食物安全焦點
Food Safety Focus

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嬰兒配方奶粉中的阪崎氏腸桿菌
Enterobacter sakazakii in Powdered Infant Formula

食物安全中心
風險評估組
科學主任莊梓傑博士報告

Reported by Dr. Ken Chong, Scientific Officer,
Risk Assessment Section,
Centre for Food Safety

今年九月，傳媒報道，三鹿牌的嬰兒配方奶粉除了被驗出含有三聚氰胺之外，還驗出阪崎氏腸桿菌(又稱為*Cronobacter*屬)。本文將會集中討論這種細菌，並詳細介紹聯合國糧食及農業組織／世界衞生組織(糧農組織／世衞)有關安全配製和處理嬰兒配方奶粉(奶粉)的建議。

阪崎氏腸桿菌與嬰兒感染個案

阪崎氏腸桿菌是革蘭氏陰性無芽孢桿菌，其最佳生長溫度為攝氏37度至43度。這種致病菌通常只會令免疫力較弱的人患病。由於阪崎氏腸桿菌可令嬰兒(即不足一歲的兒童)感染罕見但致命的疾病，因此公眾日益關注其造成的健康問題。

阪崎氏腸桿菌可對嬰兒造成入侵性感染(例如血液或腦部感染)，而早產、新生(出生不足28天)、未滿兩個月、出生體重不足(少於2.5公斤)或免疫力較弱的嬰兒的風險最高。原因之一可能是新生嬰兒(尤其早產嬰兒)的胃部酸性較成人為低，以致阪崎氏腸桿菌可在嬰兒體內生存。

奶粉中的阪崎氏腸桿菌

雖然許多個案中都無法知道嬰兒從何感染阪崎氏腸桿菌，但愈來愈多報告指奶粉是阪崎氏腸桿菌的傳播媒介，而此菌亦可在奶粉的生產環境中找到。即使奶粉只含有小量阪崎氏腸桿菌，亦可令嬰兒出現感染。

雖然阪崎氏腸桿菌不會在乾燥的奶粉內繁殖，但卻可長時間生存。經沖調的奶如放置於室溫(即攝氏4度以上)，尤其是經過一段長時間，可為阪崎氏腸桿菌提供有利的繁殖環境。

糧農組織／世衞有關阪崎氏腸桿菌的評估

糧農組織／世衞微生物風險評估聯席會議(聯席會議)曾評估有關減少奶粉中的阪崎氏腸桿菌的風險策略。由於奶粉可在生產或配製過程中受阪崎氏腸桿菌污染，故應在生產過程和沖調過程中或之後採取適當的控制措施。

聯席會議最終認為，控制內部污染(即奶粉在開封前已受污染)可降低阪崎氏腸桿菌的風險，而這有賴生產商有效推行預防措施，包括加強各項措施進一步減低微生物進入奶粉的機會和避免它們在奶粉中大量繁殖，例如在加工環境中盡量減少水分存在。此外，生產商應就生產過程中涉及的一切事宜，包括加工環境、與產品有接觸的表面和最終的產品，推行監控及環境管理計劃。

In September 2008, the media reported that apart from melamine, *Enterobacter sakazakii* (also called *Cronobacter* species) was detected in powdered infant formula (PIF) from the Sanlu brand. In this article, we shall focus on this bacterium and relevant Food and Agriculture Organization (FAO) / World Health Organization (WHO) advice on safe preparation and handling of PIF.

Enterobacter sakazakii and Infection in Infant

Enterobacter sakazakii is a gram-negative, non-spore-forming bacterium with optimum growing temperatures ranging from 37°C to 43°C. It is a pathogen that generally causes disease only in people with weakened immune systems. There is emerging public health concern of this bacterium because it can cause rare but fatal infections in infants (i.e. children < one year old).

The bacterium can cause invasive infections (e.g. blood or brain infections) in infants. In particular, neonates (≤ 28 days old), infants less than two months of age, pre-term infants, low-birth-weight infants (< 2.5 kg) and infants with weakened immunity are at greatest risk. One of the possible factors for this may be due to the stomach of newborns, especially of premature babies, is less acidic than that of adults, which may contribute to the survival of *Enterobacter sakazakii* in infants.

The Germ in the Powdered Infant Formula

Despite the source of *Enterobacter sakazakii* is not known in many cases of infant infection, increasing number of reports have suggested PIF as the vehicle for *Enterobacter sakazakii*, which can also be found in the manufacturing environment. Even low level of the bacterium in PIF can lead to infection.

Although the bacterium does not grow in dry PIF, it can survive for long periods. Reconstituted PIF can provide favourable environment for growth of the bacterium when it is held at room temperature (i.e. above 4°C), particularly for extended period.

FAO/WHO Assessments on *Enterobacter sakazakii*

The Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment (JEMRA) has evaluated the risk-reduction strategies for *Enterobacter sakazakii* in PIF. As contamination can occur at manufacturing and preparation stages, appropriate control measures should be applied during the manufacturing process as well as during and after reconstitution.

JEMRA concluded that controlling intrinsic contamination (i.e. contamination in PIF before opening) would help to decrease the risk for the bacterium, which relies on effective implementation of preventive measures by manufacturers. These include strengthening measures that further minimise entry of microorganisms and avoid their multiplication, such as exclusion of water from the processing environment to the extent possible and feasible. In addition, it is also required to implement monitoring and environmental management programmes, which cover all relevant elements including the processing environment, product contact surfaces and finished product.

焦點個案
Incident in Focus

另一方面，聯席會議曾就奶粉的不同配製和處理情況作出評估，並提出一些可減低風險的建議方法。以不低於攝氏70度的熱水沖調奶粉能有效減弱阪崎氏腸桿菌。為限制阪崎氏腸桿菌在奶中繁殖，應盡量縮短奶的配製與飲用時間，即應在配製後兩小時內飲用；預先配製的奶應立即冷卻和存放在攝氏4度或以下，並應重新加熱不超過15分鐘和在配製後24小時內飲用；至於護理機構的人員以較大容器(體積不應大於1公升)分批大量配製奶粉時，如情況許可，應放在較小容器內冷卻，因為容器愈大，冷卻速度愈慢。

奶粉並不是無菌的產品，可能含有可引發嚴重疾病的致病菌。高風險嬰兒如未有以母乳餵哺，照顧者宜盡量選用經商業無菌處理的液態嬰兒配方。

注意事項：

1. 奶粉並不是無菌的產品，可能含有可引發嚴重疾病的致病菌。
2. 新生和未滿兩個月的嬰兒，尤其是早產、出生體重不足或免疫力較弱的嬰兒感染阪崎氏腸桿菌的風險最高。
3. 只要奶粉生產商和照顧者一同採取適當的減少風險措施，便可控制微生物的危害。

給照顧者的建議

- 以不低於攝氏70度的熱水(煮沸後放置時間不要超過30分鐘)來沖調奶粉，並盡量縮短配製與飲用時間。
- 預先配製的奶在配製後應立即冷卻和貯存在雪櫃內。沖調好的奶應在即將餵食前才重新加熱，並在配製後24小時內飲用。
- 把沖調好的奶放在盛載了溫水(水位應低於奶瓶的上端)的容器內重新加熱不超過15分鐘，其間須間中搖晃或轉動奶瓶。
- 如情況許可，高風險嬰兒應飲用經商業無菌處理可即時飲用的液態嬰兒配方。

給生產商的建議

- 推行預防措施(例如優良製造規範／良好衞生守則及“食物安全重點控制”系統)和監控及環境管理計劃。
- 在產品標籤上詳列照顧者應依從的減少風險措施，以便他們安全配製、處理和使用奶粉。

更多資料

- 由中心編製有關“嬰兒配方奶粉中的阪崎氏腸桿菌”的風險簡訊
- 由糧農組織／世衞編製的《安全製備、貯存和操作嬰兒配方奶粉指導原則》

On the other hand, JEMRA evaluated different scenarios for preparation and handling of PIF and recommended several practices that can help reduce the risk. Reconstitution of PIF with water that is no less than 70°C can significantly inactivate *Enterobacter sakazakii*. To limit bacterial growth, the time from preparation to consumption should be minimised, i.e. consume the feeds within two hours after preparation; feeds prepared in advance are required to cool immediately and stored at or below 4°C as well as re-warmed for no longer than 15 minutes for consumption within 24 hours of preparation; and for making a batch in larger container (no larger than 1 litre) in care settings, formula should be cooled in small containers where possible, as larger container may result in slower cooling rate.

PIF is not a sterile product and may be contaminated with pathogens that can cause serious illness. For high-risk infants who are not breastfed, caregivers are encouraged to use commercially sterile liquid formula, whenever possible and feasible.

Key Points to Note:

1. PIF is not a sterile product and may be contaminated with pathogens that can cause serious illness.
2. Neonates and infants less than two months of age, in particular pre-term infants, low-birth-weight infants and infants with weakened immunity, are at greatest risk for *Enterobacter sakazakii* infections.
3. Microbiological hazards are controlled by appropriate risk reduction measures applied by both manufacturers of PIF and caregivers.

Advice to Caregivers

- Reconstitute PIF with water that is no less than 70°C (water left for no more than 30 minutes after boiling) and minimise the time from preparation to consumption.
- Feeds prepared in advance should be cooled immediately after preparation and stored in a refrigerator. Reconstituted feed should be re-warmed immediately before feeding and used within 24 hours of preparation.
- Re-warm reconstituted feed for no more than 15 minutes by placing in a container of warm water with occasional shake or swirl; the level of the water should be below the top of the bottle.
- Wherever possible, commercially sterile ready-to-feed liquid formula should be used for infants at greater risk.

Advice to Manufacturers

- Implement preventive measures (such as Good Manufacturing Practice / Good Hygiene Practice and Hazard Analysis & Critical Control Point) as well as monitoring and environmental management programmes.
- Communicate the risk reduction measures that the caregiver should follow for the safe preparation, handling and use of powdered formula on product label.

Further Information

- The CFS Risk-in-Brief on “*Enterobacter sakazakii* in PIF”
- FAO/WHO “Guidelines for the safe preparation, storage and handling of powdered infant formula”

風險傳達 工作一覽
Summary of Risk Communication Work

風險傳達工作一覽（二零零八年十月） Summary of Risk Communication Work (October 2008)	數目 Number
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食物安全平台
Food Safety Platform

營養素與健康：維持最佳的營養素攝入量
Nutrient and Health - Maintain Optimal Nutrient Intake

食物安全中心
風險傳達組
科學主任馮慧中女士報告

Reported by Ms. Jacqueline Fung, Scientific Officer,
Risk Communication Section,
Centre for Food Safety

營養素是指食物中可提供能量或可促進身體生長、修復組織和維持健康的物質。評估營養素攝入量是評估個人或整體人口健康的重要部分。營養素是維持生命必不可少的元素，但與食物中的污染物一樣，它們亦可損害我們的健康，因此，評估營養素攝入量可分為兩方面，就是評估缺乏的風險和攝入過量引致不良影響的風險，例如缺乏維他命A可引致夜盲症，而攝入過量又可導致肝臟異常。

由今期起，本欄將會推出以營養為主題的全新系列文章。首先，我們將會介紹“膳食營養素參考攝入量”，包括有關推薦攝入量以用作評估缺乏的風險和可耐受最高攝入量以用作評估對健康造成不良影響的風險。

由足夠到過量；由有益到有害

數十年前，營養素攝入量是否足夠一直是營養評估的重心。當時，各地衞生部門為多種營養素制定了推薦攝入水平，作為評估營養是否足夠的指標。時至今日，社會上明顯較少聽聞營養不足或缺乏食物的情況，反而較多見由營養不均衡和少做運動的安逸生活方式所引致的肥胖和慢性疾病。此外，隨着加工食物激增、強化食物日多和膳食補充品迅速廣泛食用，導致攝入過量營養素對健康造成不良影響的風險增加。為同時涵蓋攝入不足和攝入過量兩種極端情況，現稱為“膳食營養素參考攝入量”的參考值亦包括了“可耐受最高攝入量”。

膳食營養素參考攝入量的分類

雖然各國制定或採用的膳食營養素參考攝入量概念十分類似，但基於不同社羣的營養需要和公眾健康問題有別，故各國的膳食營養素參考攝入量數值可能會不同。在這一系列文章中，我們將會介紹和採用中國居民膳食營養素參考攝入量，因為這一套標準相信是最適合本港大部分市民的。

中國居民膳食營養素參考攝入量由中國營養學會於二零零零年制定，目的是在營養素攝入量方面向個人以至全國居民提供指引，並用作評估個人以至全國居民營養狀況的標準。

膳食營養素參考攝入量是一個統稱，由下列四組參考值組成：平均需要量；推薦攝入量；適宜攝入量和可耐受最高攝入量。

平均需要量 — 指每天平均營養素攝入數值，估計可滿足某特定年齡及性別羣組中*半數*身體健康的人的需要。

推薦攝入量 — 指每天營養素攝入數值，估計可滿足某特定年齡及性別羣組中*幾乎所有*（97%至98%）身體健康的人的需要。假設不同的營養素需要量正常分布，推薦攝入量的計算公式如下：

推薦攝入量 = 平均需要量 + 2 x 標準差

適宜攝入量 — 如沒有足夠的科學證據，便無法釐定平均需要量，而推薦攝入量亦因此無法計算出來。在這種情況下，衞生當局便會訂定適宜攝入量。適宜攝入量是建基於有關攝入量足以促進健康的假設上，並根據實驗數據或觀察一組身體健康的人的營養素攝入量而得出的。由於適宜攝入量並無足夠的科學數據支持，故其準確度明顯不及推薦攝入量。營養素只會訂有推薦攝入量或適宜攝入量，而不會同時訂有兩個參考值。

Nutrients are substances in foods that provide energy and are used for bodily growth, repair and maintenance. Assessing nutrient intake is an important part of health assessment at both the individual and population levels. Nutrients are essential for life. But like contaminants in food, they may also do harm to our body. In such case, assessing nutrient intake is two-fold, i.e. evaluating the risk of inadequacy and, on the other hand, the risk of adverse effects due to excessive intake. For example, low intake of vitamin A may cause night blindness, whereas high intake may cause liver abnormalities.

Starting from this issue, we will introduce a new series on nutrition. To begin with, we will introduce the “Dietary Reference Intakes (DRIs)”, which consist of reference points regarding recommended nutrient intake levels for assessing the risk of inadequacy and the tolerable upper intake levels for assessing the risk of adverse health effects.

From Adequacy to Excess; From Benefit to Risk

Decades ago, the adequacy of nutrient intake was the main focus of nutritional assessment. Back then, health authorities from different places established recommended intake levels for nutrients as indicators of nutritional adequacy. Apparently, now we hear less about nutrient deficiency and starvation in our society, but more on obesity and chronic diseases as a result of malnutrition and sedentary lifestyle. Furthermore, an upsurge of processed foods, increase in food fortification and the rapidly expanding use of dietary supplements have increased the risk of adverse health effects due to excessive intake. To cover both ends of the spectrum, a set of intake values, now called “DRIs”, was expanded to include the tolerable upper intake level.

Categories of Dietary Reference Intakes

Although the concepts of DRIs established or adopted by different countries are very much the same, different sets of DRIs may have different values since there are different nutritional needs and public health concerns in different communities. We, in this series of articles, will introduce and use the Chinese DRIs as they are deemed most appropriate for the majority of people in Hong Kong.

The Chinese DRIs were established by the Chinese Nutrition Society in 2000 with an aim to guide individuals' and population's nutrient intakes. Furthermore, they are used as benchmarks to evaluate the nutritional status at the individual and population levels.

Dietary Reference Intakes (DRIs) is a collective term of the four different sets of reference values, namely Estimated Average Requirement (EAR), Recommended Nutrient Intake (RNI), Adequate Intake (AI) and Tolerable Upper Intake Level (UL).

Estimated Average Requirement (EAR) - The EAR is the average daily nutrient intake value that is estimated to meet the needs of *half* the healthy individuals in a given age and gender group.

Recommended Nutrient Intake (RNI) – The RNI is the daily nutrient intake value that is estimated to meet the needs of *nearly all* (97 to 98 per cent) healthy individuals in a given age and gender group. Assuming the nutrient requirements are normally distributed, the RNI is calculated as follows:

RNI = EAR + 2 x Standard Deviation (SD)

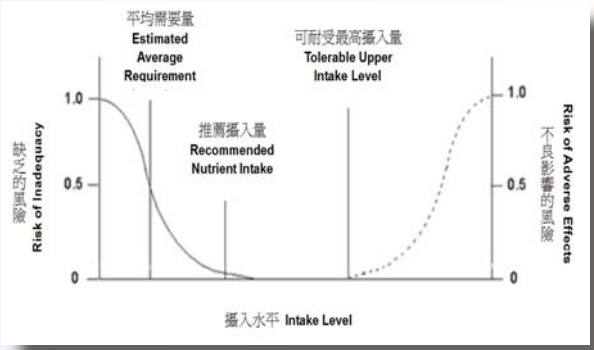
Adequate Intake (AI) – When sufficient scientific evidence is lacking, the EAR cannot be determined, in turn the RNI cannot be calculated. In such case, the AI is provided. The AI is based on experimental data or observed nutrient intake by a group of healthy people, with an assumption that the intake is adequate to promote health. Obviously, the AI is less certain than the RNI as there is insufficient scientific supporting data. A nutrient has either a RNI or an AI, but not both.

Tolerable Upper Intake Level (UL) – The UL is the highest nutrient intake value that is likely to pose no risk of adverse health effects for individuals in a given age and gender group. It is not intended to be a recommended level of intake. The UL is established when strong evidence supporting the relationship between a nutrient and the adverse effects is available. No ULs are set for macronutrients (carbohydrates, protein and fat). One of the main reasons is that multiple risk factors, such as lack of physical activities and smoking, contribute to the development of a chronic disease. Thus, it is not possible to determine a defined level of intake as the UL.

In summary, both the AI and RNI are intended to meet the needs of almost all healthy individuals in a given age and gender group, as such, both values are considered to be the goals of nutrient intake. As regards the risk of adverse health effects, the UL can be used as a guide to limit the intake levels. The risk of adverse effects increases as the intake increases above the UL.

可耐受最高攝入量 — 指通常不會對某特定年齡及性別羣組的人的健康帶來不良影響的風險的最高營養素攝入數值。此數值並非是建議的攝入水平。如有充分證據證明某營養素會對健康造成不良影響，該種營養素便會訂有可耐受最高攝入量。常量營養素（碳水化合物、蛋白質和脂肪）並沒有訂定可耐受最高攝入量，主要原因之一是有許多風險因素（如缺乏運動和吸煙）均可引發慢性疾病，因此，無法釐定特定的攝入水平作為可耐受最高攝入量。

膳食營養素參考攝入量跟營養缺乏的風險及營養素對健康造成不良影響的風險的關係
Relationship of Dietary Reference Intakes to Risk of Nutrient Inadequacy and Risk of Adverse Health Effects



簡言之，適宜攝入量和推薦攝入量都是為滿足某特定年齡及性別羣組中幾乎所有身體健康的人的需要而制定的，因此，兩個數值可視作目標營養素攝入量。至於營養素對健康造成不良影響的風險，則可採用可耐受最高攝入量作為指標限制攝入水平。如營養素攝入量增至高於可耐受最高攝入量，對健康造成不良影響的風險便會增加。

由下一期起，我們將會詳述一些營養素（如脂肪、膽固醇和碳水化合物）的化學結構、功能、食物來源和相關的健康事宜。我們希望讀者掌握有關營養素的基本知識，以便善用飲食指南金字塔和營養標籤等常見的營養教育資料。

We shall examine the chemical structures, functions, food sources and related health issues of some nutrients, such as fat, cholesterol and carbohydrates in the following issues. It is our goal that readers, with the basic knowledge on these nutrients, would be able to better apply the common nutrition education tools, such as food guide pyramid and nutrition labels.

個別營養素的膳食營養素參考攝入量
DRIs of Selected Nutrients

營養素 Nutrient	推薦攝入量或適宜攝入量 RNI or AI		可耐受最高攝入量 UL
能量 Energy	推薦攝入量 ・低運動量的男性=2 400千卡 ・低運動量的女性=2 100千卡	RNI • Male with light physical activity level=2 400 kcal • Female with light physical activity level=2 100 kcal	---
蛋白質 Protein	推薦攝入量 ・低運動量的男性=75克 ・低運動量的女性=65克	RNI • Male with light physical activity level=75g • Female with light physical activity level=65g	---
碳水化合物 Carbohydrates	適宜攝入量 = 能量攝入量的55%-65%	AI=55%-65% Energy Intake	---
脂肪 Fat	適宜攝入量 = 能量攝入量的20%-30%	AI=20%-30% Energy Intake	---
飽和脂肪 Saturated Fat	適宜攝入量 = 少於能量攝入量的10%	AI=Less than 10% Energy Intake	---
鈉 Sodium	適宜攝入量 = 2 200毫克	AI=2 200 mg	---
維他命A Vitamin A	推薦攝入量 ・男性 = 800微克視黃醇當量 ・女性 = 700微克視黃醇當量	RNI • Male=800μgRE • Female=700μgRE	3 000微克視黃醇當量 3 000μgRE
鈣 Calcium	適宜攝入量 = 800毫克	AI=800 mg	2 000毫克 2 000 mg

食物事故點滴 Food Incident Highlight

雞蛋受三聚氰胺污染

自上一期的“焦點個案”專文發表後，食物安全中心(中心)已參照三聚氰胺事件專家小組的建議，把三聚氰胺檢測工作的食物抽樣範圍擴大。除了奶類和以奶類製造的加工食物外，在第二階段的食物抽樣工作已擴及食物原材料(如雞蛋)、肉類和蔬菜。

於二零零八年十一月十六日，中心已完成第二階段的檢測工作。當中抽取了263隻雞蛋進行測試，當中有139個是產自內地，而測試合格的有260個(98.9%)。至於測試不合格的內地雞蛋樣本，相信是由於母雞吃了受三聚氰胺污染的飼料所致。中心亦已在十一月十七日展開第三階段的檢測，當中會再抽驗在先前兩個階段被驗出不合格的食品種類。

由於不合格雞蛋樣本的三聚氰胺含量頗低，市民無須過分擔心。食物及衞生局和中心會與內地當局保持緊密聯繫，以期在食物源頭控制上減低風險。

Melamine Contamination in Eggs

Since the publication of the Incident in Focus article in the last issue, the Centre for Food Safety (CFS) has expanded the sampling plan for melamine analysis on the recommendation of the Expert Group on Melamine Incident. Other than milk and processed food with milk-based ingredients, the plan for second phase included food raw materials (e.g, eggs), meat and vegetables.

On 16 November 2008, CFS has finished the second phase of testing. Of the 263 eggs sampled, 260 (98.9%) were satisfactory. Among the eggs sampled, 139 samples were produced in the Mainland. As regards the failed Mainland samples, it was believed that melamine entered the eggs after the hens had consumed contaminated feed. CFS has also entered into the third phase of testing since 17 November. Food samples found unsatisfactory in the previous phases will be re-tested.

As the level of melamine in unsatisfactory egg samples is quite low, there is no need for undue concern. The Food and Health Bureau and the CFS would maintain close contact with the Mainland authorities in an attempt to reduce the risk at the source.

已進行三聚氰胺檢測的雞蛋、雞類、肉類和魚類樣本數目（截至二零零八年十一月十六日止）
Number of Eggs, Chicken, Meat and Fish Samples Analysed for Melamine (as of 16 November 2008)

食物類別 Food Category	已檢測的樣本數目 No. of Samples Analysed	測試合格的樣本數目 No. of Satisfactory Samples (%)
雞蛋 Eggs	263	260 (98.9%)
雞類及雞類製品 Chicken and chicken products	93	93 (100%)
肉類(豬肉／牛肉／其他肉類)及肉類製品 Meat (pork / beef / other meat) and meat products	90	90 (100%)
魚類及魚類製品 Fish and fish products	172	172 (100%)
蔬菜 Vegetables	30	30 (100%)