SCIENCE IN SPORT

LEADERS IN SPORTS NUTRTION

How can nitrates, and nitric oxide, help endurance performance?

Leading endurance athletes in the world are realising the scientifically tested benefit of nitrates - find out how nitrates can help make a difference to you.

Consuming dietary nitrates can increase natural nitric oxide (NO) production by the body. Nitric NO works by relaxing and widening blood vessels, so blood pressure is reduced and blood flow is increased to organs and tissues – delivering increased oxygen and nutrients.[1,2] As a result, NO can reduce the oxygen 'cost' of exercise.[3-5] In addition, it has been shown in studies to have an effect on cell metabolism6,7 and the combined impact can increase tolerance to exercise.[8-10]

Studies of exercise performance in a range of situations and disciplines have consistently shown an improvement after consumption of dietary nitrates. For example, in one study where nitrates were consumed for 4 – 6 days, the time to exhaustion during severe-intensity running was increased by 15%, while the O2 cost of walking was reduced by 12 – 14%.10

NO can also reduce the damage that can build up from oxidation as a result of intense exercise, so it helps with recovery after sport.11,12

Introducing SiS GO+ Nitrates

SiS Go + Nitrates has been formulated to deliver the natural nitrate benefit of fresh vegetables, in an easy to use format with a standardised amount of nitrate per sachet. The nitrate level in fresh vegetables varies depending on how they are farmed. With SiS Go + Nitrates you can be sure you get the same amount in each gel. Also provided is folic acid, which your body needs for its natural nitric oxide pathway to function optimally.[13,14] It is now easier to consistently consume sufficient vegetable nitrate to achieve the beneficial effects, without altering your normal training regime in any major way.

Using SiS GO+ Nitrates to prepare for your endurance event

To achieve the full endurance benefit, you need to build up the nitrate-derived nitrite in your body to the optimal level, which requires an intake of 500 – 600mg nitrate per day.[3-5,8-10] In addition, consuming 360 – 400mg of folic acid per day will help to prevent depletion of your body's reservoir of folic acid, which can limit your natural nitric oxide pathways.[14,15] Both targets can be achieved by consuming two to three SiS GO + Nitrate gels each day, starting approximately 6 days before your endurance event. The last gel should be consumed 1 hour before the event. During your preparation and training, as well as during the event you should continue to consume your usual sports nutrition.

When others are flagging, your muscles will be able to carry on using oxygen and nutrients more effectively, allowing you to find extra power for those extra tough events.

What is NO and what does it do in the body

Ability to match muscle oxygen and nutrient supply to demand during exercise is limited by both blood delivery and the capacity of cells to extract these nutrients. Nitric oxide (NO), a gas produced by many cells in our bodies from the amino acid L-arginine, plays a role in controlling both of these processes.[16]
NO is a signalling molecule, which switches signals on and off within cells and directs cell metabolism and growth. An important result of NO-signalling in the cardiovascular system is vasodilation, or relaxation of blood vessels; by widening the vessels, blood pressure is reduced, resulting in increased blood flow to organs / tissues, and increased delivery of oxygen and nutrients.[1,2]
NO is also produced by skeletal muscle, and may play an important role in metabolic control via effects on blood delivery, glucose uptake,[17,18] inhibition of glycolysis,19 oxidative phosphorylation (cellular respiration)[7,20] and muscle fibre contractility.[21]

Why is NO important during exercise

The effects of NO on exercise performance are related to increased blood flow, and improved efficiency in aerobic metabolism.

To give some context - the reported work capacities of high-altitude populations such as Andeans and Tibetans are legendary. These populations have repeatedly been shown to have higher work capacity and lower fatigability than lowlanders, despite a VO_{2max} similar to or even lower than that of lowlanders.[22-24] Normally, a reduction in VO_{2max} is coupled to decreases in work performance, so these results have puzzled scientists for over 30 years. Current attempts to explain the so-called VO_{2max} paradox[25] use the hypothesis that high altitude populations may have a more efficient aerobic metabolism than lowlanders (even acclimatised lowlanders).[22,26] That is, they require a lesser amount of aerobic energy for carrying out set mechanical loads.

A recent study[27] has shown that Tibetans living at 4200m above sea level have > 10-fold higher circulating nitrate and nitrite levels than sea level residents, and more than double the forearm blood flow. It has been suggested that their altered NO metabolism is responsible for an improvement in mitochondrial efficiency, which allows them to work at higher capacity for the same O2 cost than sea level residents. It has been estimated (in rats, but expected to be similar in other mammals) that 20 - 25% of the basal metabolic rate may be related to inefficiency in mitochondrial respiration,[28] so it is obvious that even a partial increase in efficiency could have significant impact on work capacity.

Since 2007, a body of evidence has been growing that shows it may be possible to obtain similar effects on VO_2, $VOVO_{2max}$ and work capacity in sea level residents (in the short term) if their dietary nitrate consumption is increased.

The story started with work by Larsen et al, who showed in two small placebo controlled studies that administering sodium nitrite at a level comparable to the amount of nitrate consumed in a large serving of spinach either acutely, or for two to three days before testing, positively affected test performance but lowered $VOVO_{2max}$.[3,8]

A considerable amount of work has since been undertaken by Andy Jones and his research group. Bailey et al confirmed the work of Larsen et al, showing similar results but using beetroot juice as their source of dietary nitrate, thus demonstrating that a dietary source of nitrate would work as well as a pharmaceutical source.[4] Their work on skeletal muscle kinetics suggested that dietary nitrates might exert effects primarily through an improved coupling of ATP hydrolysis and skeletal muscle force production, rather than primarily through improvements in mitochondrial efficiency, although both mechanisms could be implicated to some degree.9 Vanhatalo et al looked at effects on incremental exercise, and established that dietary nitrate supplementation acutely reduced blood pressure and the O2 cost of submaximal exercise (2.5 hours after consumption) and that these effects were maintained for at least 15 days if supplementation is continued.10 Langsley et al showed that beetroot juice consumption increased the time to exhaustion during severe-intensity running by 15%, while the O2 cost of walking was reduced by 12 – 14%; no measurable effects on mitochondrial capacity were detected in this study.[5]

This research group further showed that it was the nitrate contained in the beetroot juice which was responsible for its effects, not other components of beetroot juice.[5]

Other workers have looked at effects of NO on skeletal muscle metabolism in isolated muscle fibres, and in animal models, adding to the overall understanding of the influence of NO on exercise performance.[12,29,30]

In summary ...

Through the effects of NO on blood flow and blood pressure, dietary nitrate supplementation can increase oxygen delivery to skeletal muscle, by improving the perfusion of oxygen through tissue.

Through the combined effects of NO on blood flow and cell metabolism, dietary nitrate supplementation can lower the oxygen cost of exercise,3-5. This may be the result of a reduced ATP cost of muscle force production, or improvements in mitochondrial efficiency, or both.3-5,8-10

These effects also result increase tolerance to exercise. Studies of exercise performance in a range of exercise modalities have consistently shown that supplementation with dietary nitrates allows high-intensity exercise to be tolerated for a greater period of time.3-5,8-10

NO can also reduce oxidative damage that can build up as a result of intense exercise, helping with post-exercise recovery.

Optimising the body's natural production of NO

Repeated exercise naturally enhances production of NO, by increasing the amounts of enzymes needed to carry out the conversion from L-arginine in blood vessel and muscle cells.[16] However production can be limited if there is a deficiency in L-arginine, or in another factor required for the conversion, tetrahydrobiopterin (BH4). Studies of L-arginine supplementation on NO production have not consistently shown any effect on levels of NO produced.[31] This indicates that, when a healthy diet is followed and protein intake is sufficient, the amount of L-arginine available for production of NO is not limiting. However tetrahydrobiopterin is derived from folic acid, which is mainly derived from leafy green vegetables, and can often be lacking in a normal diet. Supplementation with folic acid has been shown to restore NO production in individuals with a compromised NO pathway.[32,33]

Therefore to optimise the body's natural production of NO, a sufficient protein intake (for L-arginine) coupled with a sufficient folic acid intake are required.

What happens when NO runs out: replenishing the body's supply of NO

During strenuous exercise, the supply of oxygen to the body may be lower than normal (hypoxia). Oxygen is required for production of NO from L-arginine, and so strenuous exercise can reduce the amount of NO produced by the body, especially in untrained individuals.[34] When low levels of NO are available, the body experiences greater oxidative stress, and greater inflammatory signalling.[12,35]

Dietary nitrates, which are mainly obtained from eating vegetables, salads and herbs, are converted to nitrites in the body, and pass into the bloodstream where they become bound to plasma proteins. These protein-bound nitrites can be converted to NO under certain circumstances, so they act as a reservoir of NO-donors circulating in blood plasma.[36,37] During strenuous exercise, when low levels of oxygen may limit the production of NO within cells, NO can be generated from the nitrite reservoir by a different mechanism.[38] So eating plant-derived nitrates as part of the diet can augment our natural NO production.

How much nitrate do you have to eat in order to benefit performance?

Most tests have been carried out with an amount of nitrate equal to that obtainable from approximately 300g of fresh spinach, which delivers roughly 500mgs of nitrate (also referred to around 5 to 6 mmols of nitrate) per day. However remember the levels of nitrate can vary vastly in vegetables depending on how and where they are grown.

If you take two SiS GO Plus Nitrate gels per day you can be sure you get the required level of 500mg of Nitrates. Just remember start taking SiS GO Plus Nitrate gels 3 to 6 days before an event, taking 2 gels for those days, in order to benefit from the power of natural nitrates.

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