Blackcurrant intake: making headway as an ergogenic aid!

Prof Mark Willems describes why nutritional interventions were undertaken with New Zealand blackcurrant. He expects that the findings on the effectiveness of New Zealand blackcurrant at rest and during diverse exercise modalities will contribute both to the growing interest in applications of functional foods in sport and exercise sciences and the future development of innovative sports nutrition products.

Introduction - value in anecdotal information

In 2011, the Netherlands National Triathlon Elite Team disclosed the intake of New Zealand blackcurrant powder as a nutritional ergogenic aid as part of their training programme, reporting that it seemed to enhance recovery. Public sharing by elite athletes of nutritional ergogenic practice is uncommon. The disclosure in 2011 did seem to be ignored by academics with an interest in sports nutrition, as evidence-based studies to support New Zealand blackcurrant as an ergogenic aid were limited.

What evidence was out there and why the interest in New Zealand blackcurrant?

Blackcurrant is considered a superfruit with a high anthocyanin content compared to other berries. Anthocyanins are the pigments responsible for the variety of colours of berries. Berries differ substantially in anthocyanin composition with blackcurrant containing four main anthocyanins: cyanidin-3-O-glucoside, cyanidin-3-O-rutinoside, delphinidin-3-O-glucoside and delphinidin-3-O-rutinoside, those four making up ~87% of all phenolic compounds (Cyboran *et al.*, 2014). The anthocyanins contribute to the anti-oxidant and anti-inflammatory properties of berries. Regular berry intake is known to provide significant health benefits. In addition, berry intake may reduce exercise-induced oxidative stress with beneficial effects during exercise and recovery.

Blackcurrant is not commonly consumed as a fresh fruit and mainly grown to be processed for food additives or blackcurrant products. The first study on the acute effects of a powdered extract made from New Zealand blackcurrants was conducted by the New Zealand institute of Plant and Food Research. The study suggested potential health implications for individuals undertaking regular exercise (Lyall *et al.*, 2009). Five males and five females (age range 37 to 63 years) performed a 30-min row at an intensity of 80% $\dot{V}O_{2max}$ with intake of capsulated blackcurrant powder (a total anthocyanin intake of 240 mg) before and after exercise, with blood samples taken before, 1, 2 and 24 hr after exercise. The blackcurrant extract suppressed oxidative stress parameters, e.g. the protein carbonyl levels, immediately after exercise. No observations were reported for effects of blackcurrant on physiological and metabolic responses during the exercise. Interestingly, observations during typing work in humans with a blackcurrant concentrate revealed an increase of peripheral blood flow by 22% (Matsumoto *et al.*, 2005), suggesting the potential for effects during exercise for anthocyanin-containing fruits and berries. However, studies on the effects of anthocyanin-containing fruits and berries focused on the post-exercise effects (e.g. montmorency cherry juice: Bowtell *et al.*, 2011; Lyall *et al.*, 2009). An ability of blackcurrant to reduce exercise-induced oxidative stress combined with enhanced blood flow provided a physiological rationale for addressing the effects of blackcurrant during exercise.

What we did and what we found

Dosing strategies for many popular ergogenic aids, e.g. creatine and caffeine, are well established but are, as yet, unknown for blackcurrant. With support and input from stakeholders, we supplemented trained triathletes with New Zealand blackcurrant powder for 7 days, an intake of about 110 mg anthocyanins a day. We recognise that with any new nutritional intervention,

an examination of potential mechanisms for any effect is key to explain meaningful physiological, metabolic or performance effects. Our focus was applied with all studies having a randomised, double blind, cross-over design to examine effects of New Zealand blackcurrant intake. We aimed to establish whether New Zealand blackcurrant would alter the physiological and metabolic responses during exercise as well as influencing the cardiovascular responses at rest.

Thirteen trained triathletes with >3 years' experience (8 men, age: 38±8 years, body mass: 71±9 kg, BF%: 19±5%, mean±SD) performed two incremental cycling protocols with recording of physiological and cardiovascular responses. During an incremental cycling protocol, the lactate responses were substantially lower at intensities from 40% to 70% of maximum power with a maximal decrease of 27% at 40% (see Figure 1), indicating a downward and rightward shift of the lactate curve. A shift of the lactate curve is a common observation after an endurance training programme. Maximum oxygen uptake, maximum power and maximum heart rate were not different by intake of New Zealand blackcurrant powder during an incremental cycling test to exhaustion. However, at exhaustion, lactate values were 14% lower with New Zealand blackcurrant. New Zealand blackcurrant intake had no effect on cardiovascular responses during exercise. However, cardiovascular function at rest was changed with an increase in cardiac output by 26% and a decrease in total peripheral resistance by 16%, suggesting enhanced blood flow at rest that may benefit exercise recovery.

Our findings provided for the first time the evidence that a product made from berries was able to have meaningful effects during exercise. As far as we know, the shift of the lactate curve was not shown before with a nutritional intervention in endurance trained individuals. The lower lactate response could be due to changes in the energy contribution of carbohydrates and lipids, and suggesting enhanced fat oxidation. In a follow-up study using a New Zealand blackcurrant extract for 7 days (an intake of about 110 mg anthocyanins a day) with 13 endurance trained males cycling at 45%,

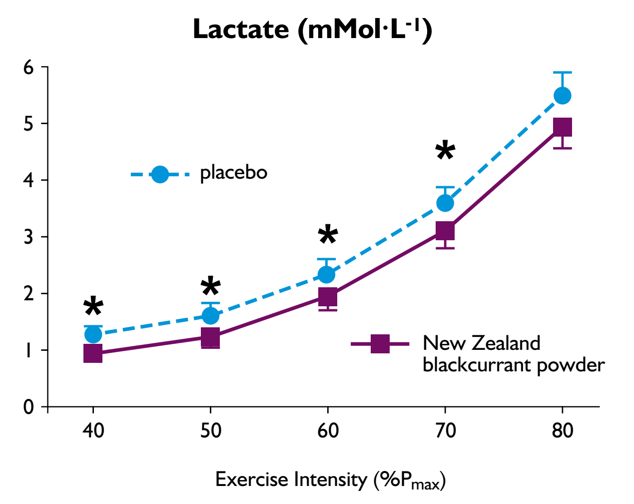

Figure 1. Lactate responses during cycling at different exercise intensities. Exercise intensity was expressed as a percentage of maximum power (%P_{max}). *, difference between placebo and New Zealand blackcurrant powder. Data are mean±SD.

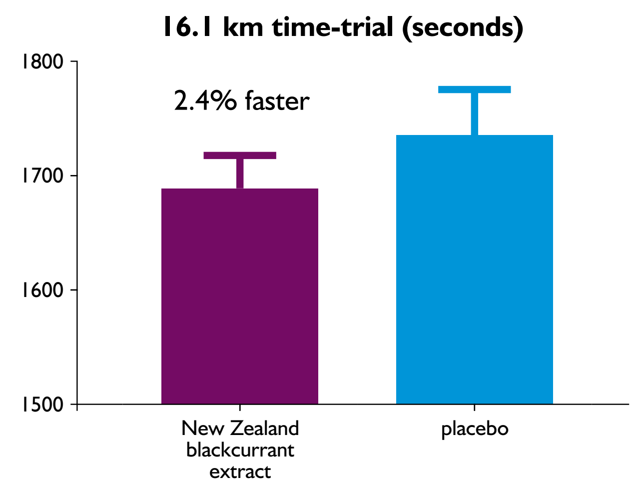

Figure 2. Time of the 16.1 km cycling time-trial. Data are mean±SD.

55% and 65% of $\dot{V}O_{2max}$, fat oxidation was enhanced up to 27% at 65% (Cook *et al.*, 2015). In the same study, we also showed that time trial performance for 16.1 km was improved by 2.4% (see Figure 2) and this was comparable to the increased performance time with an acute dose of beetroot juice (i.e. 2.7%) as observed by the work of Prof Jones and colleagues at the University of Exeter (Lansley *et al.*, 2011).

In another laboratory-based study with 7 days intake of the New Zealand blackcurrant extract, 13 active males (age: 25±4 yrs, $\dot{V}O_{2max}$: 56±4 mL·kg^{-1}·min^{-1}) performed a treadmill running protocol to exhaustion. The protocol consisted of stages with 6x19 s of high-intensity running with 15 s of low-intensity running between the 19 s runs. The rest time between the stages was 1 minute and stages were repeated with increasing sprint speeds (Perkins *et al.*, 2015). The treadmill running protocol was an adapted intermittent treadmill running test to examine running ability in soccer players. We observed that New Zealand blackcurrant intake increased the total running distance by 10.6% from 3,871±622 m to 4,282±833 m with the distance of the high-intensity runs to be increased by 10.8%. At exhaustion, lactate values tended to be higher (NZBC: 6.01±1.07 mmol·L^{-1}, placebo: 5.22±1.52 mmol·L^{-1}), which may suggest an increased tolerance for high lactate values. In addition, in a field-based study with a sport-specific test in males, the New Zealand blackcurrant extract reduced slowing of the maximal sprint during the Loughborough Intermittent Shuttle Test (Willems *et al.*, 2016). During the 5th 15-min block in the Loughborough Intermittent Shuttle Test, slowing was 0.06 sec with New Zealand blackcurrant extract and 0.12 sec in the placebo condition. Our observations on the effects of New Zealand blackcurrant intake on the metabolic responses during exercise and enhanced performance for endurance cycling and repeated high-intensity running in addition to the ability to reduce slowing of maximal sprints indicate implications for exercise over a broad range of intensities and durations.

What next?

It will be challenging to design studies to examine the mechanisms for the effects of blackcurrant intake during exercise. Intake of an anthocyanin-containing supplement results in complex bioavailability of anthocyanins and metabolites. It is likely that the synergistic actions of the metabolites on cell function and fatigue mechanisms need to be understood. In addition, an enhanced understanding of the applied effects of anthocyanins and mechanisms on in vivo exercise and recovery would require manufactured cocktails of specific anthocyanins controlling amount and type, but for now costs to create such cocktails are problematic. Blackcurrant seems to contain a potent cocktail of anthocyanins with implications in sport and exercise sciences. More research is recommended to address, for example, the effects of blackcurrant intake on exercise in extreme environmental conditions, dose-response effects to establish dosing strategies, and the implications of blackcurrant intake for individuals with clinical conditions, e.g. peripheral arterial disease.

The future of berries in sport and exercise sciences

Research on the application of anthocyanin-containing products in sport and exercise sciences is in an early stage. Future studies will likely address the effectiveness of other berries: Will we see a competition of berries in sport and exercise sciences, and if so, which are the best? New Zealand blackcurrant has shown to be effective during exercise and recovery and is making headway as a new ergogenic aid with implications for active individuals enhancing the benefits of exercise performed for health, exercise training and competitive practice. The future for berry intake by athletes seems to be bright. The scene has been set by New Zealand blackcurrant. ■

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