**AIS WEBSITE FACT SHEET – AIS SPORTS SUPPLEMENT PROGRAM**

# Beetroot juice/Nitrate

Conversion for nitrate : 1 mmol = 62 mg

## *Supplement Overview*

- The current interest in beetroot juice arises from research by Professor Andy Jones and colleagues (University of Exeter, UK) which has used this juice as a rich source of nitrate.
- Nitrate ($NO_3^-$) is one of a family of compounds containing nitrogen and oxygen that is both found in our diets and produced within our bodies. Our main dietary sources of nitrate are vegetables, processed meats (where it is added as a preservative) and the water supply.
- Estimates of the average dietary intake of adults in the US and Europe is 1-2 mmol/d (~60-120 mg/d) with vegetables providing about 80% of this total. Vegetarians are likely to consume higher nitrate intakes and people who follow "heart-friendly" eating plans such as the DASH diet are also likely to achieve nitrate intakes that are considerably higher.
- Table 1 summarises the nitrate content of a range of vegetables from several different references, with the best sources being green leafy plants and vegetables grown in low light conditions such as plant roots. The nitrate content of a specific vegetable source can vary considerably from plant to plant. The nitrate content of water comes from decay of organic material in the soil, bacterial activity and nitrogen containing fertilizers.

| **Nitrate** | **Content ( per kg fresh vegetable)** | **Common Vegetables** |
|---|---|---|
| Very High | 2500 mg/40 mmol | Beetroot and beetroot juice, celery, lettuce, rocket, spinach |
| High | 1000-2500 mg/18-40 mmol | Chinese cabbage, celeriac, endive, leek, parsley, kohlrabi, |
| Moderate | 500-1000 mg/9-18 mmol | Cabbage, dill, turnips, carrot juice |
| Low | 200-500 mg/3-9 mmol | Broccoli, carrot, cauliflower, cucumber, pumpkin, V8 vegetable juice, |
| Very low | <200 mg/< 3 mmol | Asparagus, artichoke, broad beans, green beans, peas, capsicum, tomato, watermelon, tomato, sweet potato, potato, garlic, onion, eggplants, mushroom |

(taken from Bryan NS and Hord NG (2010). Dietary Nitrates and nitrites: in: Bryan N (ed), Food Nutrition and the Nitric Oxide pathway. Destech Pub Inc: Lancaster, PA, pp 59-77)

- During the 1960s, health authorities became concerned about the nitrate and nitrite content of foods, blaming nitrite for health issues including "blue baby syndrome"in infants and an increased risk of colon cancer based on studies in rats. Based on these (now generally discredited) ideas, some countries have limits on the permitted levels of nitrate in foods and drinking water.
- In contrast to these previous concerns about the safety of intake of nitrates and nitrites, there is now evidence of health benefits, including theories that some of the health benefits of a diet high in vegetables are due to its nitrate content.

- Dietary nitrate is rapidly absorbed in the stomach and small intestine, with plasma nitrate levels peaking after ~ 1 hour. A significant proportion of plasma nitrate is extracted by the salivary glands and concentrated in saliva where bacteria found in the tongue convert it to nitrite in an oxygen independent reaction. The swallowing of nitrite into the acidic stomach environment starts the process in which nitrite is further processed into reactive nitrogen species including Nitric Oxide (NO). Plasma nitrite concentrations peak at ~ 2.5 h following the intake of dietary nitrate. Factors that interfere with salivary nitrate handling processes - such as the use of antibacterial mouthwashes and gum to reduce mouth levels of bacteria or the prevention of the swallowing of saliva – will reduce this rise in plasma nitrite.
- Some of the nitrate involved in this nitrogen cycle is produced within the body from the breakdown of NO. It was previously believed that the synthesis of NO, which regulates a large number of important processes in the body, was reliant on a pathway involving the amino acid arginine. However, we now know that NO is broken down to nitrate which is then recycled via this nitrate-nitrite conversion pathway back into NO. The discovery of this well-developed pathway of production of NO and reactive nitrogen species supports the theory that dietary nitrate is useful rather than a toxic substance.
- NO is a very important chemical in our bodies with functions ranging from relaxing the tone of blood vessels (thereby regulating blood pressure, the susceptibility of vessels to vascular disease and tissue oxygenation), regulating platelet aggregation (thereby reducing the risk of atherosclerosis) and providing some immune system activities (especially to reduce infection in the mouth, gut and skin).
- Nitrate supplementation has been shown to enhance some of known functions of NO, even in healthy people. For example, supplementation with dietary nitrate sources or sodium nitrate has been shown to reduce blood pressure even in individuals with normal blood pressure
- Recent studies have demonstrated that chronic (3-15 d) and acute (single dose prior to exercise) protocols of beetroot juice intake are associated with a consistent enhancement of exercise economy (reduced oxygen cost of exercise). Evidence is also emerging that supplementation with beetroot juice prior to exercise can enhance exercise capacity and sports performance. More research is needed with sports-specific protocols and trained individuals.
- The (patented) preparation of a nitrate-depleted beetroot juice has allowed studies to use a true placebo control in nitrate supplement studies using this vegetable source. These studies have confirmed that the nitrate content of beetroot juice is the active ingredient underpinning the observed physiological and exercise benefits.
- Early studies of beetroot juice supplementation employed a short period of standardization to a nitrate-depleted diet (minimal intake of vegetables) to ensure that the supplement achieved a substantial increase in nitrate levels. More recent studies have shown that beetroot juice supplementation still increases nitrate levels in people consuming varied diets although the degree of increase in nitrate levels (and changes in physiological/performance parameters?) is smaller.

### *Products and protocols*

- Products currently available in Australia:
  - Beet It: 70 ml shots (James White UK): 300 mg nitrate
  - Go Beet: 200 ml juice (Heinz, Australia): 260 mg nitrate
- Typical dose used in recent studies of sports/exercise performance: ~ 5-6 mmol or ~300 mg nitrate provided by a single serve of beetroot juice, consumed ~ 2-2.5 hours pre-exercise

- Preparation of own beetroot sources (i.e. cooked vegetable, relish, juice) may not result in reliable nitrate dose
- Nitrate may also be purchased as sodium nitrate which is used as a fertilizer and preservative of meats
- Further research is needed to determine optimal timing and dose of nitrate/beetroot juice supplements on sports performance, particularly in highly trained individuals

### *Situations for Use in Sport*

- Recent studies have identified several situations in which exercise capacity or performance has been enhanced by the pre-exercise consumption of beetroot juice/nitrate: these include cycling and running events of 4-30 minute duration. Further research is encouraged to expand our knowledge of beneficial applications to sports performance
- Supplementation may also be of assistance as training support, especially during periods of exposure to hypoxic conditions – e.g. altitude training

### *Concerns Associated with Supplement Use*

- While it is unlikely that consumption of beetroot juice or other vegetable sources of nitrate is harmful (and may, in fact, may offer other health benefits), the effect of acute or chronic use of nitrate supplements has not been well studied. Some research papers and accompanying journal editorials have raised concerns about the potential for unknown side effects.
- Beetroot juice, particularly in concentrated form and larger doses, sometimes causes mild gastrointestinal discomfort.
- The consumption of beetroot/juice may cause a temporary pink coloration of urine and stools. This is a harmless side-effect.
- Use of sodium nitrate supplements may be associated with a greater risk of misjudging dosages. Some athletes may also mistakenly (or deliberately) use sodium nitrite as a supplement and expose themselves to other risks. Excessive intake of sodium nitrate, and especially sodium nitrite can produce toxic effects such as methemoglobinemia ("blue baby syndrome").
- The research is too premature to know the optimal protocol(s) for beetroot juice/nitrate supplementation or the range of sports or sporting situations that may benefit.
- It is difficult to provide a placebo for beetroot juice or beetroot due to its distinct flavour and effect on urine/stools. The use of a nitrate-depleted beetroot juice as a control in studies or case study experiments is encouraged.

### *Further reading*

*Please refer to summary table on research conducted on Nitrate/Beetroot Juice*

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