SUPPLEMENTS UNDER THE MICROSCOPE

(Part 1)

Caffeine and Nitrate

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Wise and pragmatic athletes and coaches know only too well that there are no shortcuts to success. Indeed, there are no shortcuts in life. Evidence-based science advocates a logical approach to thriving in the long term, via periodised training, physical and emotional maturation, and ticking off the boxes, while managing all variables that can possibly derail progress and sustainability. Once the fundamental foundations are laid, athletes will naturally gravitate towards exploring the marginal gains that may help them extract those extra one-percenters. Since the dawn of athlete performance time, a vast array of supplements has featured in the marginal gains space. Many supplements have no measurable benefit, numerous have performance benefits but are classified by doping regulatory bodies as illegal and some legal supplements do provide measurable performance gains. The objective of this editorial is not to advocate or dismiss the use of supplements for performance benefits but to provide perspectives on a selection of popular sports supplements that demonstrate scientific evidence for performance gains.

CAFFEINE

The ubiquitous caffeine hits a chord in more ways than one. Caffeine's performance benefits have been studied for decades, with benefits found via modifications to cardiovascular, respiratory, and renal and smooth muscle function; plus up-regulation of endorphin release, neural function, alertness and suppression of effort. For the purpose of this brief synopsis, only the benefits of caffeine supplementation for endurance sports will be discussed.

A detailed review by Ganio and colleagues (2009) pooled the data of 21 independent studies and found that caffeine supplementation contributed to an average performance improvement of 3.2% during endurance based time trials (5-150min duration), across modes that included running, cycling and swimming – amongst others. The dose range of 3–6 mg.kg-1 of body mass is reported as the ergogenic dose "sweet spot", consumed in pill or powder form approximately 60 minutes prior to starting time trials. There is also evidence that smaller doses (<3mg.kg-1) also provide some performance benefit but that doses >6 mg.kg-1 provide no additional benefit.

Research also shows performance gains when consuming caffeine during exercise. A study by Talanian and Spriet (2016), demonstrated a 4-7% improvement in a moderate duration cycling time trials when caffeine (100-200mg) was consumed with a carbohydrate solution after an 80-minute cycling pre-load.

Furthermore, caffeinated chewing gum (200-300mg) consumed after 10km during a 30km cycling time trial improved mean power output by 4% during both the final 10 km and the final sprint of the time trial (Paton et al., 2015).

CONSIDERATIONS FOR TRIATHLETES:

There does not appear to be any difference in the ergogenic properties of caffeine when comparing effects on habitual versus non-habitual caffeine consumers. However, those who don't normally consume caffeine in their diet may be more sensitive to an ergogenic dose. For example, 6mg.kg-1 for a 70kg athlete (420mg of caffeine) is equivalent to five shots of espresso coffee in one hit. Contraindications of caffeine include nausea, anxiousness, insomnia and restlessness, which are counterproductive to performance. Peak plasma caffeine concentrations occur between 15 and 120 minutes after oral ingestion, with a mean elimination half-life range between 1.5-9.5hrs. On the basis of current scientific evidence, caffeine consumption prior to the start of a triathlon has potential performance benefits for all race durations. While more research is required to examine combinations of timing, bolus and maintenance doses it appears that a bolus dose of caffeine 60min prior to race start to be the preferred choice for events <2hrs in duration. For longer events, perhaps it is worth considering shifting the pre-race dose to closer to the start time (less than 30 minutes before the event start perhaps), and/or to factor in micro-doses during the longer events.

NITRATE

Ingestible nitrate (NO3–) has been popularised during the past decade for its ergogenic effects on cardiovascular function and metabolism, including improvements in prolonged oxygen uptake kinetics. The primary mechanism appears to be largely in response to upregulation of nitric oxide bioavailability. Nitric oxide plays a significant regulatory role in mitochondrial and muscle function (Jones, 2014). The subsequent exercise performance benefits of nitric oxide upregulation include a reduction in energy cost per unit of work done and increased blood flow to skeletal muscle. Nitrate supplementation has been associated with a 5% reduction in sub-maximal oxygen cost (i.e. improvement in metabolic economy) and 4-25% improvements in incremental time to fatigue cycling trials (Jones, 2014), with smaller (1-3%) improvements during sport specific time trial exercise (McMahon et al., 2016).

The current consensus appears to support ergogenic benefits for sports duration less than 40 minutes duration.

> *"On the basis of current scientific evidence, caffeine consumption prior to the start of a triathlon has potential performance benefits."* — Simon Sostaric

CAFFEINE: Can give you some performance benefits.

NITRATE: Has benefits of increasing blood flow to skeletal muscle and improvements in incremental time to fatigue.

The diminished effects of ingestible nitrate beyond 40 minutes may be due to a combination of low exercise intensity and subsequently reduced modulatory role for nitric oxide production via the nitrate stimulus. On the other end of the spectrum, there appears to be inconclusive evidence that supports nitrate supplement efficacy for intense exercise <12 minutes duration, with exception for repeated sprint improvement of 1-4%, following nitrate supplementation over five consecutive days (Thompson et al., 2016).

The efficacy of nitrate supplement protocols appears to vary depending on an athletes training status, with a higher nitrate dose required to improve performance in higher-level athletes (Jones, 2014). However, in principle, nitrate supplementation is similar to the majority of studies that investigate ergogenic aids - that there is limited data to support supplement efficacy in world-class athletes, mostly due to the difficulty of recruiting elite athletes for quality controlled scientific trials. Recent research by Muggeridge and colleagues (2017) showed that chronic nitrate supplementation improves sprint cycling induced training adaptations. A group of untrained males consumed 8mM (500mg) of nitrate 2.5 hours prior to each sprint cycle training session, three times per week, for three weeks duration. Maximal cycling work rate (assessed by a sprinting fatigue index) increased 8.7% in the nitrate supplement group compared to 4.7% in the control group.

Whole food sources of nitrate include green leafy vegetables and root vegetables primarily beetroot, rocket, spinach and celery. Commercially available beetroot juice is the most popular source of nitrate used by participants in experimental trials and athletes in competitive sport.

CONSIDERATIONS FOR TRIATHLETES:

Unlike caffeine, there appears to be a wider range of efficacy considerations for nitrate that athletes need to account for, particularly differences in athlete training status and acute versus chronic dose responses. On the basis of current scientific evidence, an acute bolus nitrate dose of 5-9mM (310-560mg) within 2-3 hours of the start of a triathlon has potential performance benefits for race durations of <40 minutes. While the effects of chronic nitrate supplementation on performance are limited, perhaps it is plausible to consider periodic nitrate supplementation for between 3-21 days in order to promote several training adaptations.

CONCLUSION

In light of the evidence-based ergogenic benefits that caffeine and nitrate supplementation may provide, athletes, coaches and allied personnel need to carefully consider the timing, frequency and appropriateness of utilising supplements. For example, with a growth and development perspective, at what age is it appropriate for young athletes to expedite marginal gains with the use of supplements? Also, athletes need to validate how they respond to supplements in training before considering their usefulness and viability in competition. Once athletes and their support network have satisfied efficacy and confidence in protocols to be applied, supplements should not be used on a regular basis, given that there is very little known about longer-term effects of chronic use, and at what point athletes will respond with diminishing returns. AT

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