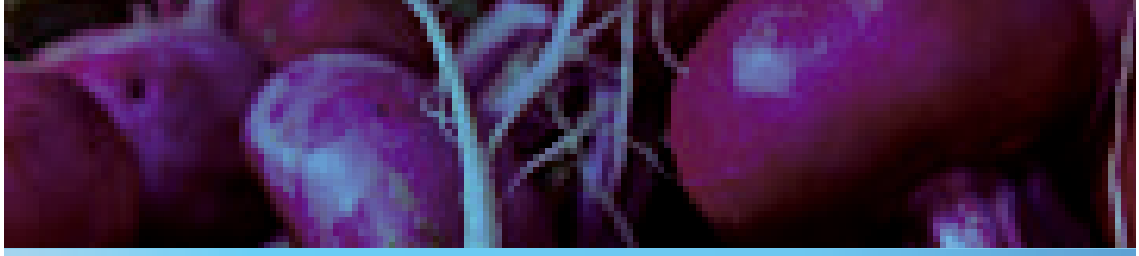


SPORTS DIETITIANS AUSTRALIA

FACT SHEET

NITRATE

WHAT IS NITRATE?

Nitrate has become increasingly popular as an ergogenic aid, with a number of recent studies finding benefits to sports performance following the ingestion of nitrate-rich foods. But what is nitrate?

The nitrate (NO_3) ion alone is considered to be biologically inert, and while a direct effect of the nitrate ion itself cannot be excluded, it is considered likely that its reduced state of nitric oxide (NO) and other related nitrogen intermediates may be responsible for physiological effects.

NO acts as a neurotransmitter/signalling molecule for a range of body systems and has a number of effects on the human body, which includes:

- vasodilation to increase blood flow
- regulation of muscle contraction and glucose uptake
- regulation of cellular respiration.

Our bodies can synthesise NO from the amino acid L-arginine, however previous attempts to supplement athletes with L-arginine have found mixed results on performance or physiology (1). Alternatively, NO can also be formed from the reduction of NO_3. Specifically, nitrate (NO_3) is reduced to nitrite (NO_2) by oral bacteria, which can be reduced further to NO in the stomach as required by the body. Increasing nitrate levels has shown more potential for enhancing exercise performance than L-arginine supplementation. It should be noted that antibacterial mouthwashes and chewing gum that reduce the levels of oral bacteria will impede the body's capacity to breakdown nitrate.

WHERE IS NITRATE FOUND ?

Our main dietary sources of NO_3 are vegetables (particularly leafy greens) and processed meats (where it is added as a preservative usually in the form of sodium nitrite/nitrate). It is important to consider that there is a large variability in the nitrate content of vegetables, even amongst the same variety. The freshness of the vegetable and the farming practices employed to harvest them all play a part in determining how much nitrate is present at the time of consumption. Fresh vegetables grown with nitrogen containing fertilizer will yield the greatest amounts of nitrate (therefore organically grown vegetables are likely to have lower nitrate levels).

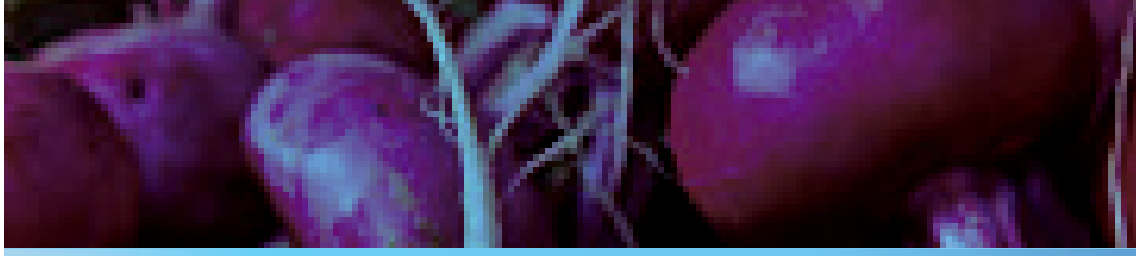
Nitrate	Content per kg fresh veg	Common Vegetables
Very High	2500mg/40mmol	Beetroot & juice, celery, lettuce, rocket, spinach
High	1000-2500mg / 18-40mmol	Chinese cabbage, celeriac, endive, leek parsley, kohirabi
Moderate	500-1000mg / 9-18mmol	Cabbage, dill, turnip carrot juice
Low	200-500mg / 3-9mmol	Broccoli, carrot. cauli, cucumber, pumpkin, V8 vegetable juice
Very low	<200mg / <3mmol	asparagus, artichoke, broad beans, green beans, peas, tomato watermelon, sweet potato, potato, garlic onion, eggplant & mushroom

(taken from Byran NS and Hord NG (2010). Dietary Nitrates and nitrates in: Bryan N(ed), Food Nutrition and the Nitric Oxide pathway. Destech Pub Inc: Lancaster, PA, pp59-77)

Courtesy of AIS Nutrition, November 2011. Note the conversion for nitrate: 1mmol = 62mg

WHY TAKE NITRATE AS A SPORTS SUPPLEMENT ?

The main benefit of nitrate supplementation appears to be a reduction in the energy cost of exercise, thereby improving efficiency at submaximal workloads. It was previously thought that changes to oxygen consumption at any given submaximal exercise intensity are difficult to improve, therefore there is significant interest in the impact of nitrate on this parameter. An improvement in exercise efficiency theoretically allows an individual to exercise at a greater intensity for the same level of effort.



SPORTS DIETITIANS AUSTRALIA

FACT SHEET

NITRATE

A number of studies using well-trained individuals as subjects have shown positive outcomes in reducing oxygen demand during submaximal exercise. A study conducted by Larsen et al (2007) found that sodium nitrate supplementation in an amount achievable with regular green vegetable intake, resulted in a reduced VO2 during submaximal exercise, improving cycling efficiency by ~1.4% (2). This effect was also reported by Bailey et al (2009) who observed a reduction in oxygen use by 19% at moderate workloads coupled with a ~16% improvement in cycling exercise to exhaustion, following the ingestion of 500ml of beetroot juice per day for 6 days (3). More recent studies have demonstrated how these changes may equate to greater performances in competition. Lansley and colleagues (2011) reported an improvement of ~3% to 4km and 16km cycling time trials respectively, in trained individuals following an acute dose of beetroot juice just 2.5hrs before exercise (4).

WHO SHOULD TAKE NITRATE?

Because of its vasodilatory and various other physiological effects, nitrate has been advocated for individuals with cardiovascular problems (e.g. angina) by medical professionals. More recently, its potential in sport and exercise has also been recognised. Although it is still early days, research has shown that athletes training for endurance events may benefit from a dose of nitrate before training and/or competition. The application of nitrate to other sports such as team and power sports is yet to be explored.

NITRATE DOSAGE AND PROTOCOLS

Currently there is inadequate evidence to formulate specific recommendations for individual sports. Studies which have reported benefits have used nitrate doses ~ 5-6 mmol (or ~300 mg), which is equivalent to 250-300g nitrate-rich vegetables (such as rocket lettuce, spinach, bok choy, broccoli, radish and beetroot). However the question remains as to whether we simply eat 250g of vegetables per day, or take a more concentrated dose, such as beetroot juice. Further research is also required to determine the optimal timing of intake, whether chronic intake or acute doses will be more beneficial. Commercially available beetroot juice provides an acute, concentrated dose of nitrate which can be taken up to 2 hours prior to exercise for immediate benefits. As with all competition strategies however, these must be trialled in training first to assess the effect on the individual.

The 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

ARE THEY ANY RISKS OR SIDE EFFECTS ?

The first question that many people ask is:
"Don't nitrates cause cancer?"
These concerns date back to around 50 years ago, when nitrite was blamed for a range of health issues including "blue baby syndrome" in infants and an increased risk of colon cancer based on studies in rats. As a result, many countries introduced limits on the permitted levels of nitrate in foods and drinking water.
In contrast to these previous concerns, there is now evidence of health benefits from a diet rich in nitrates. The European Food Safety Authority concluded in 2008 that "the beneficial effects of eating vegetables and fruit outweigh potential risk to human health from exposure to nitrate through vegetables". This is based on the consumption of up to 400g mixed fruit and vegetables per day, which does not exceed the recommended daily intake for nitrate. Furthermore, a summary of epidemiological studies concluded that nitrate from the diet or drinking water is not associated with cancer risk (5).
As there is currently limited evidence of the risks associated with higher levels of nitrate intake, caution must be taken when supplementing with doses above what would normally be consumed through regular dietary intake.

Other points to note:

- Beetroot juice may cause gastrointestinal discomfort.
- There may be a temporary pink coloration of urine and stools after beetroot juice consumption, which is harmless.
- Nitrite supplementation should be avoided, as overdosing is much easier and carries more significant consequences.

The current research surrounding nitrate intake reports potential benefits for athletes, however further investigation is required to enable sport-specific recommendations about timing, dosage and safety to be made.

1. Álvares, T. S., C. M. Meirelles, et al. (2011). "L-Arginine as a Potential Ergogenic Aid in Healthy Subjects." Sports Medicine 41(3): 233-248.
2. Larsen, F. J., E. Weitzberg, et al. (2007). "Effects of dietary nitrate on oxygen cost during exercise." Acta Physiologica 191(1): 59-66.
3. Bailey, S. J., P. Winyard, et al. (2009). "Dietary nitrate supplementation reduces the O2 cost of low-intensity exercise and enhances tolerance to high-intensity exercise in humans." Journal of Applied Physiology 107(4): 1144-1155.
4. Lansley, K. E., P. G. Winyard, et al. (2011). "Acute Dietary Nitrate Supplementation Improves Cycling Time Trial Performance." Medicine & Science in Sports & Exercise 43(6): 1125-1131 1110.1249/MSS.1120b1013e3182159 7b31821594.
5. World Health Organization "Guidelines for Drinking-water Quality. Nitrates and nitrites in drinking-water". Geneva, Switzerland: WHO, 2004.
6. AIS Sports Nutrition Department, November 2011.