

Message to Healthcare Colleagues
on Nitrate/Nitrite in Vegetables and Methaemoglobinaemia in Infants

The following information is about:

- Part 1 - Background information
 - (A) nitrate and nitrite content in vegetables
 - (B) methaemoglobinaemia, and how it relates to consumption of nitrate/nitrite containing vegetables
- Part 2 – Key messages to parents – “Vegetables as weaning food”
- Part 3 - Q&A – Colleagues may refer to this when handling parents’ questions

Part 1 - Background information

(A) Nitrate and Nitrite in Vegetables

1. Nitrate is a naturally occurring compound in the environment and plants. It is also a form of fertilizers. Nitrate and nitrite compounds can be added as preservative and colour retention agent in some processed meat products, including bacon, corned beef, beef jerky, luncheon meats, sausages and hams.
2. The study of Centre for Food Safety (CFS) found that some locally available vegetables contain higher nitrate content than others. They include leafy green vegetable such as Chinese spinach (莧菜), Shanghai cabbage (小棠菜), and petiole Chinese cabbage (白菜), spinach (菠菜) etc. and beetroot (紅菜頭).
3. Nitrate is relatively non-toxic by itself, but its metabolite, nitrite would be harmful and may lead to methaemoglobinaemia.
4. Conversion of nitrate (硝酸鹽) to nitrite (亞硝酸鹽) in vegetables:
 - a. Nitrate is naturally converted to nitrite by an enzyme (nitrate reductase) within the vegetables.
 - b. Bacteria action on vegetables also causes accumulation of the nitrite before and after cooking, and after ingestion.
5. Processing and cooking alters the nitrate and nitrite level:
 - a. Pureeing can release the enzyme (nitrate reductase) and accelerate the conversion of nitrate to nitrite.
 - b. Boiling can reduce nitrate content of the vegetables to some extent.

6. In order to reduce intake of nitrate and nitrite from leafy green vegetables, Table 1 shows the key steps that are specific in reduction of nitrate and nitrite intake.

Table 1 : Key steps to reduce nitrate/nitrite intake from leafy vegetables	
a.	Store the leafy vegetables in refrigerator if they are not cooked immediately;
b.	Cook vegetables soon after chopping or mashing;
c.	Wash and peel vegetables before cooking;
d.	Blanch (焯水) leafy vegetables or high-nitrate-containing vegetables in boiling water for 1 - 3 minutes and discard the cooking water before consumption.
e.	Infant foods such as vegetable puree and vegetable congee should be prepared for immediate use.
f.	If there is delay in consumption of the puree/congee, it is best to be kept in freezer (at or below -18°C) to avoid accumulation of nitrite due to contamination of bacteria of the food.
g.	If refrigerated (at 0 - 4 °C), puree/congee should not be stored for more than 12 hours. Refrigerated storage longer than 12 hours is considered unsafe in this situation.

(B) Methaemoglobineamia

1. What is methaemoglobineamia?

- The ferrous (Fe^{2+}) iron in oxyhemoglobin is oxidized to ferric iron (Fe^{3+}) forming methemoglobin. Methemoglobin cannot bind oxygen, hence excessive methemoglobin or methaemoglobineamia results in hypoxia and cyanosis.

2. What are the symptoms of methaemoglobineamia?

- Shortness of breath, cyanosis, mental status changes, headache, fatigue, exercise intolerance, dizziness and loss of consciousness (呼吸困難, 皮膚發紫/變藍).

3. How consumption of nitrate/nitrite relates to methaemoglobineamia?

- The relatively non-toxic nitrate in vegetables can be converted to nitrite by enzyme and bacteria due to improper storage and handling. Ingested nitrate can also be converted to nitrite in human.
- Excess nitrite intake mediates oxidation of ferrous (Fe^{2+}) iron in oxyhemoglobin to ferric iron (Fe^{3+}) forming methemoglobin. Methemoglobin cannot bind oxygen, hence resulting in hypoxia and cyanosis.
- Infants consuming excess nitrite experience methaemoglobineamia or “blue baby syndrome”.

4. Why infants are vulnerable to nitrite related methaemoglobineamia?

- Infants have a higher gastric pH than older children or adults, resulting in proliferation of bacteria and conversion of nitrate to nitrite.
- Very young babies have higher level of fetal haemoglobin which is more easily oxidized by nitrite.
- They also have a **limited** capacity to reduce methaemoglobin to normal state than adults.
- Therefore, American Academy of Pediatrics (AAP) concluded that home prepared infant food containing vegetables should be avoided until the baby is 3 months or older regarding prevention of methaemoglobineamia.
- AAP also concluded that breastfed infants are not at risk of nitrite poisoning if their mothers have a high nitrate intake.

5. How much nitrite will cause methaemoglobineamia?

- The issue is controversial and the dose that causes methaemoglobineamia varied among individuals.
- Multiple factors come into play when methaemoglobineamia occurs due to nitrate/nitrite intake:

- i. Dietary factors - The intake of high levels of nitrate and nitrite from water (e.g. contaminated well water) and vegetables. The nitrate and nitrite levels in vegetables depends on species variation, growing methods and conditions, fertilizers used, as well as storage and cooking methods.
- ii. Non-dietary factor - Gastrointestinal infection which commonly occurs in children may cause an additional increase in conversion of nitrate to nitrite in intestine.

6. Is it safe to eat vegetables given that nitrate level in vegetables is high?

Although certain leafy vegetables are relatively high in nitrate, they are also rich in many important nutrients with beneficial effects in protecting against chronic diseases. Therefore, leafy vegetables should be maintained in our diet but should not be the only type of vegetables in our diet. People are advised to eat a wide variety of vegetables including leafy vegetables, brassica vegetables, root and tuber vegetables, fruiting vegetables, legume vegetables, etc.

7. From the literature, case reports of methaemoglobinaemia in infants were found in those who consumed vegetable congee and vegetable soup that were stored overnight.

8. Apart from young infants, who are also susceptible to methaemoglobineamia?

- Persons with genetic defects of enzymes in various metabolic pathways, e.g. G6PD deficiency, are susceptible. However, methaemoglobineamia is a rare occurrence among G6PD individuals.

9. Apart from taking excess nitrite, what may cause methaemoglobinemia?

Pharmaceutical agents	Environmental agents
<ul style="list-style-type: none"> ● Local anesthetic agents ● Antimalarial drug ● Methylene blue ● Vasodilators, e.g. amyl nitrite, nitrates, nitrites, nitroglycerin, nitroprusside ● Analgesics , e.g. phenacetin ● Antibiotics, such as nitrofurans, quinones, and sulfonamides ● Resorcinol- an ingredient of ointment used at chronic skin condition such as acne, psoriasis, eczema, cosmetic and hair dye ● Methylene blue can also be the antidote of methemoglobinemia 	<ul style="list-style-type: none"> ● Aniline dyes used for crayons ● Aromatic amines ● Chromates used for metal plating ● Chlorates, used as combustion products of matches ● Acetonitril-containing nail varnish remover ● Naphthalene-containing mothballs

Part 2 – Key messages to parents – “Vegetables as weaning food”

1. Infants are recommended to start weaning when they reach 6 months of age but NOT earlier than 4 months.
2. Vegetables should be introduced as one of the weaning foods, but **SHOULD NOT** be given to babies under 3 months.
3. Babies can be given a small amount of vegetables once a day when complementary feeding commences. The amount gradually increases to 2 - 4 tablespoons per day when the amount of solid food increases at 9 - 12 months. **A variety of vegetables of different colours and forms** (葉菜、花菜類：如西蘭花，塊莖類：如甘筍、馬鈴薯，瓜類，豆類：如荷蘭豆，果菜：如蕃茄、燈籠椒，鱗莖類：如洋蔥等) **should be given and in rotation.**
4. In preparing weaning food with vegetables, the following key points in food safety should be followed:

General Food Safety Key Points
<ol style="list-style-type: none">a. Choose wholesome vegetables.b. Wash and then soak for 1 hour before cooking to remove chemicalsc. Cooked vegetables should be consumed as soon as they are prepared.d. If not consumed immediately, cooked vegetables should be properly stored to suppress bacterial growth. Proper storage methods are :<ol style="list-style-type: none">i. Cool down the food as quickly as possible, and put into refrigerator within 2 hours.ii. Keep uneaten portion refrigerated at 4°C or below. If the expected delay in consumption is more than 12 hours, the food should be kept frozen in the freezer.iii. When the food is consumed, it should be cooked thoroughly by boiling for 1 minute. Consume as soon as possible.
Specific safety precautions to avoid excess intake of nitrite in infants when preparing leafy vegetables
<ol style="list-style-type: none">h. Store the leafy vegetables in refrigerator if they are not cooked immediately;i. Wash and peel vegetables before cooking;j. Cook vegetables soon after chopping or mashing;k. Blanch (焯水) leafy vegetables or high-nitrate-containing vegetables in boiling water for 1 - 3 minutes and discard the cooking water before consumption.l. Infant foods such as vegetable puree and vegetable congee should be prepared for immediate use.m. If there is delay in consumption of the puree/congee, it is best to be kept in freezer to avoid accumulation of nitrite due to contamination of bacteria of the food.

n. If refrigerated (at 0 - 4°C), the puree/congee should not be stored for more than 12 hours. Refrigerated storage longer than 12 hours is considered unsafe in this situation.

5. It is safe to eat locally available vegetables containing higher nitrate content if preparation and storage are appropriate (see point 4). Vegetables contain high nitrate content are green leafy vegetable such as Chinese spinach (莧菜), Shanghai cabbage (小棠菜), and petiole Chinese cabbage (白菜), spinach (菠菜), etc. and beetroot (紅菜頭).
6. Babies suffering from gastrointestinal disease should avoid eating vegetables or the soup of vegetables that are high in nitrate.
7. Refrain from giving babies processed meat or preserved food products as nitrate / nitrite and salt may be added.

Part 3 - Q & A

1	<p>Is it safe for babies to eat vegetables?</p> <ul style="list-style-type: none"> ● Yes, it is safe for babies to eat vegetables but proper preparation is needed.
2	<p>When can babies eat vegetables?</p> <ul style="list-style-type: none"> ● Usually after 6 months when solid foods are being introduced. Some parents introduce solid food earlier but they should NOT be eaten before 4 months.
3	<p>What vegetables are high in nitrate?</p> <ul style="list-style-type: none"> ● The study of CFS found that - green leafy vegetable such as Chinese spinach (莧菜), Shanghai cabbage (小棠菜), and petiole Chinese cabbage (白菜), spinach (菠菜), etc and beetroot (紅菜頭) are high in nitrate.
4	<p>Is it safe for babies to eat these vegetables?</p> <p>Yes, provided these guides on preparation and storage are followed:</p> <ul style="list-style-type: none"> ● Preparation of vegetables for infants: <ul style="list-style-type: none"> - Blanch the vegetables in water. Discard the water used for cooking. Then mince or puree the vegetable. ● Storage of the vegetable puree: <ul style="list-style-type: none"> - If the vegetable puree is not eaten immediately, keep it at 4°C or below in refrigerator to suppress bacterial growth and actions. - If the expected delay in consumption is more than 12 hours, the vegetable puree should be kept frozen in the freezer.
5	<p>Is it safe to keep vegetable puree or vegetable congee in thermal flask?</p> <ul style="list-style-type: none"> ● It is not recommended. ● There are various factors affecting temperature of the food kept in the flask, e.g. size of the flask, quality of flask, tightness of the cover, volume of food, temperature of the food at the time of transfer, etc. ● Thus, the temperature may not be maintained above 60°C to suppress bacterial growth and actions.
6	<p>How to cook or prepare the vegetables that are low in nitrate?</p> <ul style="list-style-type: none"> ● The additional blanching step may not be necessary. ● Storage of food and vegetable puree should follow the instructions and precautions of those high in nitrate mentioned above.
7	<p>Is it safe for babies to drink vegetable soup?</p> <ul style="list-style-type: none"> ● Soups from high nitrate containing vegetables are better avoided or restricted in quantity. ● Babies suffering from gastrointestinal infection or diarrheal diseases should not drink vegetable soup.
8	<p>Is it safe for older children or adults to eat or drink soup prepared from high nitrate vegetables?</p> <ul style="list-style-type: none"> ● It is safe to eat the vegetables. ● It is safe to drink the soup if they are properly prepared.
9	<p>Is it safe for older children or adults to drink these vegetables soup stored overnight?</p> <ul style="list-style-type: none"> ● There is always a risk of consuming leftover food. One should make sure the food is adequately reheated before consumption.
10	<p>How much vegetable is safe?</p> <ul style="list-style-type: none"> ● To prevent methemoglobinaemia, <ul style="list-style-type: none"> ■ No actual level of nitrate intake, or type and amount of vegetable is quoted as safe by expert agencies. ■ Follow the above procedures in preparing and storing vegetables. ■ Avoid consuming vegetable soup or vegetable congee stored overnight even in

	<p>refrigerator.</p> <ul style="list-style-type: none"> ■ Those suffering from diarrheal diseases should not eat vegetables or soup of vegetable with high nitrate content.
11	<p>How much vegetable is recommended for babies of 6 - 12 months old in a day?</p> <ul style="list-style-type: none"> ● The usual quantity of intake is around 2 - 4 tablespoon per day. <p>For children and adults:</p> <ul style="list-style-type: none"> ● 1 - 3 year : 80 - 160g (2 - 4兩) vegetables, 1/3 to 2/3 bowl of cooked vegetables ● 3 - 6 year: 160 - 240g (4 - 6兩) vegetables, or 2/3 to 1 bowl of cooked vegetables ● Adults: 240 - 320g (6 - 8兩), or 1 to 1.3 bowls of cooked vegetables.
12	<p>Are organic vegetables of lower nitrate content?</p> <ul style="list-style-type: none"> ● We have no information on the issue. We advise parents to adopt the above procedures regardless of how the vegetables are grown.
13	<p>Since keeping food in a thermal flask may not be safe, what weaning foods should parents feed the baby when going out?</p> <ul style="list-style-type: none"> ● Parents should plan ahead if going out with the baby. The following are possible alternatives : <ul style="list-style-type: none"> ■ Modify parents' activity schedule to suit infant's feeding schedule. ■ Change the feeding schedule so that it is not necessary to feed the baby with food stored in thermal flask. ■ Feed baby with alternative food (bottled or reconstituted with warm water). ■ For older infants, share foods with adults. Prepare a clean towel and scissors to cut adult's food to size that baby can eat.
14	<p>If a breastfeeding mother eats a lot vegetables high in nitrate, will it affect her milk?</p> <ul style="list-style-type: none"> ● The milk is safe.

Prepared by Department of Health and Centre for Food Safety, Food and Environmental Health Department.

29th July 2010