱食，應在烹煮後及分享食物前把所需分量存起，然後盡快冷卻，並在兩小時內貯存於雪櫃內。此外，可考慮使用根莖類蔬菜或球莖類蔬菜，因為其硝酸鹽含量通常較低。

蔬菜公認具有預防癌症及慢性疾病的益處。市民應保持均衡飲食，進食各類蔬菜，同時適當處理蔬菜以防止亞硝酸鹽累積。

注意事項

1. 硝酸鹽及亞硝酸鹽天然存在於蔬菜及許多其他食物中。攝入大量亞硝酸鹽可引致正鐵血紅蛋白血症，嬰兒會較容易患上此症。
2. 適當的食物加工程序及貯存環境可有效減少蔬菜中形成亞硝酸鹽。
3. 現有的證據顯示，從膳食攝入硝酸鹽不會增加患癌的風險。進食蔬菜是大有益處的，有助預防慢性疾病及癌症。

給市民的建議

- 保持均衡飲食，進食各類蔬菜，對健康有益。
- 適當處理蔬菜(例如貯存於雪櫃內；烹煮前先清洗或去皮；切碎或磨碎後盡快烹煮等)。為嬰兒烹製的菜泥應即煮即食，而且最好不要貯存。
- 為防細菌污染，如打算隔夜貯存熱食，應在烹煮後把所需分量存起，然後放進雪櫃貯存。

給業界的建議

- 適當處理和貯存蔬菜(例如存放於陰涼乾爽的地方或在可行的情況下放進雪櫃)，以防止新鮮蔬菜變壞。
- 定期檢查蔬菜的狀況，如有變質須將之棄掉。

Nitrite may also react with amines to form nitrosamines in the body through a process known as endogenous nitrosation. Nitrosamine is potentially cancer-causing in experimental animals, but epidemiological studies do not suggest that nitrate intake from diet is associated with increased cancer risk. When nitrate is consumed through a normal diet containing vegetables, other bioactive substances such as vitamin C may inhibit the endogenous formation of nitrosamines. The European Food Safety Authority also considered that the beneficial effects of eating vegetables and fruit outweigh the potential risk to human health from exposure to nitrate through vegetables.

Factors Affecting the Nitrate and Nitrite Contents in Vegetables

(A) Food processing

Nitrate is soluble in water. Studies showed that the nitrate contents of vegetables decrease upon washing and boiling due to leaching of nitrate into the water. Removing high nitrate-containing parts, such as peeling the skin of potatoes, is also found to lower the nitrate contents.

Chopping or mashing of vegetables, whereby releases enzymes in the plant cells that convert nitrate into nitrite, may cause excessive formation of nitrite. Therefore, it is advisable to cook vegetables soon after these processing and infant foods such as vegetable puree should also be prepared for immediately use.

(B) Storage condition

The nitrite concentrations in fresh, undamaged and well-stored vegetables are usually very low. Studies showed that nitrite formation tends to be inhibited under refrigeration as the activities of enzymes and bacteria are inactivated. Hence, vegetables are preferably stored in a refrigerator (at or below 4°C) if they are not cooked immediately.

Cooking can destroy the enzyme activity within the vegetables, but any subsequent bacteria contamination can result in nitrite accumulation as nitrate is converted to nitrite by the bacteria. Therefore, if you plan to store cooked food including vegetables overnight, pack the amount to be stored after cooking and before sharing among diners. Reduce the cooling time as far as possible and store it in a refrigerator within two hours. You may consider using root vegetables or bulb vegetables as their nitrate levels are generally lower.

The beneficial effects of vegetables in protecting against cancers and chronic diseases are well-recognised. The general public should maintain a balanced diet containing a variety of vegetables while handle the vegetables properly to prevent nitrite accumulation.

Key Points to Note

1. Nitrate and nitrite are naturally present in vegetables and many other foods. Consumption of a high level of nitrite may cause methaemoglobinaemia and infants are more susceptible.
2. Proper food processing and storage are effective in reducing the formation of nitrite in vegetables.
3. While available evidence suggests that nitrate intake from diet is not associated with increased cancer risk, consuming vegetables has strong beneficial effects against chronic diseases and cancers.

Advice to the Public

- Maintain a balanced diet containing a variety of vegetables for the benefits of health.
- Handle vegetables properly (e.g. keep under refrigeration; wash or peel before cooking; cook soon after chopping or mashing etc.). For vegetable puree prepared for infants, they should be consumed immediately and preferably not be stored at all.
- If you plan to store cooked food overnight, pack the amount to be stored after cooking to prevent bacterial contamination, and keep the stored food refrigerated

Advice to the Trade

- Properly handle and store vegetables (e.g. in cool, dry places or a refrigerator if possible) to prevent damage of fresh produce.
- Regularly monitor the condition of vegetable. Remove those which are deteriorated.

食物安全平台
Food Safety Platform

抗菌素耐藥性微生物 — 必須監察的食物安全威脅

Antimicrobial Resistant Microorganisms – A Food Safety Threat to be Monitored

食物安全中心風險管理組
科學主任翁智仁先生報告

Reported by Mr. Kenneth YUNG, Scientific Officer, Risk Management Section, Centre for Food Safety

抗菌素耐藥性是指微生物(通常是細菌)對於抗微生物藥物的反應出現變化，藥物因而未能有效治療抗菌素耐藥性微生物(或稱為「超級細菌」)所引致的感染，導致感染更難以治療，並且增加疾病傳播、重症及死亡的風險。超級細菌不僅在臨牀中找到，也存在於環境、動物及食物中。由於人類、畜牧業及農業濫用抗菌素等原因，抗菌素耐藥性問題日趨嚴重。從食物安全角度來看，推行全面的抗菌素耐藥性監測計劃，向不同界別收集數據，是風險分析機制不可或缺的一環。本文旨在闡述如何監測食物中的抗菌素耐藥性。

食源性抗菌素耐藥性監測的目的

收集食源性抗菌素耐藥性的監測數據及抗菌素的使用數據，有助找出食源性抗菌素耐藥性的普遍性與動物中使用抗菌素有何潛在關係。監測計劃亦為食源性抗菌素耐藥性風險評估提供資料來源，有助有關當局監察食物鏈中的風險、識別食物中抗菌素耐藥性的新趨勢、制訂相關應對措施，以及評估其成效。

如何監測食源性抗菌素耐藥性

鑑於這個問題備受全球關注，世界多地(例如丹麥、荷蘭及美國)都推行了食源性抗菌素耐藥性監測計劃。雖然各國的計劃內容各有不同，但世界衞生組織與聯合國糧食及農業組織編製了指導文件或指引，以協助各國及持份者制訂食源性抗菌素耐藥性細菌綜合監測計劃。

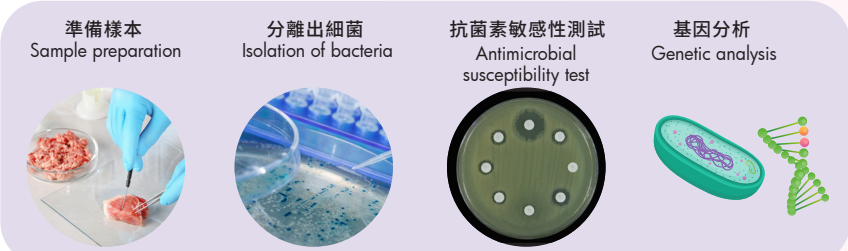

圖2：準備和處理好食物樣本後，便可培養、分離和鑑定存在於食物中的細菌。進行抗菌素敏感性測試，以測定分離出的細菌對某些抗菌素呈敏感反應還是耐藥性。找出和分析細菌的基因特性，以進一步了解耐藥機制。

Figure 2: Food samples are prepared and processed so that bacteria present in food can be cultured, isolated and identified. Antimicrobial susceptibility tests are conducted to determine whether the isolated bacteria are susceptible or resistant to certain antimicrobials. Genetic properties of the bacteria are characterised and analysed to better understand the resistance mechanisms.

食物樣本的種類及來源

不論是產自陸地或海洋、源自動物或植物、未經烹煮或可供即食、進口或本地生產，各種食品均可抽樣作食源性抗菌素耐藥性監測。在決定採集哪些種類及來源的食物樣本作監測時，應考慮消費者的購買習慣、消費量模式及食物中抗菌素耐藥性的普遍性估算。牛肉、雞肉及豬肉等源自牲畜的食物，是人類接觸食源性抗菌素耐藥性病原體的主要途徑，因此是多項監測計劃的焦點。至於植物源食物(例如綠葉蔬菜)及即食食物(例如刺身)等其他食品，亦可進行採樣。在零售層面採集食物樣本，可以方便監察接近食物鏈末端的食源性抗菌素耐藥性情況。

監察的細菌種類

大腸桿菌及腸道球菌是食用動物中常見的細菌。這些細菌可能帶有耐藥性基因並可將之傳給食用動物腸道內的人類病原體或其他共生菌。至於引致人畜共患病的細菌，例如沙門氏菌及彎曲菌，也是多項監測計劃所通常針對的細菌。

Antimicrobial resistance (AMR) occurs when microorganisms, commonly bacteria, do not respond to antimicrobial drugs the same way as before. Medicines are therefore less effective against infections caused by AMR microorganisms, otherwise known as 'superbugs'. As a result, infections are more difficult to treat and risks of disease spread, severe illness and death increase. Superbugs are found not only in clinical settings, but also in the environment, animals and food. The situation of AMR has been exacerbated due to factors like misuse of antimicrobials in humans, livestock and agriculture. A comprehensive surveillance programme of AMR collects data under different sectors, which is an integral part of the risk analysis framework from the perspective of food safety. This article aims to discuss the surveillance of AMR in food.

Purpose of Foodborne AMR Surveillance

Surveillance data of foodborne AMR, together with data of antimicrobial use, may help to identify potential relationship between the prevalence of foodborne AMR and the use of antimicrobials in animal sector. Surveillance programme is also one of the sources of information for foodborne AMR risk assessment. It may help authorities to monitor the risk along the food chain, identify new trends of AMR in food, deduce relevant interventions and evaluate their effectiveness.

Surveillance of Foodborne AMR

In view of global concern of the issue, surveillance of foodborne AMR is in place in many parts of the world, e.g. Denmark, the Netherlands and the United States. While the details of foodborne AMR surveillance programmes vary among countries, the World Health Organization and the Food and Agriculture Organization of the United Nations have prepared guidance document or guidelines to assist countries and stakeholders in the development of integrated surveillance programmes of foodborne AMR bacteria.

Type and source of food samples

Various food items, harvested from land or sea, animal or plant origin, raw or ready-to-eat, imported or locally-produced, could be collected for surveillance of foodborne AMR. When deciding the type and source of food samples collected for surveillance, purchasing habits of the consumer, consumption pattern and likely prevalence of AMR in food should be taken into consideration. Food originated from livestock, such as beef, chicken and pork, represents the major route of human exposure to foodborne AMR pathogens, and is therefore the main focus of many surveillance programmes. Other food items such as food of plant origin (e.g. leafy greens) and ready-to-eat food (e.g. sashimi) could also be sampled. Food collected at retail level could facilitate monitoring of foodborne AMR near the end of the food chain.

Type of bacteria to be monitored

Bacteria, such as *Escherichia coli* and *Enterococci*, are commonly found in food animals. These bacteria may harbour and transfer resistance genes to human pathogens or other commensal bacteria in the intestine of food animals. Zoonotic bacteria, such as *Salmonella* and *Campylobacter*, are also commonly targeted bacteria in many surveillance programmes.

進行的檢測及分析種類

抗菌素耐藥性微生物會從食物樣本中被分離，然後加以鑑定。通常會進行細菌基因分析及分型，以便找出耐藥性基因的特徵，從而進行追蹤及流行病學研究。對三類或以上抗菌素呈耐藥性的細菌分離株有時又稱為多重耐藥性細菌，往往更為令人關注。

數據通報

食源性抗菌素耐藥性監測的數據及結果應與不同的界別及持份者分享，從而令各界得以整合和共享數據，並通報抗菌素耐藥性及抗菌素使用的情況，以制訂可行的應對措施。

Type of tests and analysis to be conducted

AMR microorganisms are isolated from food samples and then identified. Genetic analysis and typing of bacteria are often conducted to facilitate the characterisation of resistant genes for tracing and epidemiological purposes. Bacterial isolates resistant to three or more classes of antimicrobials are sometimes described as multidrug-resistant, and usually of a higher concern.

Data reporting

Data and results of foodborne AMR surveillance should be communicated with different sectors and stakeholders, with an aim to achieve integration and share of data across sectors with combined reporting of AMR and antimicrobial use, so as to facilitate possible interventions.

食物事故點滴
Food Incident Highlight

發芽的馬鈴薯可安全食用嗎？
Is It Safe To Eat Sprouted Potatoes?

最近網上有人討論，已發芽的馬鈴薯是否可以食用。事實上，此舉絕不明智，因為發芽的馬鈴薯可能含有大量配糖生物鹼(又稱糖苷生物鹼或苷生物鹼)。

配糖生物鹼是天然產生的毒素，遍布馬鈴薯植株的各個部分，主要集中在花、芽及皮，而塊莖的含量則低得多。由於配糖生物鹼十分耐熱，因此烹煮不能減少其含量。食用含大量配糖生物鹼的食物可引致腸胃不適，出現噁心及腹瀉等症狀。

馬鈴薯應存放在陰涼乾爽的地方，以減少產生配糖生物鹼。購買時應選擇完整而無切口、瘀痕或腐爛的馬鈴薯。避免長時間貯存馬鈴薯。烹煮前應先削去外皮，並切去受損(例如切口及瘀痕)、腐爛、發綠及發芽的部分。如有疑問，應把整個馬鈴薯棄掉。

Recently, there have been some online discussion on whether sprouted potatoes can be eaten. In fact, it is unwise to put these sprouted tubers on your plates as they may contain high levels of glycoalkaloids.

Glycoalkaloids are naturally produced toxins occurring in all parts of a potato plant. While concentrated in flowers, sprouts and skins, their contents are much lower in tubers. Since glycoalkaloids are heat stable, they are not decomposed by cooking. Consuming food with high amounts of glycoalkaloids may cause gastrointestinal discomfort such as nausea and diarrhoea.

Potatoes should be stored in a cool, dry and dark place to minimise glycoalkaloids formation. When buying potatoes, choose the intact ones without cuts, bruises or rotten parts. Prolonged storage should be avoided. Peel the skin and cut away the parts that show damage (e.g. cuts and bruises), rotting, green colouring and sprouting before cooking. When in doubt, discard the entire potato.

出現苦味的絲瓜及其他葫蘆科瓜菜
Bitterness in Angled Loofah and Other Cucurbit Fruits and Vegetables

傳媒最近報道，有人在食用出現苦味的自家種植絲瓜後腹瀉多日。

葫蘆科植物的果實，包括許多經常食用的瓜菜，例如絲瓜、翠玉瓜、青瓜、苦瓜、南瓜及西瓜，據知有時會天然地生產大量葫蘆素。小劑量的葫蘆素會產生苦味，但如果攝入足夠的分量，可引致噁心、胃痙攣及腹瀉。世界各地都曾報告發生食用有苦味的葫蘆科果實後造成食物中毒的個案。

雖然大部分常見的葫蘆科果實不具苦味，但有時當植物發生基因回復突變、與苦味的葫蘆科品種雜交，或因生長條件不利或蟲害而受壓力時，便可能會累積較多葫蘆素。消費者應避免食用味道變苦或有異常味道的瓜菜，如食用後感到不適，應及早求醫。

The media has recently reported an incident where a person suffered from days of diarrhoea after consuming bitter-tasting angled loofah that he cultivated himself.

It is known that fruits of the cucurbit family plants, which include many commonly consumed fruits and vegetables, such as angled loofah, zucchini, cucumber, bitter gourd, pumpkin and watermelon, may at times form significant levels of cucurbitacins naturally. Cucurbitacins impart a bitter taste at low dose but can cause nausea, stomach cramps and diarrohea if sufficient amount is consumed. Food poisoning cases have been reported worldwide from consumption of bitter cucurbit fruits.

While most of the commonly-consumed cucurbit fruits are not bitter, cucurbitacins may occasionally accumulate when the plants back-mutate, form hybrids with bitter varieties of cucurbits, or become stressed from adverse growing conditions or insect infestations. Consumers should avoid consuming fruits and vegetables when they taste turn bitter in taste or differ from their usual taste, and seek medical attention promptly if feeling unwell after consumption.

風險傳達工作一覽（二零二零年十月）
Summary of Risk Communication Work (October 2020)

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