AIS SPORTS SUPPLEMENT FRAMEWORK
FRUIT-DERIVED POLYPHENOLS (CHERRIES, BERRIES, BLACKCURRANTS & POMEGRANATE)

What is it?

Polyphenols are a class of organic compounds primarily found in plants that can be classified into four main families: lignans, phenolic acids, stilbenes and flavonoids. They play a number of critical roles including growth, pigmentation, pollination and resistance to pathogens of plants.[1] Polyphenols also influence the taste and colour characteristics of fruit and vegetables. Brightly coloured fruit including cherries, blackcurrants, blueberries, blackberries and pomegranate are particularly good sources of polyphenols, which have been investigated for their health-promoting, anti-oxidant and anti-inflammatory properties.

What do they do?

> The promotion of fruit and vegetable intake to support general health has been advocated for years. A greater understanding of the emerging role of polyphenols in favourable health, exercise performance and recovery outcomes further strengthens the public health message to maintain a high intake of fruit and vegetables. A summary of emerging research on outcomes relating to exercise performance and recovery from polyphenol ingestion follows below. Polyphenols appear to mimic some aspects of exercise training and may have an additive effect alongside exercise.[2]

> Polyphenols, by virtue of their antioxidant and anti-inflammatory properties, may reduce oxidative stress, inflammation and muscle pain associated with muscle damage induced by exercise, thereby enabling an earlier return to normal muscle strength/force.[2, 3, 4, 5, 6]

> Early studies on quercetin (a type of flavonoid) supplementation promoted reduced perception of exercise effort, perhaps related to improved blood flow, including cerebral.[7]

> A meta-analysis of studies on blackcurrants showed an overall improvement to performance of high intensity prolonged exercise, predominantly cycling, with a greater effect in higher level athletes than sub-elite.[9] Polyphenols may also reduce muscle soreness and improved recovery post exercise.[4, 5, 6]

> Flavonoids may reduce the incidence of upper respiratory tract infections in healthy adults.[8]

> Anthocyanins (a type of flavonoid) may enhance nitric oxide production, facilitating blood flow during exercise.[7]

> Tart cherries contain melatonin which may aid sleep.[5]

What does it look like?

> In addition to whole fruit and vegetables, there are a number of supplemental forms in which fruit polyphenols may appear. These forms are summarised in Table 1.

> There are a number of products on the market, however many do not state the exact content of active compounds, which makes it difficult to determine an effective dose.

ASC36194

Table 1: Fruit-derived polyphenols and sport performance

Food	Product form and therapeutic dose	Mechanism of action	Outcomes
Blackcurrant (specifically New Zealand derived Blackcurrants)	Predominant polyphenol is flavonoid (anthocyanin, type delphinidin-3-rutinoside) Blackcurrant whole-fruit powder Blackcurrant extract with known anthocyanin content Blackcurrant juice and concentrate juice (shot) 105-210 mg blackcurrant anthocyanins/day for 7 days prior to competition with final dose 1-2 h before exercise.[9]	Anti-inflammatory Cardiovascular adaptations and blood flow. Possible positive benefits on executive function and mood	Blackcurrants have a small positive effect (0.45%) on prolonged high intensity performance (15-30 min).
Blueberries	Predominant polyphenol is flavonoid (anthocyanin, type malvidin-3-monogalactoside) Blueberry containing smoothies Blueberry fruit Freeze-dried blueberries	Anti-inflammatory and antioxidant activity	No specific performance data
Cherries (specifically Tart cherries such as Montmorency and Balaton, may include Bing sweet cherries)	Contains the polyphenol flavonoid (anthocyanin, type cyanidin-3-glucosylrutinoside) and melatonin Tart cherry juice and juice concentrate Tart cherry powdered skin Tart cherry dried 90-200 cherry equivalents split across 2 doses per day (e.g. for tart cherry juice concentrate, 30ml twice a day) for 4-7 days before and throughout the period of competition	Anti-inflammatory. Melatonin content in tart cherry products may enhance sleep.	Mixed performance effects: > Half marathon performance following 7 day consumption enhanced, with associated attenuation of inflammation and catabolism.[10] > Recovery of strength and reduced muscle soreness following intense exercise bouts or endurance events which result in muscle damage is enhanced. Potentially beneficial where repeat performance is required within a day or across multiple days.[5] > Preliminary evidence supporting sleep duration and efficiency, presumably as a significant source of melatonin.[11]
Red grapes, apples, raspberries, citrus fruits, onions and green leafy vegetables	Contains quercetin. Quercetin supplement powder Dosing protocol: 1000 mg/day, taken as 2 x 500 mg or 4 x 250 mg doses spaced over the day, usually for 7 days	Anti-inflammatory, anti-oxidant, anti-carcinogenic, cardio-protective	Quercetin improves endurance performance when 1000 mg/day is consumed for at least 7 days.[2, 7]
Pomegranate	Predominant polyphenol is elagitannin (primarily punicalagin) Pomegranate drink (dose most commonly used is 1L per day consumed over the day) Pomegranate powdered capsules	Anti-inflammatory, anti-oxidant	Only one study has investigated time to exhaustion or aerobic type event and reported benefit.[12]

How and when do I use it?

> The absorption and metabolism of most polyphenols is thought to be slow and incomplete. However, the benefits to gastrointestinal health and gut bacteria are likely to play an important role in the mechanism of action of polyphenols, but at this stage have been poorly investigated.

> Apart from quercetin, cherries and blackcurrant, there is insufficient human data to recommend an effective dosing strategy of other polyphenols.

- **Quercetin:** 1000 mg/day for at least 7 days prior to competition.[3] Effects of chronic intake uncertain but probably best avoided.
- **Blackcurrant:** 105-210 mg blackcurrant anthocyanins/day for 7 days prior to competition.[6] Effects of chronic intake uncertain but likely ill advised. The majority of research has been conducted on New Zealand black currant, however provided the anthocyanin dose is achieved, there is no indication that other products would not have equal efficacy.
- **Tart Cherries:** 90-200 cherries (in the form of cherry juice, cherry juice concentrate or capsulated powder) in a split dose for 4-7 days before and 2-4 days after eccentric exercise or endurance exercise that induces inflammation (such as a marathon). This includes competition which must be repeated multiple times within one day or multiple times over consecutive days.

> Approximately 150g blueberries or 300g mixed berries is sufficient to achieve the polyphenol content provided in many research studies.

Are there any concerns or considerations?

1. There remains little consensus on specific doses of most of these fruit polyphenols.

> Athletes are encouraged to consume a wide range of fruits and vegetables within a well-chosen diet to supply a variety of phytochemicals.

> Furthermore, there may be variations in anthocyanin content of different variants of berries according to the conditions they're grown in.

> Further research is required to compare different variants of berries, including their bio-availability.

2. The research may only be relevant to specific variants of the fruit – such as New Zealand blackcurrants, Montmorency cherries

> It is important to check the source / variant of the fruit in any supplement.

3. Gastrointestinal distress in those with sensitive gastrointestinal tracts

> Cherries are known to have a laxative effect, and high doses of other berries may also cause gastrointestinal distress in those with sensitive gastrointestinal tracts. This may be particularly of concern in athletes with physical impairments that limit voluntary bowel control. As such, increasing berry/ cherry intake or the use of berry/ cherry juices (or derived products) should be trialled outside of exercise first.

4. The role of flavonoids on upper respiratory tract infections in athletes is yet to be fully researched.

5. Research indicates consuming high doses of antioxidants and anti-inflammatory compounds reduce the adaptive response to exercise training.

> While consuming a wide range of fruits is strongly supported in the daily diet of athletes, supplementation of high doses of these fruit-derived polyphenols is NOT recommended during day to day training periods.

Where can I find more information?

Gatorade Sport Science Institute

https://www.gssiweb.org/docs/default-source/sse-docs/bowtell_sse_195-v3_final.pdf?sfvrsn=2

Supplement safety information and batch tested product list

https://www.sportintegrity.gov.au/what-we-do/anti-doping/supplements-sport

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The Australian Institute of Sport (AIS) Supplement Framework is an initiative of the Australian High Performance Sport System. The AIS acknowledges the support of members of the National Institute Network (NIN) and National Sporting Organisations (NSO) and their staff in delivering content expertise. This information is intended to help athletes, coaches and scientists make evidence-based decisions about the use of supplements and sports foods. Before engaging in supplement use, we recommend that each individual refer to the specific supplement policies of their sporting organisation, sports institute or parent body, and seek appropriate professional advice from an accredited sports dietitian (**www.sportsdietitians.com.au**).

Athletes should be aware that the use of supplements may have doping implications. Athletes are reminded that they are responsible for all substances that enter their body under the 'strict liability' rules of the World Anti-Doping Code. Some supplements are riskier than others. The Sport Integrity Australia (SIA) app is a useful resource to help mitigate the risk of inadvertent doping by helping to identify supplements that have been batch-tested. The SIA App provides a list of more than 11,000 batch-tested products. We recommend that all athletes consult the educational resources of SIA regarding the risks associated with supplements and sports foods.. While batch-tested products have the lowest risk of a product containing prohibited substances, they cannot offer you a guarantee that they are not contaminated (**www.sportintegrity.gov.au/what-we-do/supplements-sport**).

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