食物安全焦點
Food Safety Focus

食物安全中心 Centre for Food Safety

食物環境衞生署 Food and Environmental Hygiene Department

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蔬菜與鉻污染
Vegetables and Chromium Contamination

食物安全中心 風險評估組 科學主任游天頌先生報告

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

今年八月底，本港某報章稱，從數個位於雲南省曲靖市附近距離非法傾倒鉻渣地點約三公里的註冊供港菜場所抽取的蔬菜樣本，驗出含有每公斤0.21至0.64毫克鉻。本文會闡述鉻對市民健康可能造成的影響，並探討本港對鉻的規管情況。

今年八月底，本港某報章報道曾就青梗菜（又稱小棠菜）、芥蘭及菜心進行鉻總含量測試

Shanghai cabbage, Chinese kale and flowering cabbage were tested for total chromium in a local news report in late August 2011

In late August 2011, a local newspaper reported detection of chromium (Cr) at levels between 0.21 and 0.64 mg/kg in vegetables sampled from farms registered for export to Hong Kong near Qujing, Yunnan Province and located about three km from an illegal chromium dumping site. We shall examine the potential impacts of chromium to public health and review the local control.

鉻 — 從大自然到食物

鉻及其化合物天然廣泛存在於地球上。鉻主要以三種形態存在於岩石、土壤、植物、動物和火山爆發時的噴出物，當中大部分為金屬鉻和三價鉻化合物，而六價鉻則主要屬於工業活動產物。美國國家研究委員會在二零零五年發表的一份刊物指出，植物所吸收的六價鉻會即時在根部轉化成三價鉻。

大氣中的鉻主要是塵粒，並會透過沉降方式沉積在土壤和水中。鉻對人體健康十分重要，因為它是胰島素發揮作用所需的元素。海產、肉類和穀類是膳食鉻的豐富來源。當使用不銹鋼、金屬和陶瓷製成的食物容器時，鉻可能會透過這些容器進入食物鏈。

鉻的毒性和致癌性

三價鉻和金屬鉻並非致癌物，但過量攝入三價鉻仍可能令心臟停止跳動。美國國家環境保護局基於三價鉻會令老鼠的肝及脾重量減輕(毒理學終點)的研究，把不可溶性三價鉻鹽的長期口服參考劑量訂為每日每公斤體重1.5毫克。

另一方面，按每公斤體重計算，攝入50至70毫克六價鉻會導致急性中毒，可損害肝臟及腎臟。長期攝入六價鉻化合物可損害皮膚、呼吸道、腎臟、肝臟、胃腸道和循環系統，經實驗證明會引致基因改變和細胞突變。國際癌症研究機構已表明，從工作環境中吸入六價鉻可令人患呼吸道癌，但未能確定經口服途徑攝入六價鉻會

Chromium – From Nature to Food

Chromium and its compounds are naturally occurring and widely distributed on earth. They exist in rocks, soils, plants, animals and volcanic emissions in three main forms: most of them as chromium metals or Cr (III) compounds, while Cr (VI) mainly exists as products of industrial activities. According to a publication by the US National Research Council in 2005, Cr (VI) taken up by plants will be immediately converted to Cr (III) in their roots.

Chromium exists in the atmosphere mainly as particles, and is deposited into soil and water through precipitation. It is essential to health as it is necessary for insulin action. Seafood, meats and grains are good sources of dietary chromium. Chromium may get into our food chain through stainless steel, metals and pottery, when they are used as food containers.

Toxicity and Carcinogenicity of Chromium

Cr (III) and chromium metal are not carcinogens. However, excessive intake of Cr (III) may still cause the heart to stop beating. The US Environmental Protection Agency (EPA) has established a chronic oral reference dose of 1.5 mg/kg bw/day for insoluble Cr (III) salts, based on reduction of liver and spleen weight as toxicological endpoints in rat studies.

On the other hand, Cr (VI) has an acute toxicity of 50 to 70 mg/kg body weight, where it can cause liver and kidney damages. Chronic exposure to Cr (VI) compounds can affect skin, respiratory tract, kidneys, liver, gastrointestinal tract and the circulatory system. It has been shown to cause changes to genes and mutations in cells in laboratory. The International Agency for Research on Cancer established that Cr (VI), when inhaled, could cause respiratory cancers in occupationally exposed persons. For oral exposure,

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否致癌。美國國家環境保護局基於六價鉻會令老鼠出現器官變化的研究，把六價鉻的長期口服參考劑量訂為每日每公斤體重0.003毫克。

注意要點：

1. 食物中的鉻主要以三價鉻的形態存在。三價鉻是人體必需的營養素。
2. 六價鉻是呼吸道致癌物，長期攝入會損害其他器官。
3. 本港現時有關蔬菜中鉻含量的規管水平可充分保障市民健康。

本港的規管

在上述傳媒報道刊出後，食物安全中心（中心）與內地有關當局國家質量監督檢驗檢疫總局保持密切聯絡，跟進有關情況。中心又加強對蔬菜進行鉻測試，特別是來自相關地區菜場的蔬菜，由八月底至九月中抽取共148個樣本作檢測，只有三個驗出含小量鉻，總含量由百萬分之0.05至0.06不等，結果全部合格。是次所驗出的鉻水平遠低於本港有關蔬菜中總鉻含量的規管水平百萬分之一。

至於日常監察工作方面，中心在二零一零年一月至二零一一年八月共抽取了944個蔬菜樣本，當中只有六個（0.6%）驗出含鉻，總含量介乎每公斤0.07至0.6毫克。對於超出內地標準每公斤0.5毫克鉻的唯一一個樣本，我們利用本港食物消費量的資料進行風險評估，結果顯示不會影響市民健康。同時，我們的風險評估也認為，現時本港就蔬菜訂出的總鉻含量百萬分之一的規管水平，並不會影響市民的健康。

為加強規管工作，中心已就食物中重金屬（包括鉻）的規管標準展開檢討，並在食物安全專家委員會之下設立工作小組。

給市民的建議

- 向可靠的零售商購買蔬菜；
- 徹底洗淨蔬菜才烹煮，因為清洗過程可大量除去蔬菜中的重金屬及污染物；
- 保持均衡飲食，進食不同的蔬菜及食物。

給業界的建議

- 向可靠的供應商採購蔬菜；
- 菜場應奉行優良務農規範，避免以受污染的水灌溉蔬菜。

carcinogenicity has, however, not been established. A chronic oral reference dose of 0.003 mg/kg bw/day for Cr (VI) has been established by the US EPA based on organ changes in rat studies.

Key Points to Note:

1. Chromium mostly exists as Cr (III) in food. Cr (III) is an essential nutrient for human.
2. Cr (VI) is a known respiratory carcinogen and chronic exposure can affect other organs.
3. The current Hong Kong regulatory level on chromium in vegetables offers adequate public health protection.

Regulatory Control in Hong Kong

With the release of the above quoted media report, the Centre for Food Safety (CFS) has maintained close contact with State General Administration of Quality Supervision, Inspection and Quarantine, the Mainland authority, in following up the situation. The CFS has also stepped up chromium testing on vegetables, especially those from the farms in the affected area. The results were all satisfactory, with only three out of 148 samples taken from late August to mid September containing low level of total chromium detected from 0.05 to 0.06 ppm, much lower than the local regulatory level of 1 ppm on total chromium in vegetables.

As for the CFS regular surveillance, of the 944 vegetable samples taken between January 2010 and August 2011, only six (0.6%) were detected to have total chromium at a level ranged from 0.07 to 0.6 mg/kg. For the only sample that exceeded the Mainland standard of 0.5 mg/kg, we have conducted a risk assessment based on local food consumption data and it shows that adverse effects are unlikely. We have also found that the current Hong Kong regulatory level of 1 ppm of total chromium in vegetables would not pose adverse effects to the public health.

For more efficient regulatory control, the CFS has initiated a review on the regulatory standards on heavy metals, including chromium, in food. A working group has been formed under the Expert Committee on Food Safety.

Advice to the Public

- Purchase vegetables from reliable retailers;
- Wash vegetables thoroughly before cooking as substantial proportion of heavy metals and contaminants can be removed by washing;
- Maintain a balanced diet and eat a variety of vegetables and food.

Advice to Trade

- Source vegetables from reliable suppliers;
- Farms should practise good agriculture practice and avoid using contaminated water for irrigation.

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

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食物安全平台
Food Safety Platform

食物中的加工過程污染物
Process Contaminants in Food

食物安全中心
風險評估組
科學主任陳蓉蓉女士報告

Reported by Ms. Melva CHEN, Scientific Officer,
Risk Assessment Section,
Centre for Food Safety

加工過程污染物是指某些食物加工過程中不經意產生的化學物，當中有些可能有害甚至會致癌。究竟哪些加工過程可產生有害化學物呢?

可產生食物污染物的加工過程

食物物質屬於化學性質。理論上，只要加工過程令食物出現化學變化，就會產生化學物，當中有些可能有毒。加工過程污染物，是指在食物生產、烹煮（包括家中烹煮）、包裝及其他加工活動中產生的化學物質。最廣為人知會令食物出現劇變的加工過程包括烹煮、發酵和加酸水解法。

乾熱烹煮方法產生的加工過程污染物的例子有炸薯條中的丙烯酰胺及燒肉中的多環芳香族碳氫化合物
Examples of process contaminants produced by dry-heat cooking include acrylamide in French fries and PAHs in roasted pork

(1)乾熱烹煮

乾熱烹煮方法利用空氣或脂肪烹煮食物，故所產生的烹煮溫度會高於水煮方法（即以水和蒸氣烹煮食物）的溫度。一些常見的加工過程污染物，例如丙烯酰胺、多環芳香族碳氫化合物及雜環胺，會在乾熱烹煮過程中產生。

(2)發酵和加酸水解法

發酵和加酸水解法是把食物成分分解為或轉化成細小分子的兩種常見方法。這兩種加工過程會產生多種反應產物，當中有些屬於有毒的加工過程污染物，例如氨基甲酸乙酯及氯丙二醇。

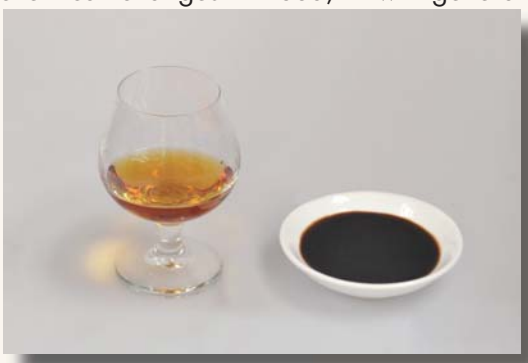
減低加工過程污染物含量

雖然加工程序無可避免會在食物中產生污染物，但我們能夠透過降低烹煮溫度和縮短烹煮時間等方法減低污染物的含量。國際和各國食物安全

Process contaminants refer to chemicals formed unintentionally during certain food processing methods. Some of the chemicals are harmful and may even cause cancers. What are the food processing methods that can generate such undesirable chemicals?

Processes that Generate Food Contaminants

Food substances are chemical in nature. Theoretically, as long as a process causes chemical changes in food, it will generate chemicals and some of them could be harmful. Process contaminants are chemical substances that are produced in food during food manufacturing, cooking (including home cooking), packaging and other processing activities. The best known processes that cause substantial changes in food include cooking, fermentation and acid hydrolysis.



加工過程污染物的例子有氨基甲酸乙酯及氯丙二醇，前者可能透過發酵過程在酒和豉油中產生，而後者則透過加酸水解法在豉油中產生
Process contaminants such as ethyl carbamate may be generated during fermentation in wine and soy sauce and 3-MCPD during acid hydrolysis in soy sauce

(1) Dry-heat Cooking

In dry-heat cooking, either air or fat is used as the medium of cooking. A higher temperature can be achieved as compared with moist-heat cooking, which uses water and steam as the medium of cooking. Some common process contaminants such as acrylamide, polycyclic aromatic hydrocarbons (PAHs) and heterocyclic amines (HCAs) can be formed during dry-heat cooking.

(2) Fermentation and Acid Hydrolysis

Fermentation and acid hydrolysis are two commonly used methods to breakdown or convert food componants into small molecules. During these processes, many reaction products are formed. Some of these products such as ethyl carbamate and 3-MCPD are undesirable and are classified as process contaminants.

Reducing Process Contaminants

The formation of process contaminants in food is unavoidable but they can be reduced by, for instance, lowering cooking temperature and reducing

表一：乾熱烹煮的溫度通常較高
Table 1: Dry-heat Cooking Usually Reaches a Much Higher Temperature

方法 Methods	例子 Examples	烹煮溫度 Cooking Temperatures
乾熱烹煮 Dry-heat cooking	油炸 Deep-frying	大約攝氏160至180度 ~160 °C-180 °C
	烘焙 Baking	最高約為攝氏220度 Up to ~220 °C
	碳燒 Charcoal grilling	最高約為攝氏370度 Up to ~370 °C
	氣體爐／電爐燒烤 Gas/electric grilling	最高約為攝氏315度 Up to ~315°C
水煮 Moist-heat cooking	清蒸 Steaming	大約攝氏100度 ~100°C
	放在水中烹煮 Boiling	大約攝氏100度 ~100°C

表二：發酵和加酸水解法令部分食物出現化學變化
Table 2: Chemical Changes of Some Foods by Fermentation and Acid Hydrolysis

食品 Food	加工過程 Processes	化學變化 Chemical changes
酒 Wine	發酵 Fermentation	水果或穀類中的糖分 → 酒精 Sugar in fruits or grains → Alcohol
芝士 Cheese	發酵 Fermentation	奶類中的乳糖 → 乳酸 Lactose in milk → Lactic acid
豉油 Soy sauce	發酵 Fermentation	小麥和黃豆中的蛋白質 → 游離氨基酸 Protein in wheat and soy bean → Free amino acids
	加酸水解法 Acid hydrolysis	黃豆中的蛋白質 → 游離氨基酸 Protein in soy bean → Free amino acids

當局及食物業一直研究食物加工過程中產生污染物的機理，制定方法減低污染物在食物工業加工和家中烹煮過程中產生，進行食品調查，以及掌握有關健康風險評估的最新資料。

從消費者的角度來說，均衡飲食和不過量進食某幾類食物（例如酒精飲品，油炸、燒烤或發酵食物）可減少攝入加工過程污染物。

食物安全中心一向密切留意有關加工過程污染物的國際發展及科學研究結果，並對部分加工過程污染物進行風險評估研究。我們會在下兩期深入探討在烹煮、發酵和加酸水解法中產生的一些常見加工過程污染物。

cooking time. International and national food safety authorities and food industries have been investigating the mechanisms of the formation of process contaminants in food; developing ways to reduce process contaminant formation in both industrial and home settings; conducting food product surveys; and updating on relevant health risk assessments.

From the consumer perspective, a balanced diet without over-indulgence of particular foods, such as alcoholic beverages, deep-fried, babecued or fermented foods contribute to reducing exposure to process contaminants.

The Centre for Food Safety has been keeping in view the international development and scientific findings, and conducting risk assessment studies on some process contaminants. In the coming two issues, we will further discuss some common process contaminants formed during cooking, fermentation and acid hydrolysis respectively.

食物事故點滴
Food Incident Highlight

在海參中使用火鹼（又稱「哥士的」）

近日，傳媒報道內地有人在海參中濫用火鹼。由於高濃度的火鹼具有腐蝕性，故事件引起市民關注。

火鹼是氫氧化鈉的俗名，可在食物中用作酸度調節劑或清洗劑兼去皮劑。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已評估氫氧化鈉在食物中使用的安全性，認為氫氧化鈉如按照優良製造規範用於食物中不會損害健康。

食物業應遵從優良製造規範在海參製品中使用氫氧化鈉。食物商應向可靠的供應商採購海參，並確保他們出售或進口的所有食物適宜供人食用。人們通常會把海參長時間浸泡後才烹煮，這種做法可大幅減低氫氧化鈉含量。大家應以乾淨清水徹底洗淨海參，並棄掉浸泡海參的水才烹煮。

Use of Caustic Soda in Sea Cucumber

Recently, there were media reports on the abuse of caustic soda in sea cucumber on the Mainland. This raised public concerns as caustic soda is corrosive at high concentrations.

Caustic soda is the common name for sodium hydroxide, which functions as an acidity regulator or is used as a washing and peeling agent in food. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has evaluated the safety on the use of sodium hydroxide in food and considered its use in food according to Good Manufacturing Practice would not pose adverse effects to health.

The food trade should follow Good Manufacturing Practice on the use of sodium hydroxide in sea cucumber products. Traders should source sea cucumbers from reliable suppliers and ensure all foods they sell or import are fit for human consumption. The common practice of prolonged soaking of sea cucumber before cooking reduces the level of sodium hydroxide substantially. Sea cucumber should be washed in clean water thoroughly and the water used for soaking should be discarded before cooking.

燕窩的亞硝酸鹽和硝酸鹽含量

在發生有關血燕中的亞硝酸鹽事件後，本港某大學進行了一項有關燕窩的亞硝酸鹽和硝酸鹽含量的研究。結果顯示，全部67個燕窩樣本均含有這兩種化學物，含量差異極大，當中以血燕的平均含量最高。

在本港，亞硝酸鹽及硝酸鹽不得添加在燕窩中，但有關規例不適用於燕窩天然含有的亞硝酸鹽及硝酸鹽。人們對燕窩為何會天然含有亞硝酸鹽所知不多。有些說法指，亞硝酸鹽可能因發酵過程而形成，含量或因環境污染程度而有異。

為釋除市民的疑慮，該項本港大學的研究在測試後證實，清洗和浸泡可除去大部份亞硝酸鹽和硝酸鹽。為減少攝入亞硝酸鹽和硝酸鹽，燕窩應清洗並浸泡數小時甚至過夜才燉煮；在浸泡過程中，應換水一兩次，並棄掉浸泡燕窩的水。

Nitrite and Nitrate Levels in Bird's Nest

Following up the incident of nitrites in blood-red bird's nest, a local university conducted a study on nitrite and nitrate levels in bird's nests revealing the presence of both chemicals in all 67 samples of bird's nests. The amounts varied significantly with blood-red bird's nests having the highest average levels.

In Hong Kong, nitrite and nitrate are not permitted to be added in bird's nest, but relevant regulation is not applicable to nitrite and nitrate naturally present in bird's nest. The mechanism of the natural presence of nitrite in bird's nest is not entirely clear. Some suggested that nitrite may be formed due to fermentation and the levels may vary with the extent of environmental contamination.

To alleviate public concern, the local university study also tested and confirmed that majority of nitrites and nitrates can be removed by washing and soaking. To reduce exposure to nitrites and nitrates, bird's nest should be washed and soaked for several hours or even overnight before cooking. Soaking water should be replaced once or twice during the process and be discarded.