

本期內容 IN THIS ISSUE

焦點個案

食物中的硼酸及硼砂

食物安全平台

基因改造食物：耐抗生素標示基因

食物事故點滴

雪糕及冰凍甜點含微生物的情況

食物中的三聚氰胺

風險傳達工作一覽

Incident in Focus

Boric Acid and Borax in Food

Food Safety Platform

Genetically Modified Food –
Antibiotic Resistance Marker Gene

Food Incident Highlight

Mircrobiological Quality of Ice-
cream and Frozen Confections

Melamine in Food

Summary of Risk Communication Work

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焦點個案

Incident in Focus

食物中的硼酸及硼砂

Boric Acid and Borax in Food

食物安全中心

風險評估組

科學主任馬嘉明女士報告

Reported by Ms. Janny MA, Scientific Officer,

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食物安全中心最近公布有關港式甜品的食物調查結果，發現一個清心丸樣本和三個含有清心丸的甜品含有硼酸這種非准許防腐劑，含量由每公斤830至11 000毫克。本文旨在提供更多有關硼酸及硼砂的食物安全資訊。



含有清心丸的糖水
Sweet soup containing root starch jelly

The Centre for Food Safety (CFS) has recently released the results of food surveillance on Hong Kong-style desserts. Results showed that a root starch jelly sample and three desserts containing root starch jelly were found to contain boric acid, a non-permitted preservative, at levels ranging from 830 to 11 000 mg/kg. This article provides more food safety information on boric acid and borax in food.

硼酸和硼砂是什麼？

硼酸(H_3BO_3)及硼砂($Na_2B_4O_7 \cdot 10H_2O$)是常見的含硼化合物。

硼是一種非金屬元素，絕不會在大自然中單獨存在，主要與其他物質結合成為不同形式的硼酸鹽存在於大自然中。此外，對植物而言，硼屬於必需的微量營養素，有利其生長。不過，現時專家對硼在人體中的功能所知不多。

硼酸及硼砂天然存在於水和泥土中，可廣泛用於多種消費品，包括防腐劑、玻璃、防火品及除害劑等。

食物中的硼酸及硼砂

天然存在於食物中

硼以硼酸鹽($B_4O_7^{2-}$)或硼酸的形式天然存在於食物中。水果、葉菜、豆類及木本堅果是硼含量最豐富的食物。酒類、蘋果酒及啤酒亦含有大量硼。至於奶類製品、魚類、肉類及大部分穀類，則只含有少量硼。(表1)

表1 部分食物的報告硼含量(世界衛生組織，1998)

Table 1. Reported levels of boron in some foods (World Health Organization, 1998)

食物類別 Food Category	食品 Food Item	硼含量(毫克/公斤) (除非另有列明，含量按新鮮重量計算) Level of Boron (mg/kg; fresh weight basis, unless otherwise specified)
水果 Fruits	未經加工處理的連皮紅蘋果 Apple, red with peel, raw	2.38-2.73
	未經加工處理的香蕉 Banana, raw	3.72
木本堅果 Nuts	杏仁 Almonds	23
	花生 Peanuts	13.8-18
飲料 Beverages	啤酒 Beer	0.13-1.8 毫克/升 (mg/L)
	酒類 Wine	3.5 毫克/升 (mg/L)
穀類製品 Cereal grain products	添加了營養成分的白麵包 Enriched white bread	0.20-0.48
	速食白米 Instant white rice	≤0.015

焦點個案
Incident in Focus

食物(通常為水果及蔬菜)是一般市民攝入硼的最主要來源。世界衛生組織(世衛)估計,人們每天平均從食物攝入約1.2毫克硼,而這一分量完全在世衛建議的成年人平均攝入量的安全範圍(每天1.0至13毫克硼)之內。

用作食物添加劑

硼酸及硼砂在不同食物中用作添加劑已有悠久歷史。由於硼酸及硼砂能有效抑制酵母菌,對霉菌和細菌亦有輕微抑制作用,故可用來防止食物腐壞。此外,這兩種添加劑亦可令食物更有彈性和更加鬆脆,並防止蝦變黑。

根據文獻記載,早於二十世紀初期,已有科學家開始質疑在食物中使用大量硼酸及硼砂的安全問題。到二十年代中,由於這兩種添加劑具有毒性,故許多國家開始立法禁止它們在食物中使用。不過,在第二次世界大戰時,糧食短缺問題嚴重,有關食物防腐劑(包括硼酸及硼砂在食物中的應用)的使用限制隨之放寬。二戰結束後,各國逐步重新限制在食物中使用這些添加劑。現時,中國內地、澳洲、新西蘭和加拿大等多國都不准許硼酸及硼砂在食物中使用。

一九六一年,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(專家委員會)總結認為硼酸及硼砂不適宜用作食物添加劑。不過,歐洲聯盟仍然准許這兩種添加劑用於魚子醬中。

硼酸及硼砂對健康的影響

低濃度的硼砂在人體內會轉化為硼酸,被身體所吸收。

專家相信,每天攝入小量硼酸不會引致人體不良健康影響,但短時間攝入大量硼酸則會損害胃部、腸道、肝臟、腎臟和腦部,甚或引致死亡。

動物研究顯示,長時間攝入大量硼酸會令動物的生殖能力及發育受影響。實驗動物如從膳食攝入硼酸,不但會有睪丸病變,並且會出現不育情況。不過,目前沒有證據顯示硼酸對基因有害或會致癌。

每日可容忍攝入量

世衛在制定有關飲用水的準則時,已訂出每日可容忍攝入量為每公斤體重0.16毫克硼。

注意要點

- 硼酸及硼砂在不同食物中用作添加劑已有悠久歷史。不過,專家委員會總結認為硼酸及硼砂不適宜用作食物添加劑。
- 動物研究顯示,長時間攝入大量硼酸會令動物的生殖能力及發育受影響。
- 在本港,硼酸及硼砂並非可用於食物中的准許防腐劑。

本港情況

在本港,根據《食物內防腐劑規例》,硼酸及硼砂並非可用於食物中的准許防腐劑。

過去數年,新鮮豬肉、魚蛋、糰子和中式點心(包括蝦餃)等食物曾驗出含有硼酸。由二零零七年一月一日至二零零九年六月三十日,中心就2 670多個食物樣本進行硼酸測試,當中有六個樣本驗出非法添加了硼酸。

給市民的建議

- 向可靠店鋪購買食物。
- 保持均衡飲食。

給業界的建議

- 切勿在食物中使用硼酸或硼砂。

更多資料

- 中心有關“在食物中使用硼酸及硼砂”的《風險簡訊》。

For the general population, the greatest boron exposure comes from the oral intake of food, mainly fruits and vegetables. The World Health Organization (WHO) has estimated the average daily intake of the population is about 1.2 mg boron from diet, which falls well within the safe range of population mean intakes for adults (1.0-13 mg boron/day) suggested by the WHO.

As Food Additive

Boric acid and borax have long been used as additive in various foods. Since boric acid and borax are effective against yeasts, and to a much lesser extent, against moulds and bacteria, they can be used to preserve food products. In addition, both of these additives can be used to increase the elasticity and crispiness of foods as well as prevent shrimps from darkening.

According to literature, in the early 1900s, some scientists started questioning the safety of the use of large amounts of boric acid and borax in foods. By the mid-1920s, many countries began legislating against the use of these additives in foods due to their toxicity. However, during the Second World War, there was serious food shortage, and restrictions on the use of food preservatives including the application of boric acid and borax in foods were eased. After the War, restrictions on the use of these additives in foods were gradually re-imposed. Nowadays, their uses in food are not permitted in many countries such as Mainland China, Australia, New Zealand and Canada.

In 1961, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) concluded that boric acid and borax were not suitable for use as food additive. However, they are still permitted to be used in caviar in the European Union.

Health Effects of Boric Acid and Borax

At low concentrations, borax can be converted to boric acid in body prior to absorption.

In humans, it is believed that adverse reactions associated with low doses of boric acid per day are unlikely to occur. However, exposure to large amounts of boric acid over a short period of time can affect the stomach, bowels, liver, kidney, and brain, and may even lead to death.

Animal studies indicated that excessive ingestion of boric acid over a prolonged period of time may cause adverse developmental and reproductive effects. Testicular lesions and impaired fertility have been observed in experimental animals given boric acid in the diet. However, there is no evidence that boric acid is toxic to the genes or carcinogenic.

Tolerable Daily Intake Level

The WHO has established a Tolerable Daily Intake (TDI) of 0.16 mg boron/kg bw during the development of the guidelines for drinking water.

Key Points to Note

- Boric acid and borax have long been used as additive in various foods; however, JECFA concluded that boric acid and borax were not suitable for use as food additive.
- Animal studies indicated that excessive ingestion of boric acid over a prolonged period may cause adverse reproductive and developmental effects.
- Boric acid and borax are non-permitted preservatives in food in Hong Kong.

Local Situation

In Hong Kong, under the Preservatives in Food Regulation, boric acid and borax are not permitted preservatives in food.

In recent years, boric acid has been detected in fresh pork, fish balls, rice dumplings and Chinese dim sums including shrimp dumplings etc. From 1 January 2007 to 30 June 2009, the CFS tested some 2 670 food samples for boric acid, in which six were found to have used boric acid illegally.

Advice to Public

- Obtain food from reliable sources.
- Maintain a balanced diet.

Advice to Trade

- Do not use boric acid or borax in food.

Further information

- CFS Risk in Brief on “Use of Boric Acid and Borax in Food”.

基因改造食物：耐抗生素標示基因

Genetically Modified Food – Antibiotic Resistance Marker Gene

食物安全中心
風險評估組
科學主任周淑敏女士報告

Reported by Ms. Shuk-man CHOW, Scientific Officer,
Risk Assessment Section,
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除了上一期提及的致敏性外，基因改造食物含有耐抗生素標示基因亦引起公眾關注。我們將會在近期探討有關使用耐抗生素標示基因的安全問題。

耐抗生素標示基因的作用

耐抗生素標示基因(例如耐卡那霉素*基因)通常在基因改造農作物的研發過程中用來識別轉化細胞。在基因工程進行初期，科研人員往往難以確定植物細胞是否已經攝入目標脫氧核糖核酸。為方便識別已植入轉基因的細胞，科研人員會把耐抗生素標示基因與有關基因連接，同時轉移至植物細胞內。由於耐抗生素標示基因對有毒的抗生素具有抗性，帶有耐抗生素標示基因和有關基因的細胞便可在含有相關抗生素的培養基中生存。科研人員其後會從轉化細胞(見圖1)種植出帶有有關基因的基因改造植物。雖然耐抗生素標示基因在成功研發出轉基因植物後便再無用處，但它們仍然會留存在該植物內。

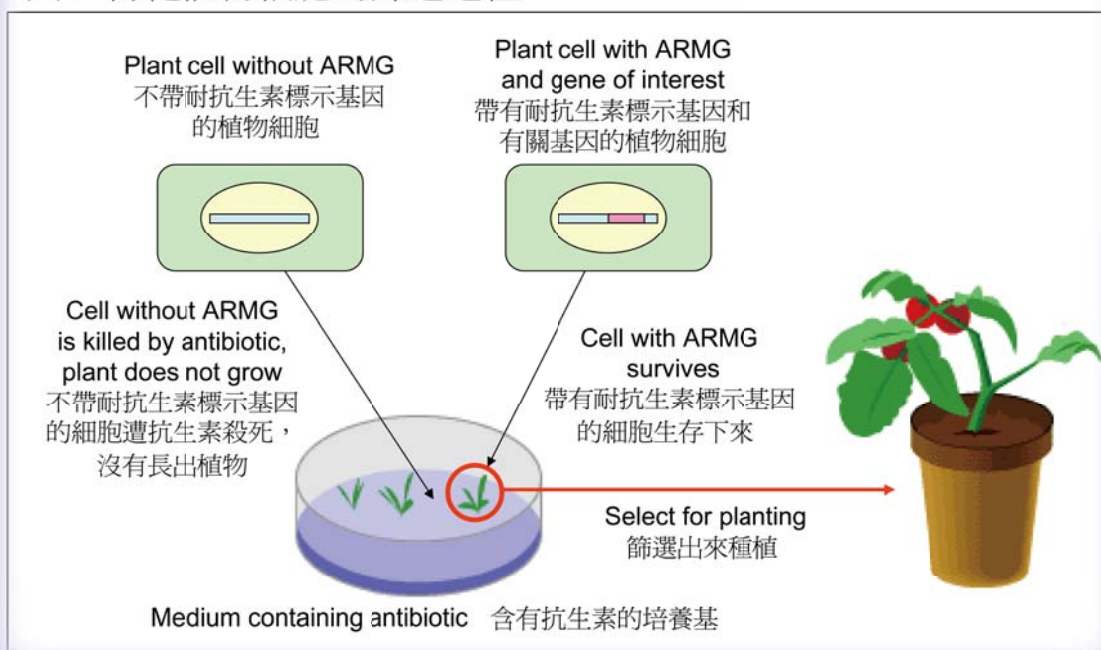
Besides allergenicity mentioned in the previous issue, the presence of antibiotic resistance marker genes (ARMGs) in genetically modified (GM) food has also raised public concern. In this issue, we are going to discuss the safety of the use of ARMGs.

Role of ARMGs

ARMGs (e.g. kanamycin* resistance gene) are commonly used for the identification of transformed cells during the development of GM crops. In the early stage of genetic engineering, it is often difficult to determine whether a plant cell has taken up the target DNA. To facilitate the identification of cells inserted with the transgene, an ARMG is linked with the gene of interest and transferred simultaneously into the plant cells. Since the ARMG confers resistance against the sinister antibiotics, cells that contain the ARMG, and hence the gene of interest, will be able to survive in a medium containing the corresponding antibiotic. GM plants carrying the gene of interest can then be regenerated from the transformed cells (Figure 1). Although ARMGs do not serve any purpose once a transgenic plant has been developed, they remain part of the plant.

Figure 1. Selection of transformed plant cells

圖1. 轉化植物細胞的篩選過程



基因改造農作物含有耐抗生素標示基因引起的關注及安全問題

基因改造農作物含有耐抗生素標示基因令人關注到，人類腸道中的細菌可能會從經消化的基因改造植物釋出的脫氧核糖核酸中，攝入耐抗生素標示基因，因而對抗生素產生抗性。一旦致病微生物攝入耐抗生素標示基因，這種基因轉移可能會減低抗生素的功效，影響人體健康。

基因轉移的機會

雖然基因轉移一直是理論上可能出現的風險，但世界衛生組織及食品法典委員會均指出，耐抗生素標示基因由植物轉移至人體腸道中的微生物的機會很低，因為耐抗生素標示基因須經過多個繁複的步驟才可轉移和穩定地表達。此外，近年的人類研究亦顯示，沒有一種基因改造物質在經過整個消化道後仍能保持完整，故此人體腸道中的微生物攝入仍具有功能的脫氧核糖核酸的機會微乎其微。

*卡那霉素一向用於治療結核病和某些經由性接觸傳染的疾病。

Concerns and Safety of the Presence of ARMG in GM Crops

The presence of ARMGs in GM crops has aroused concerns that bacteria in human guts might become antibiotic resistant through the uptake of ARMGs from the DNA spilling out of the ingested GM plants. Such gene transfer may compromise the effectiveness of antibiotics and pose risk to human health when the ARMG is taken up by pathogenic microorganisms.

Likelihood of gene transfer

While it remains a theoretical risk, the World Health Organization and the Codex Alimentarius Commission have pointed out that the potential for the transfer of ARMGs from plants to microorganisms in human guts is very low given the complexity of steps required for the ARMGs to transfer and stably express. Recent human studies have also demonstrated that no GM material is able to survive the passage through the whole digestive tract and that the likelihood of functioning DNA being taken up by microorganisms in human gut is extremely low.

*kanamycin has been used in treatment of tuberculosis and certain sexually transmitted diseases.

耐抗生素標示基因及含有耐抗生素標示基因的基因改造農作物的安全問題

國際及多國食物安全機關已就基因改造植物中的常用耐抗生素標示基因的安全問題作出評核。直至目前為止，並無證據證明現時使用的耐抗生素標示基因會損害人體健康。

至於含有耐抗生素標示基因的基因改造農作物，則會與任何新研發的基因改造植物一樣，必須先接受安全評估，然後才獲准推出市場，而有關當局將會考慮耐抗生素標示基因產物的安全問題和有關抗生素的臨牀重要性等因素。如有關資料的評估顯示，農作物含有該種耐抗生素標示基因或該種基因產物會影響人體健康，該種標示基因或基因產物便不得存在於食物中。

耐抗生素標示基因以外的其他選擇

有關當局已採取預防措施，鼓勵科研人員採用不會令基因改造植物含有耐抗生素標示基因的轉化技術，包括在成功轉移基因後移除耐抗生素標示基因，以及使用其他標示基因(例如耐除草劑的基因)代替耐抗生素標示基因。

雖然公眾關注到衍生自基因工程的食物可能會引致過敏和含有耐抗生素標示基因，但現時在國際市場上銷售的基因改造食物均通過安全評估，可供人安全食用。

Safety of ARMGs and GM crops containing ARMGs

Safety of ARMGs commonly used in GM plant has been reviewed by a number of national and international food safety authorities. Up till now, there is no evidence that ARMGs currently in use pose a health risk to humans.

For GM crops containing ARMGs, like any newly developed GM plants, their safety have to be evaluated before market approval. Factors like the safety of the ARMG product and the clinical importance of the antibiotic in question will be considered. If evaluation of the data suggests that the presence of the ARMG or gene product presents risks to human health, the marker gene or gene product should not be present in the food.

Alternatives to ARMGs

As a precautionary measure, use of transformation technologies that do not result in ARMGs in GM plants is encouraged. These include the removal of ARMGs after successful gene transfer and the use of alternative markers genes (e.g. herbicide tolerance gene) to replace ARMGs.

Despite concerns over the potential allergenicity and presence of ARMGs in food derived from genetic engineering, GM food available in the international market has undergone safety assessment and is safe for human consumption.



雪糕及冰凍甜點含微生物的情況

雪糕及冰凍甜點在夏季特別受歡迎。不過，由於天氣炎熱，這些食物如處理不當(例如貯存溫度不夠低(攝氏零下18度或以下)和冰箱門沒有關好)，便會有利細菌生長。

今年五月及六月，食物安全中心(中心)進行有關雪糕及冰凍甜點含微生物的情況的專項食品調查，一共測試了1 000個樣本，全部沒有驗出致病菌。在質素和衛生情況指標方面(即總含菌量及大腸菌羣測試)，有11個樣本超出法定標準。不過，一般食用不會對健康造成嚴重影響。中心已針對有問題樣本發出警告信，並加強巡查有關店舖，所有跟進樣本的測試結果全部合格。中心提醒消費者應向可靠店舖購買雪糕及冰凍甜點，切勿進食任何已過期或質素欠佳的食物。

Microbiological Quality of Ice-cream and Frozen Confections

Ice-cream and frozen confections are particularly popular during summer time. However, due to the hot weather, improper handling of these products (e.g. storage temperature not low enough (-18°C or below) and freezer door not properly closed) is favourable to bacterial growth.

In May and June 2009, the Centre for Food Safety (CFS) conducted a targeted food surveillance project on the microbiological quality of ice-cream and frozen confections. A total of 1 000 samples were tested and none was found with pathogens. Regarding the quality and hygienic indicators, meaning the total bacterial count and tests of coliform organisms, 11 samples were found to exceed the legal standards. Nevertheless, usual consumption was unlikely to pose significant health effect. Regarding the unsatisfactory samples, the CFS issued warning letters and conducted follow-up inspections. Test results of follow-up samples were all satisfactory. The CFS advises consumers to buy ice-cream and frozen confections from reliable shops and not to consume any product which is out of expiry date or of inferior quality.

食物中的三聚氰胺

去年九月，內地出現攙雜了三聚氰胺的奶類及奶類產品，政府立即修訂《食物內有害物質規例》(第132 AF章)，就食物內的三聚氰胺訂出法定上限，即奶類和供36個月以下幼兒、懷孕或授乳女性食用的食物為每公斤1毫克，而其他食物則為每公斤2.5毫克。

自事件發生後，食物安全中心(中心)已為超過5 600個食品進行三聚氰胺分析，發現其中40個樣本超出法定上限。在合格食品中，驗出32個樣本的三聚氰胺含量介乎每公斤1至2.5毫克的法定上限之內。有關結果已在中心網頁內另表列出。進食驗出含有少量三聚氰胺的有關食物不會影響健康。自二零零八年十二月起，中心再沒有在食物樣本中驗出三聚氰胺。

Melamine in Food

Following the emergence of adulterated use of melamine in milk and milk products in the Mainland in September last year, the Government immediately amended the Harmful Substances in Food Regulations (Cap. 132 AF) to establish legal limits for melamine in food at 1 mg/kg for milk and food for children under the age of 36 months, pregnant and lactating women, and at 2.5 mg/kg for other food.

Since the onset of the incident, the Centre for Food Safety (CFS) has conducted analyses for melamine in over 5 600 food products and found that 40 samples exceeded the legal limits. Among the satisfactory products, 32 samples were found to contain melamine within the legal limits at levels between 1 to 2.5 mg/kg. The results are listed in a separate table on the CFS website. Consumption of these foods at the low levels of melamine detected would not pose health concerns. There have been no positive results since December 2008.

風險傳達 工作一覽 Summary of Risk Communication Work

風險傳達工作一覽 (二零零九年七月) Summary of Risk Communication Work (July 2009)	數目 Number
事故/食物安全個案 Incidents / Food Safety Cases	65
公眾查詢 Public Enquiries	170
業界查詢 Trade Enquiries	181
食物投訴 Food Complaints	327
給業界的快速警報 Rapid Alerts to Trade	33
教育研討會/演講/講座/輔導 Educational Seminars / Lectures / Talks / Counselling	89
上載到食物安全中心網頁的新訊息 New Messages Put on the CFS Website	17