

## Messages to Healthcare Colleagues

### on Nitrate/Nitrite in Vegetables and Methaemoglobinaemia in Babies (Blue Baby Syndrome)

The following information consists of:

- Part 1 – Background Information
  - (A) Nitrate and Nitrite in Vegetables
  - (B) Methaemoglobinaemia
- Part 2 – Key Messages to Healthcare Colleagues

#### Part 1 - Background information

##### (A) *Nitrate and Nitrite in Vegetables*

1. Nitrate is naturally present in the environment and vegetables. It is also used as a fertiliser. Nitrate and nitrite compounds can be used as food preservatives in cheese products and cured meat.
2. In general, leafy vegetables have higher nitrate contents than root vegetables (e.g. carrot), bulb vegetables (e.g. onion), fruiting vegetables (e.g. cucumber), or legume vegetables (e.g. snow pea).
3. A study conducted by the Centre for Food Safety (CFS) has revealed that among leafy vegetables, amaranth (莧菜), green Chinese cabbage (小棠菜), Pak-choi (白菜), and spinach (菠菜) have higher levels of nitrate. Beetroot (紅菜頭), a root vegetable, also has a high level of nitrate.<sup>1</sup>
4. Nitrate is relatively non-toxic by itself, but its metabolite, nitrite can lower the blood's ability to carry oxygen in humans.
5. Nitrate can be converted to nitrite by:
  - a. an enzyme (known as nitrate reductase) naturally present in vegetables
    - in fresh and undamaged vegetables, the enzyme and nitrate are kept separate from each other.
    - when fresh vegetables are pureed or mashed, the enzyme comes into contact with nitrate and converts nitrate to nitrite.
  - b. bacteria on cooked vegetables
    - some bacteria from the air or utensils may contaminate cooked vegetables and

convert nitrate to nitrite.

c. bacteria in the stomachs of babies

- babies less than 6 months have less stomach acid than adults.<sup>2</sup> This favours the growth of bacteria in their stomachs, resulting in increased conversion of nitrate in the ingested vegetables to nitrite.

6. Processing, cooking, and storage can affect the nitrate and nitrite levels in vegetables:

a. Washing and peeling can reduce the levels of nitrate in vegetables.

b. Boiling can reduce the nitrate contents of vegetables.

c. Pureeing raw vegetables releases the enzyme that catalyses the conversion of nitrate to nitrite.

d. Low temperature can reduce the growth of bacteria and their activities of converting nitrate to nitrite in cooked vegetables:

- at refrigerated temperature (0 - 4°C), the conversion rate of nitrate to nitrite is low.
- at frozen temperature, the conversion of nitrate to nitrite stops.

(B) *Methaemoglobinaemia*

**1. What is methaemoglobinaemia?**

- Haemoglobin in red blood cells can be oxidised to methaemoglobin. Methaemoglobin is unable to bind and transport oxygen and excessive methaemoglobin results in methaemoglobinaemia.
- Methaemoglobinaemia can be inherited or acquired. Acquired methaemoglobinaemia can be caused by exposure to certain medications (e.g. sulphonamides), chemicals (e.g. naphthalene), or foods.

**2. What are the symptoms of methaemoglobinaemia?**

- The symptoms include shortness of breath, cyanosis, mental status changes, headache, fatigue, exercise intolerance, dizziness, and loss of consciousness.

**3. How does consumption of vegetables relate to methaemoglobinaemia in babies?**

- Nitrite is able to oxidise haemoglobin to methaemoglobin. Exposure to high levels of nitrite may result in methaemoglobinaemia.
- Nitrite concentrations are low in fresh and undamaged vegetables. However, the nitrite levels can increase rapidly in certain nitrate-rich vegetables (e.g. spinach), particularly if the raw vegetables are pureed before cooking and/or the cooked

vegetable puree is kept at room temperature for a prolonged period.

- There were reports of methaemoglobinaemia in babies (also called “blue baby syndrome”) after ingesting nitrate-rich vegetables which have been inappropriately handled.

**4. Why are babies under 6 months particularly vulnerable to methaemoglobinaemia induced by nitrate and nitrite in vegetables?**

- Very young babies have a higher level of foetal haemoglobin that is more readily oxidised to methaemoglobin by nitrite. Once oxidised, it is also more difficult for methaemoglobin to be converted back to normal haemoglobin.
- Babies secrete less stomach acid than adults until they reach about 6 months of age. This favours the growth of bacteria in their stomachs, resulting in increased conversion of nitrate in the ingested vegetables to nitrite.

**5. How can we prevent methaemoglobinaemia in babies?**

- Babies are recommended to start weaning when they reach 6 months of age. Nitrate-rich vegetables (e.g. amaranth, green Chinese cabbage, and Pak-choi) should not be given to babies below 6 months of age.
- A variety of vegetables should be introduced to babies so as to avoid overconsumption of certain vegetables naturally high in nitrate.
- Babies suffering from bacterial infections of the gastrointestinal tract should not be given nitrate-rich vegetables because there is a risk of more nitrate being converted into nitrite in the gut after the intake of high-nitrate foods.<sup>3,4</sup>

**6. Is it safe for babies above 6 months of age to eat nitrate-rich vegetables?**

- Although certain vegetables are relatively high in nitrate, they are also rich in many important nutrients (e.g. vitamins and minerals). It is advised to introduce a wide variety of vegetables including leafy vegetables, brassica vegetables, root vegetables, fruiting vegetables, legume vegetables, etc. to babies above 6 months of age.

## Part 2 – Key Messages to Healthcare Colleagues

1. Babies are recommended to start weaning when they reach 6 months of age. Nitrate-rich vegetables should not be given to babies until they are 6 months or older.
2. Babies suffering from gastroenteritis should avoid eating nitrate-rich vegetables.
3. Babies should not eat processed meats because table salt and/or nitrite compounds are commonly added to these products.
4. A variety of vegetables (including leafy vegetables, brassica vegetables, root vegetables, fruiting vegetables, legume vegetables, etc.) should be introduced to babies so as to avoid overconsumption of certain vegetables naturally high in nitrate.
5. Weaning food should be prepared hygienically and stored safely. When preparing and handling weaning food with leafy vegetables, the following points should be followed:

Procedures	Remarks
Use fresh and wholesome leafy vegetables.	Fresh and undamaged leafy vegetables have low levels of nitrite.
Wash leafy vegetables under running water.	Washing can remove dirt and bacteria from the surface and reduce nitrate.
Cook leafy vegetables in boiling water for 1 to 3 minutes.	Cooking softens the vegetables for pureeing. Cooking also kills bacteria and denatures the enzyme in leafy vegetables so that nitrate cannot be converted to nitrite.
Puree leafy vegetables (e.g. use a fine grater, strainer or sieve or a blender)	Use clean utensils to prevent bacterial contamination.
(a) Feed immediately and throw away any leftovers in the bowl; or (b) If not used immediately, cool the vegetable puree as quickly as possible and store it in the refrigerator within one hour after cooking: (i) store at refrigerated temperature and use within one day; or (ii) store at frozen temperature and use within one week.	(a) Saliva contaminates the food with bacteria. (b) Low temperature reduces the growth of bacteria as well as their activities to convert nitrate to nitrite.
After taking the puree from the refrigerator, reheat it until piping hot before use. (Do not reheat more than once)	High temperature kills bacteria.

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

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## Reference

<sup>1</sup> Centre for Food Safety. Risk Assessment Studies: Nitrate and Nitrite in Vegetables Available in Hong Kong. July 2010. Report No. 40. Available from [https://www.cfs.gov.hk/english/programme/programme\\_rafs/programme\\_rafs\\_fc\\_01\\_23\\_Nitrate\\_Nitrite\\_Vegetables.html](https://www.cfs.gov.hk/english/programme/programme_rafs/programme_rafs_fc_01_23_Nitrate_Nitrite_Vegetables.html)

<sup>2</sup> Dallas DC, Underwood MA, Zivkovic AM, German JB (2012) Digestion of Protein in Premature and Term Infants. *J Nutr Disorders Ther* 2:112. Available from doi: 10.4172/2161-0509.1000112

<sup>3</sup> EFSA CONTAM Panel (EFSA Panel on Contaminants in the Food Chain), 2010. Scientific Opinion on possible health risks for infants and young children from the presence of nitrates in leafy vegetables. *EFSA Journal* 2010;8(12):1935, 42 pp. Available from <https://www.efsa.europa.eu/en/efsajournal/pub/1935>

<sup>4</sup> Bundesinstitut für Risikobewertung (BfR), 11 June 2013. Frequently Asked Questions on nitrate and nitrite in food. Available from <https://www.bfr.bund.de/cm/349/frequently-asked-questions-on-nitrate-and-nitrite-in-food.pdf>