Dietary nitrate supplementation

Beetroot juice and exercise

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Dietary nitrate NO_3^- intake through a diet rich in vegetables has been reported to exert several health effects, due to its transformation into the biological messenger nitric oxide (NO), which induces smooth muscle relaxation leading to haemodynamic effects like vasodilatation, increased blood flow and reduced blood pressure. The healthy effects of dietary nitrate have also been tested in sport, like cycling, walking and running, due to the reduction of O_2 uptake during exercise.

Dietary nitrate intake can be greatly enhanced making appropriate selections of high nitrate-containing foods or dietary supplements.

A recent study [1], done on 10 healthy men, who ingested the supplement 2.5 h prior to moderate-intensity and severity-intensity cycle exercise tests, reported that dietary supplementation with beetroot juice (BRJ), containing 0.06 nmol/ml (about 4 mg/ml) nitrate concentration, altered the physiological responses to exercise, with 70 ml (4.2 nmol) having no effects, while 140 (8.4 nmol) and 280 ml (16.8 nmol) reduced the steady-state oxygen uptake during moderate-intensity exercise by 1.7% ($p=0.06$) and 3% ($p=0.05$), respectively. The time-to-task failure was extended by 14% and 12% (both $p=0.05$), respectively. Although plasma nitrite (NO_2^-) levels were increased dose dependently, with peak occurring at 2–3 h, there is no additional improvement in exercise tolerance after ingestion of 8.4 or 16.8 nmol NO_3^- .

The positive effect of 140 ml/day of BRJ was confirmed also after repeated ingestion [2]. In this randomised, double-blind, crossover study, nine healthy, physically active subjects were assigned to receive BRJ or placebo for 6 days. On Days 4, 5 and 6, the subjects completed a double-step exercise followed immediately by moderate- to severe-intensity exercise.

BRJ elevated plasma nitrite concentration compared to placebo (348 ± 170 and 65 ± 32 nM respectively, $p < 0.01$), but the time constant of oxygen uptake (VO_2) kinetics (τ) was reduced by 22% ($p < 0.05$) only during severe-intensity exercise, not during moderate- to severe-intensity exercise. The near-infrared spectroscopy-derived muscle deoxyhaemoglobin kinetics was faster and the time-to-task failure was 22% greater ($p < 0.05$) during severe-intensity exercise. The Authors concluded that BRJ supplementation speeds VO_2 kinetics and enhances exercise tol-

erance during severe-intensity exercise when initiated from an elevated metabolic rate, possibly via specific effects on type II muscle fibres.

In addition to early reports in cycling, walking and running, BRJ supplementation has recently been tested in swimming [3]. The study recruited 14 moderately trained male swimmers (master athletes regularly involved in regional and national competition, who trained about 6 h per week, with a frequency of 3–4 times per week) in the middle phase of their training season. They underwent two incremental swimming tests, before (control) and after six days of BRJ supplementation (about 5.5 nmol nitrate/500 ml). Workload at anaerobic threshold was significantly increased and the aerobic energy cost was significantly reduced by BRJ supplementation. Although this study lacks a placebo group, thus requiring further studies to confirm, it suggests that BRJ supplementation might positively affect swimmers' performance.

Nitrate *per se* is relatively non-toxic, but concerns can be raised for its metabolites (like N-nitroso compounds). It is of interest that the doses of nitrate used in these studies are all above the World Health Organization's acceptable daily intake (ADI) of 3.7 mg nitrate/kg body weight/day, equivalent to 222 mg nitrate/day for a 60 kg adult [4]. The highest BRJ dose utilised in the first study (16.8 nmol) is about 5-fold above this ADI and more than 2-fold above the one recommended by United States Environmental Protection Agency (7.0 mg nitrate/kg body weight/day for a 60 kg individual). Therefore, in light of the reported health benefits of nitrate, it seems that revision of its ADI would be useful.

References

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