New Zealand Blackcurrant: A New Ergogenic Aid in Sport?

Mark Willems

Professor in Exercise Physiology

United Kingdom

Blackcurrant – "The Stress Hero"

Sponsored by

Vilnius - June 10-12, 2015

Take home prediction

<u>Specific</u> anthocyanin-rich products (e.g. blackcurrant) will emerge as *new* sports nutrition supplements

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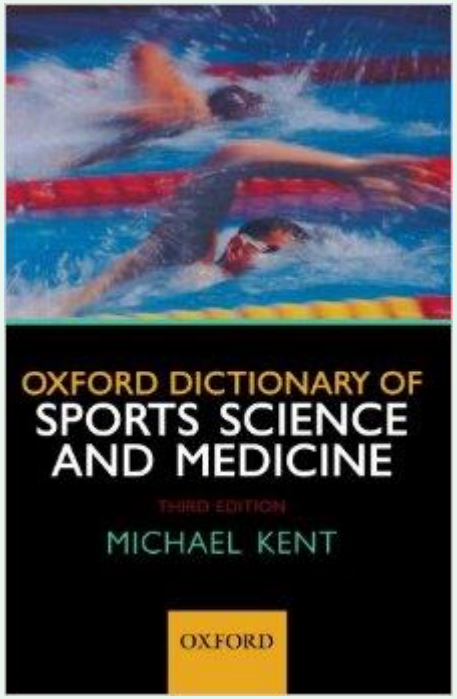
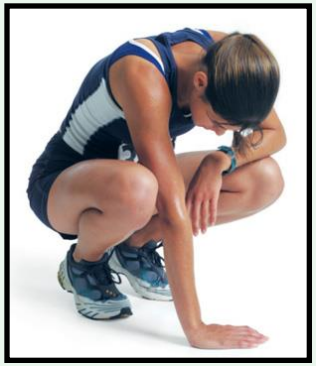
New Zealand Blackcurrant: A New Ergogenic Aid in Sport?



"Any application that improves physical performance, enhances responsiveness to training, or accelerate recovery"

exercise



recovery

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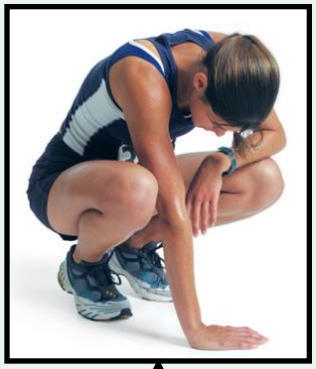

exercise

recovery

functional foods

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The Influence of Chokeberry Juice Supplementation on the Reduction of Oxidative Stress Resulting from an Incremental Rowing Ergometer Exercise

chokeberry

Pilaczynska-Szczesniak et al., *Int J Sport Nutr Exerc Metab*. 14, 48-58, 2005

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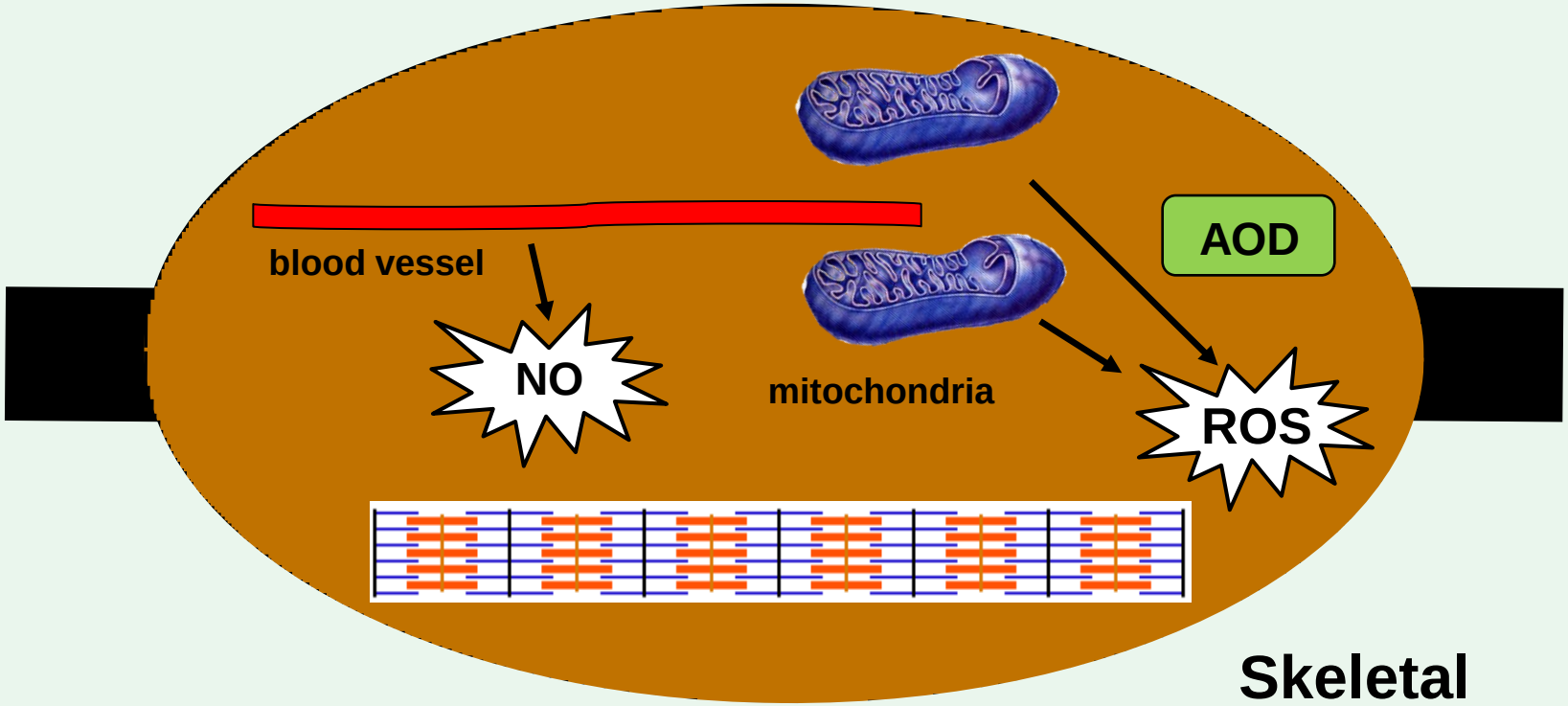
Exercise

ROS > AOD : oxidative stress



Skeletal Muscle

NO – nitric oxide

AOD – antioxidative defenses

ROS – reactive oxygen species

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The Influence of Chokeberry Juice Supplementation on the Reduction of Oxidative Stress Resulting from an Incremental Rowing Ergometer Exercise

TBARS is a measure of lipid peroxidation

(a footprint of oxidative stress)

chokeberry

before

TBARS (μmol/gHb)	
at rest	1.2 ± 0.3
after ET	1.8 ± 0.2
24 h after ET	2.3 ± 0.5

3x50 mL/day for 4 weeks

5x3 min at 50, 60, 70, 80, 90% of maximal power (ET)

TBARS - thiobarbituric acid reactive substances

Pilaczynska-Szczesniak et al., *Int J Sport Nutr Exerc Metab*. 14, 48-58, 2005

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The Influence of Chokeberry Juice Supplementation on the Reduction of Oxidative Stress Resulting from an Incremental Rowing Ergometer Exercise

TBARS is a measure of lipid peroxidation

(a footprint of oxidative stress)

chokeberry

	before	**after**
TBARS (μmol/gHb)		
at rest	1.2 ± 0.3	1.3 ± 0.4
after ET	1.8 ± 0.2	1.4 ± 0.2 *
24 h after ET	2.3 ± 0.5	1.4 ± 0.2 *

3x50 mL/day for 4 weeks

5x3 min at 50, 60, 70, 80, 90% of maximal power (ET)

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Pilaczynska-Szczesniak et al., *Int J Sport Nutr Exerc Metab*. 14, 48-58, 2005

The Influence of Chokeberry Juice Supplementation on the Reduction of Oxidative Stress Resulting from an Incremental Rowing Ergometer Exercise

TBARS is a measure of lipid peroxidation

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chokeberry

	before	**after**
TBARS (μmol/gHb)		
at rest	1.2 ± 0.3	1.3 ± 0.4
after ET	1.8 ± 0.2	1.4 ± 0.2 *
24 h after ET	2.3 ± 0.5	1.4 ± 0.2 *

3x50 mL/day for 4 weeks
3x ~17 mg anthocyanins/day for 4 weeks

These findings indicate that an increased intake of anthocyanins limits the exercise-induced oxidative damage to red blood cells, most probably by enhancing the endogenous antioxidant defense system.

Pilaczynska-Szczesniak et al., *Int J Sport Nutr Exerc Metab*. 14, 48-58, 2005

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Outline

- **Why the interest in anthocyanins?**
- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

exercise

- **lactate curve**
- **lactate at maximum oxygen uptake**
- **fat oxidation (data under review)**
- **16.1 km cycling time trial**
- **running - repeated sprints**

- **Some future directions – still quite a journey!**

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Outline

- **Why the interest in anthocyanins?**

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Berry anthocyanins: isolation, identification and antioxidant activities†

blackcurrant

billberry

cowberry

delphinidin-3-glucoside

delphinidin-3-rutinoside

cyanidin-3-glucoside

cyanidin-3-rutinoside

Table 4. Anthocyanin composition (% of total anthocyanins) of anthocyanin isolates quantified as corresponding anthocyanin compounds

Anthocyanin	Blackcurrant	Bilberry	Cowberry
Dp-3-glu	15.3	13.7	
Dp-3-rut	39.1		
Cn-3-gal		9.0	74.2
Cn-3-glu	6.9	8.5	1.9
Cn-3-rut	38.7		
Cn-3-ara		13.6	23.9
Pt-3-glu		6.0	
Pn-3-gal		0.6	
Pn-3-ara		1.0	
Mv-3-glu		8.4	
Dp-3-gal		14.9	
Dp-3-ara[a]		15.3	
Pt-3-gal[b]		2.1	
Pt-3-ara[b]		1.3	
Pn-3-glu[c]		0.1	
Mv-3-gal[d]		3.1	
Mv-3-ara[d]		2.4	
Total	100.0	100.0	100.0

Dp, delphinidin, Cn, cyanidin; Pt, petunidin; Pn, peonidin; Mv, malvidin; gal, galactoside; glu, glucoside; ara, arabinoside; rut, rutinoside. [a–d] Corresponding standards not available; quantified as [a] Dp-3-glu, [b] Pt-3-glu, [c] Pn-3-gal, [d] Mv-3-glu.

Kähkönen et al. *J Sci Food Agric.* 83, 1403-1411, 2003

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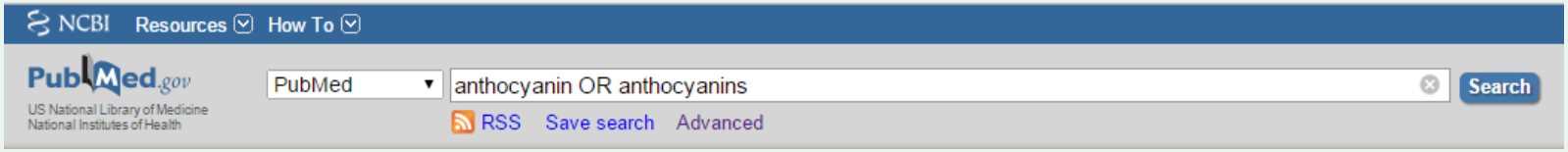

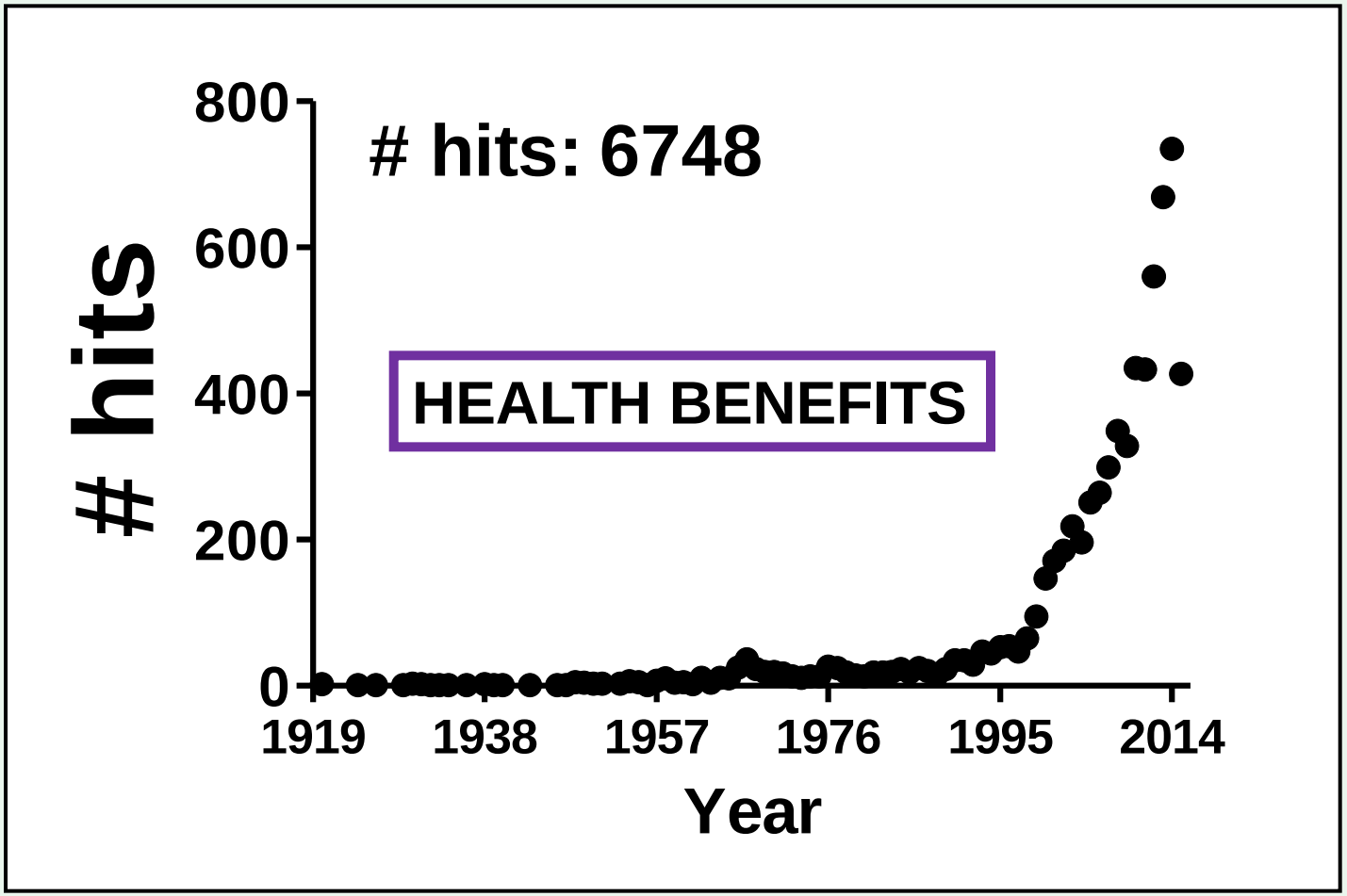

access 26/05/2015

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Blueberry and Mulberry Juice Prevent Obesity Development in C57BL/6 Mice

blueberry

mulberry

12 weeks ad libitum access to juice

HEALTH BENEFITS

high fat diet
water

high fat diet
blueberry juice

high fat diet
mulberry juice

Wu et al. *PLOS ONE* 8(10), e77585, 2013

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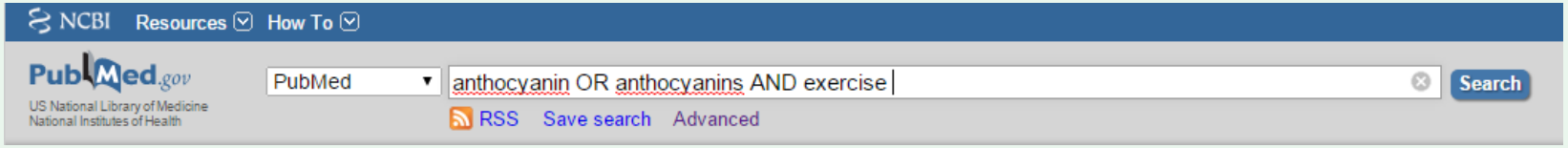

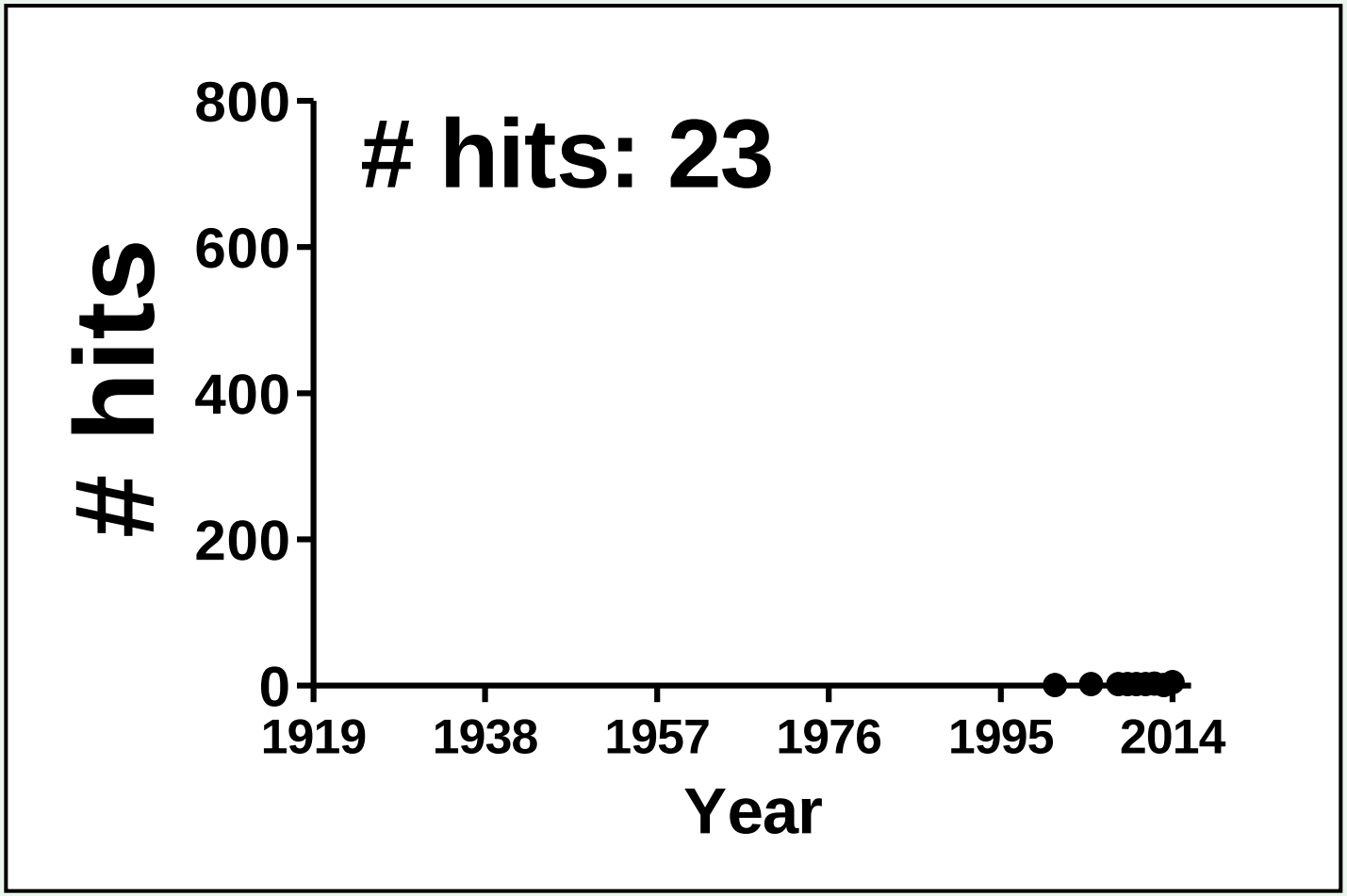

access 26/05/2015

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Short-term blackcurrant extract consumption modulates exercise-induced oxidative stress and lipopolysaccharide-stimulated inflammatory responses

Lyall et al., *Am J Physiol Regul Integr Comp Physiol*. 297(1):R70-81, 2009

Montmorency Cherry Juice Reduces Muscle Damage Caused by Intensive Strength Exercise

Bowtell et al., *Med Sci Sports Exerc*. 43(8):1544-1551, 2011

Efficacy of a tart cherry juice blend in preventing the symptoms of muscle damage

Connolly et al., *Br J Sports Med*. 40(8):679-683, 2006

Effect of New Zealand blueberry consumption on recovery from eccentric exercise-induced muscle damage

McLeay et al., *J Int Soc Sports Nutr*. 9(1):19, 2012

Influence of tart cherry juice on indices of recovery following marathon running

Howatson et al., *Scand J Med Sci Sports* 20(6):843-852, 2010

Black Currant Nectar Reduces Muscle Damage and Inflammation Following a Bout of High-Intensity Eccentric Contractions

Hutchison et al., *J Diet Suppl*. (in press)

CHICHESTER CENTRE OF APPLIED SPORT & EXERCISE SCIENCE

Short-term blackcurrant extract consumption modulates exercise-induced oxidative stress and lipopolysaccharide-stimulated inflammatory responses

Lyall et al., *Am J Physiol Regul Integr Comp Physiol*. 297(1):R70-81, 2009

All post-exercise effects

Black Currant Nectar Reduces Muscle Damage and Inflammation Following a Bout of High-Intensity Eccentric Contractions

Hutchison et al., *J Diet Suppl*. (in press)

CHICHESTER CENTRE OF APPLIED SPORT & EXERCISE SCIENCE

Short-term blackcurrant extract consumption modulates exercise-induced oxidative stress and lipopolysaccharide-stimulated inflammatory responses

Lyall et al., *Am J Physiol Regul Integr Comp Physiol*. 297(1):R70-81, 2009

What about effects during exercise?

Black Currant Nectar Reduces Muscle Damage and Inflammation Following a Bout of High-Intensity Eccentric Contractions

Hutchison et al., *J Diet Suppl*. (in press)

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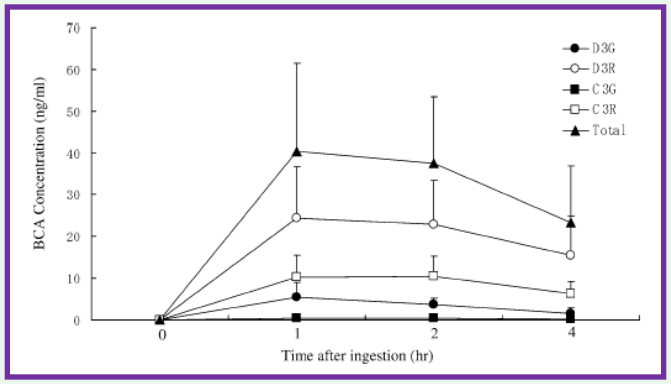
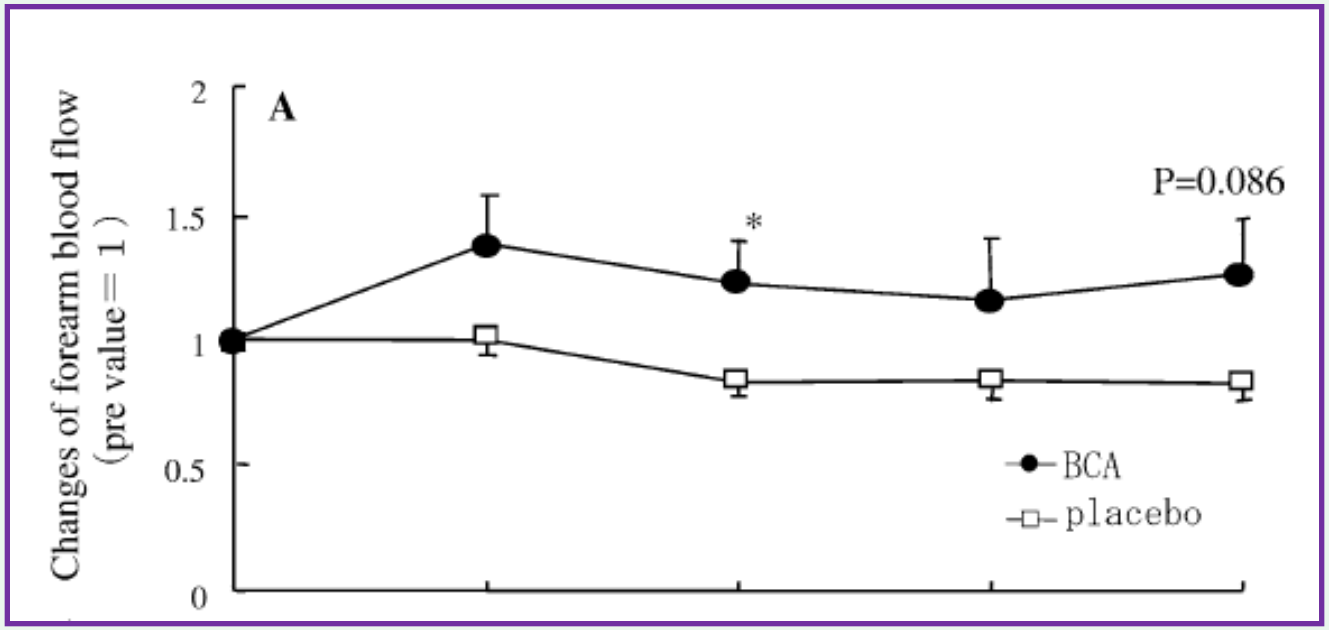
Effects of blackcurrant anthocyanin intake on peripheral muscle circulation during typing work in humans



BCA concentrate 17 mg (kg BW)$^{-1}$

blackcurrant-induced increase in blood flow by 22% (2 hr)



Matsumoto et al., *Eur J Appl Physiol*. 94(1-2):36-45, 2005

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Outline

- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

exercise

- **lactate curve**
- **lactate at maximum oxygen uptake**

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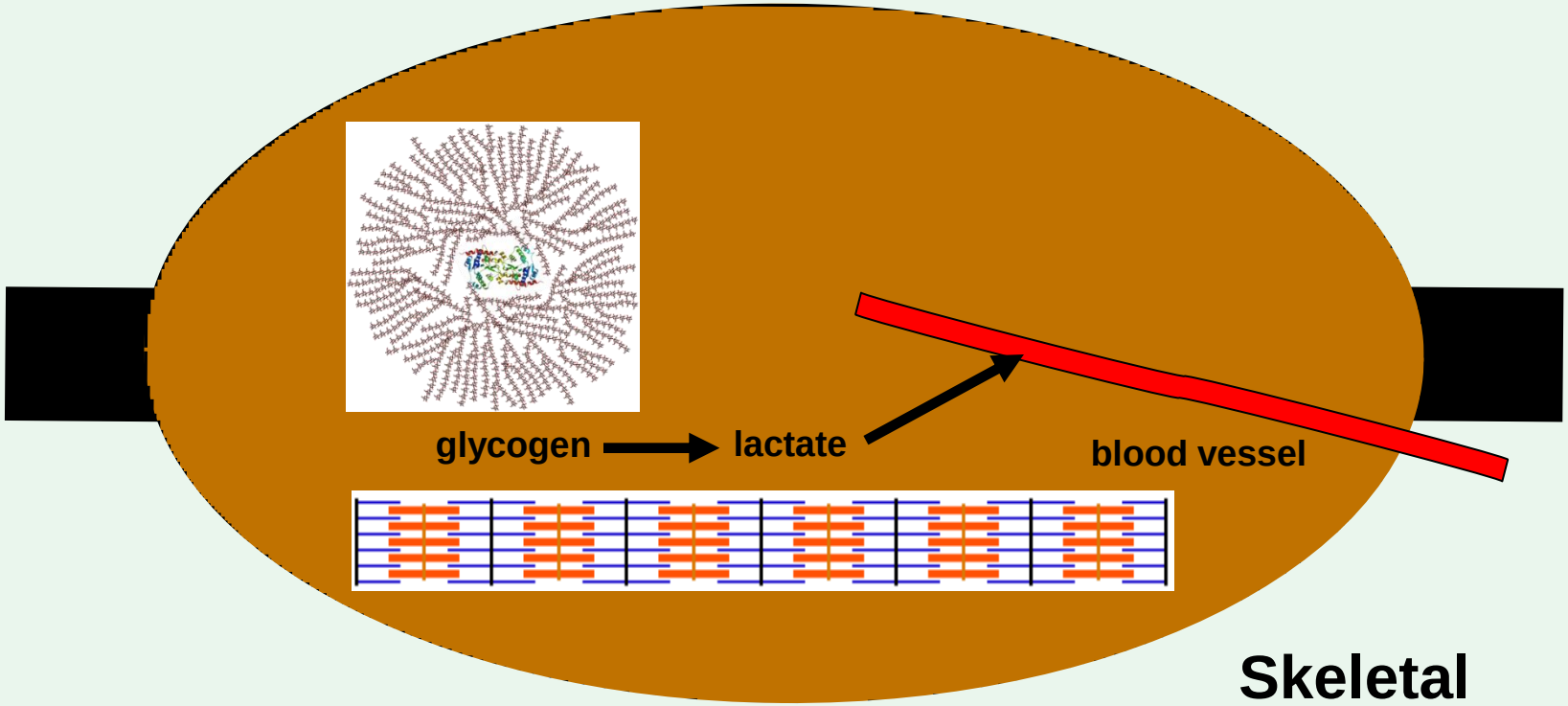
Exercise and Lactate



Skeletal Muscle

Lactate is associated with muscle fatigue

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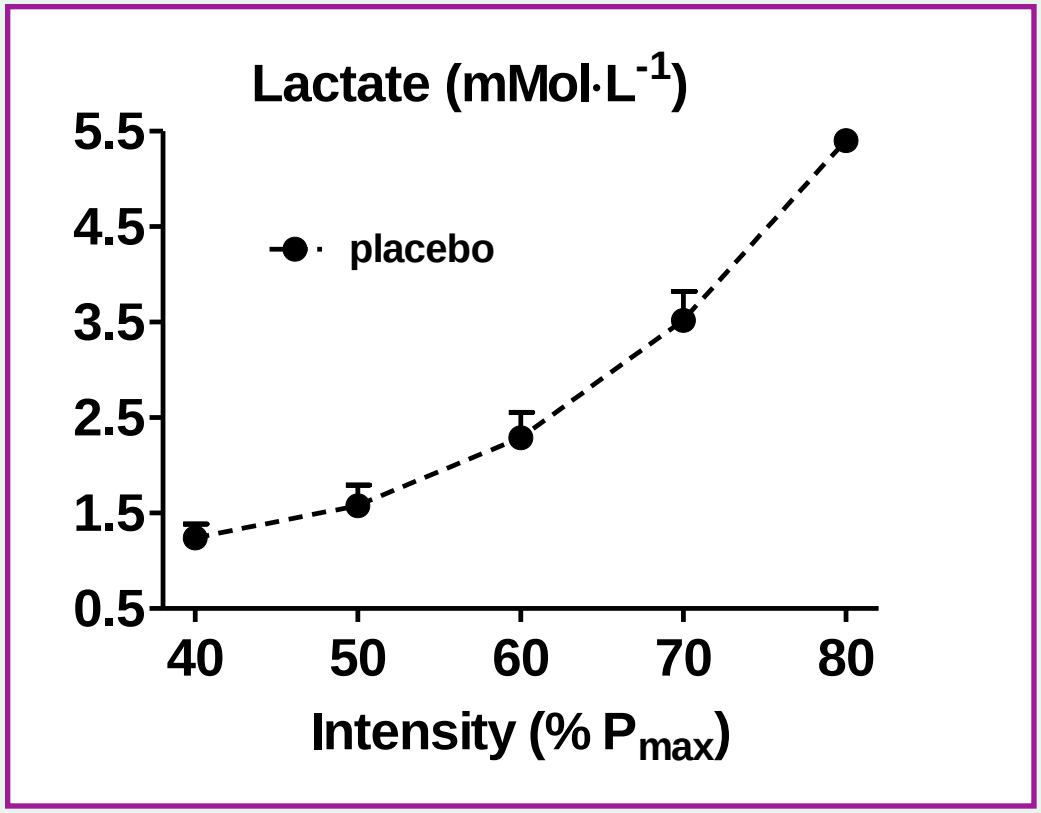
- the lactate curve



n = 13 (triathletes)

~110 mg anthocyanins/day for 7 days

Lactate is associated with muscle fatigue

Willems et al., *Int J Sport Nutr Exerc Metab* (in press)

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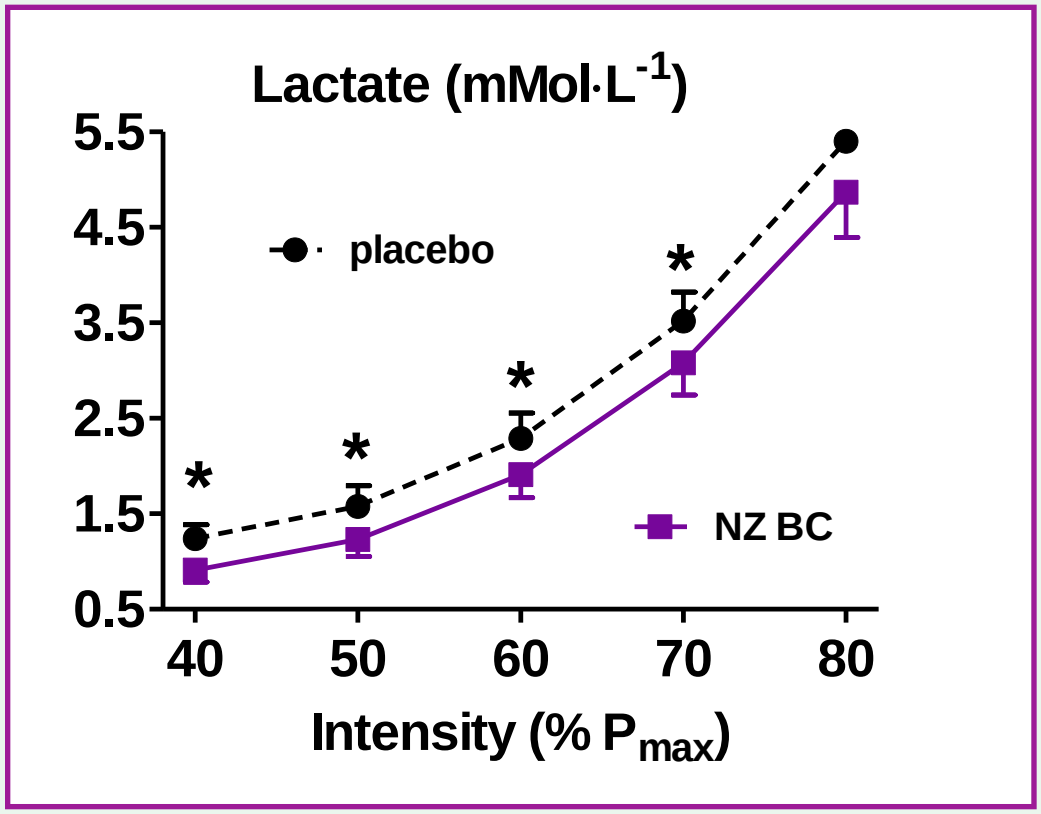
- the lactate curve



n = 13 (triathletes)

~110 mg anthocyanins/day for 7 days

New Zealand blackcurrant resulted in a complete shift of the lactate curve

Willems et al., *Int J Sport Nutr Exerc Metab* (in press)

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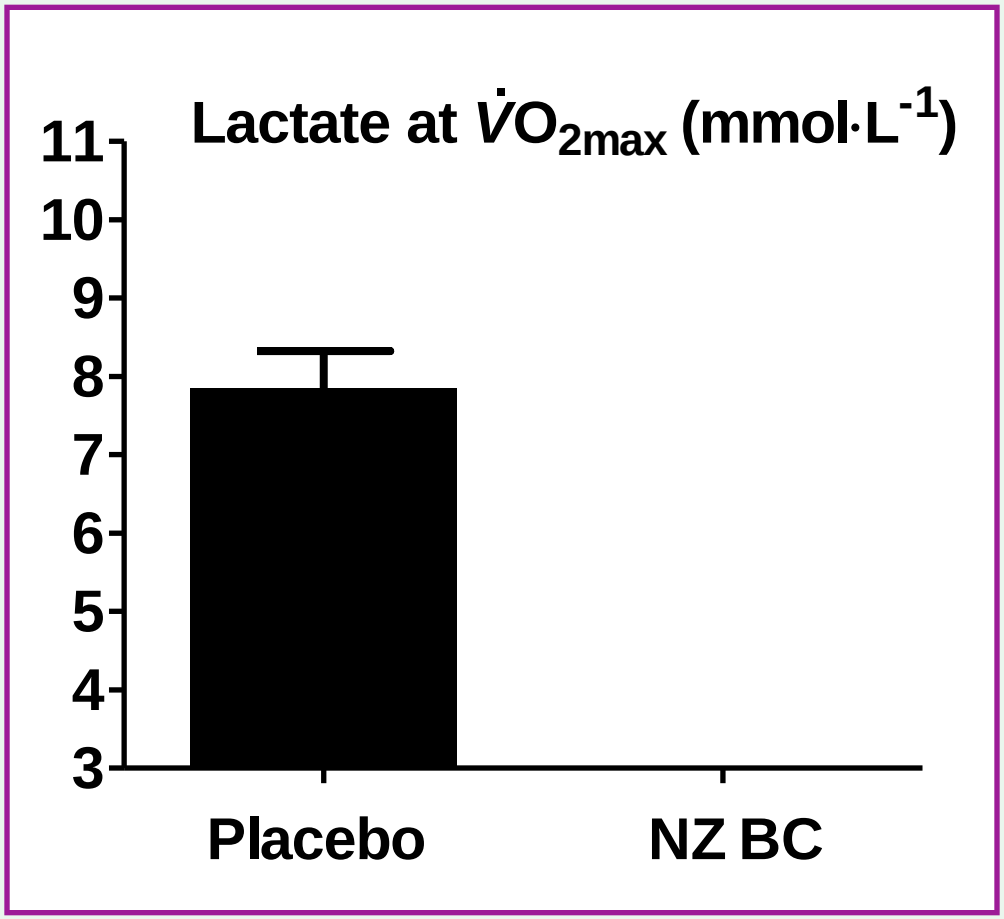
- **lactate at maximum oxygen uptake**



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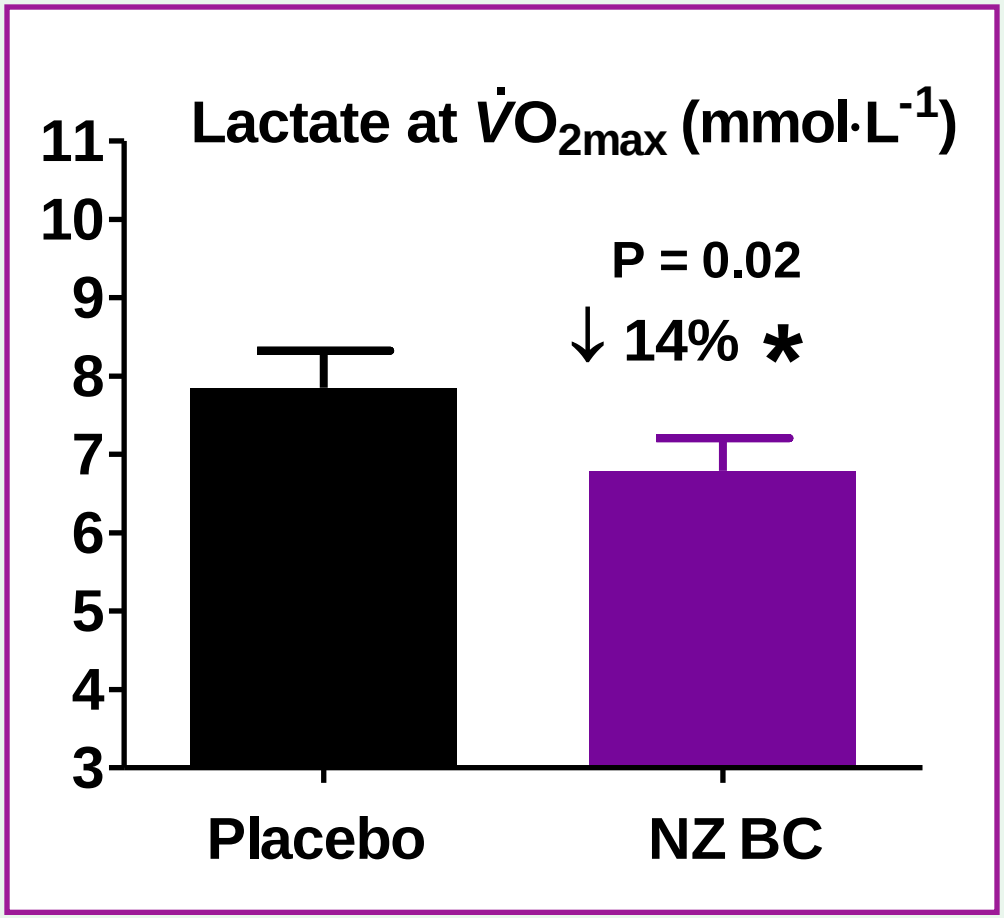
Willems et al., *Int J Sport Nutr Exerc Metab* (in press)

CHICHESTER CENTRE OF APPLIED SPORT & EXERCISE SCIENCE

- **lactate at maximum oxygen uptake**



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- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

exercise

- **fat oxidation (data under review)**

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Outline

- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

exercise

- **16.1 km cycling time trial**

Highly aerobic exercise

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Outline

- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

performance

double-blind randomized cross-over design

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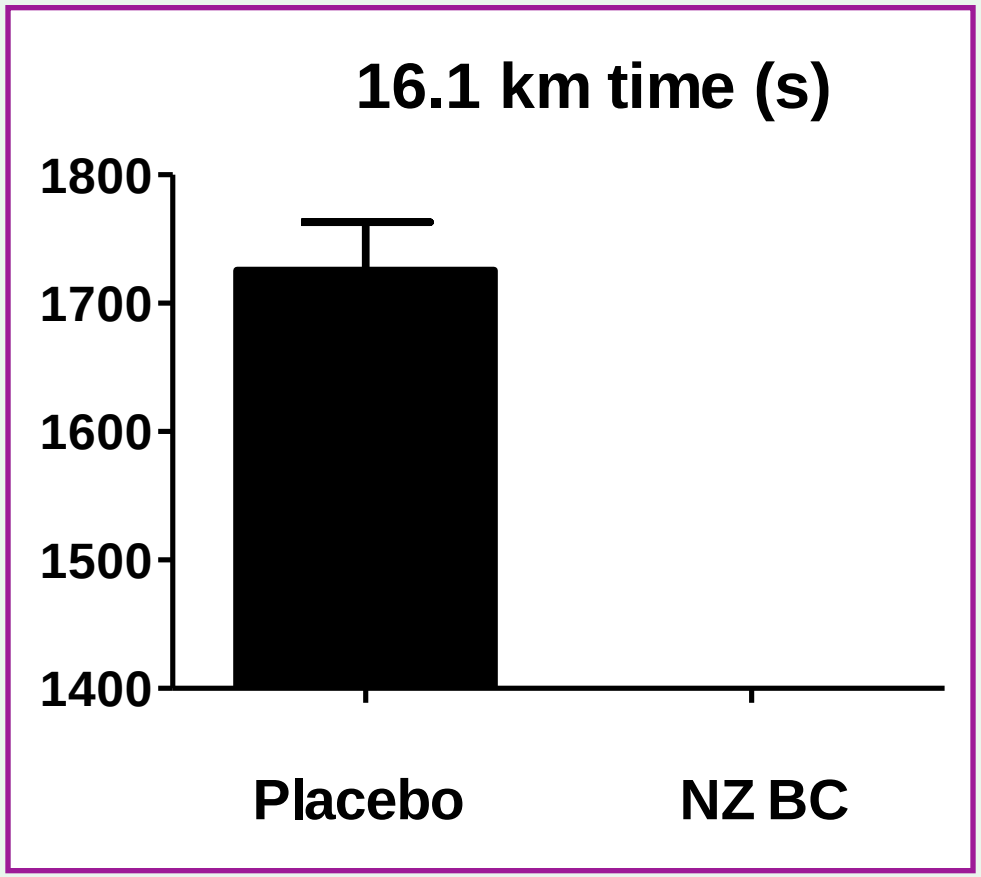
- **16.1 km cycling time-trial performance**



***n* = 14 (cyclists)**

~105 mg anthocyanins/day for 7 days

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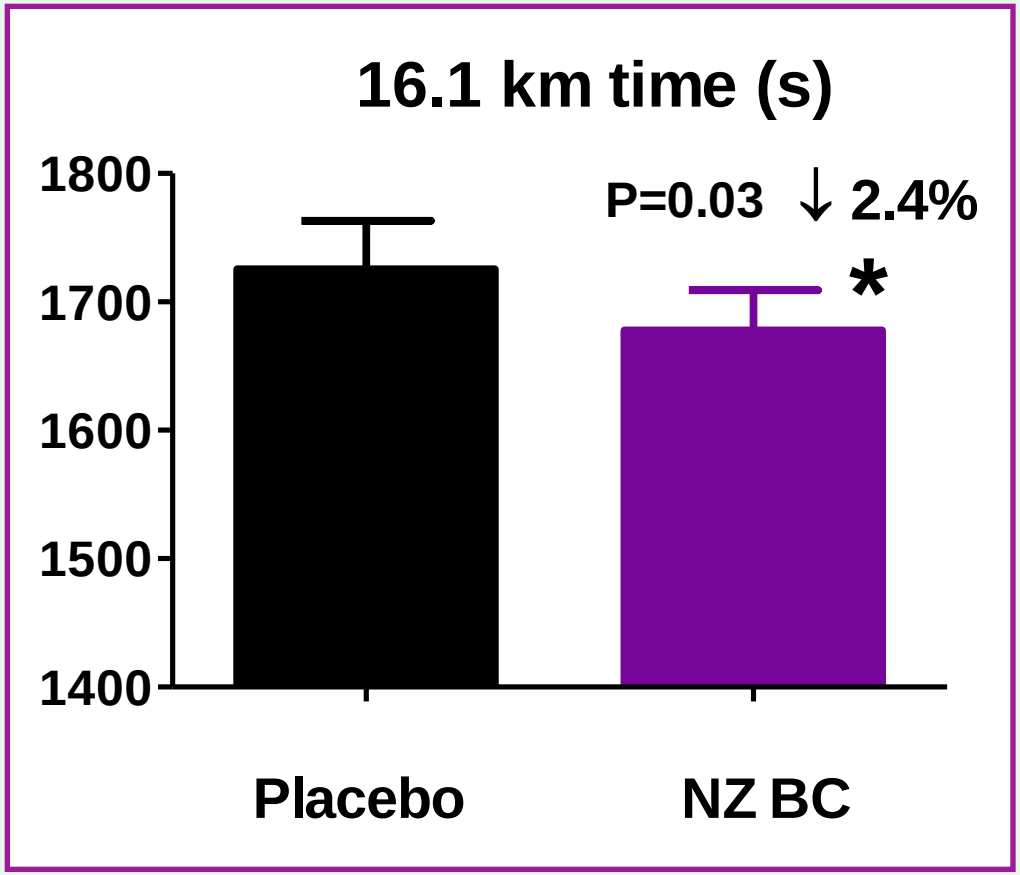
Cook et al. (ISENC 2014)

- 16.1 km cycling time-trial performance



n = 14 (cyclists)
11 did go faster

Acute Dietary Nitrate Supplementation Improves Cycling Time Trial Performance

Lansley et al., *Med Sci Sports Exerc* 43, 1125-1131, 2011

↓ 2.7%

Cook et al. (ISENC 2014)

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Outline

- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

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Highly aerobic exercise

CHICHESTER CENTRE OF APPLIED SPORT & EXERCISE SCIENCE

Outline

- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

exercise

- **running - repeated sprints**

Highly anaerobic exercise

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- **running – repeated sprints**

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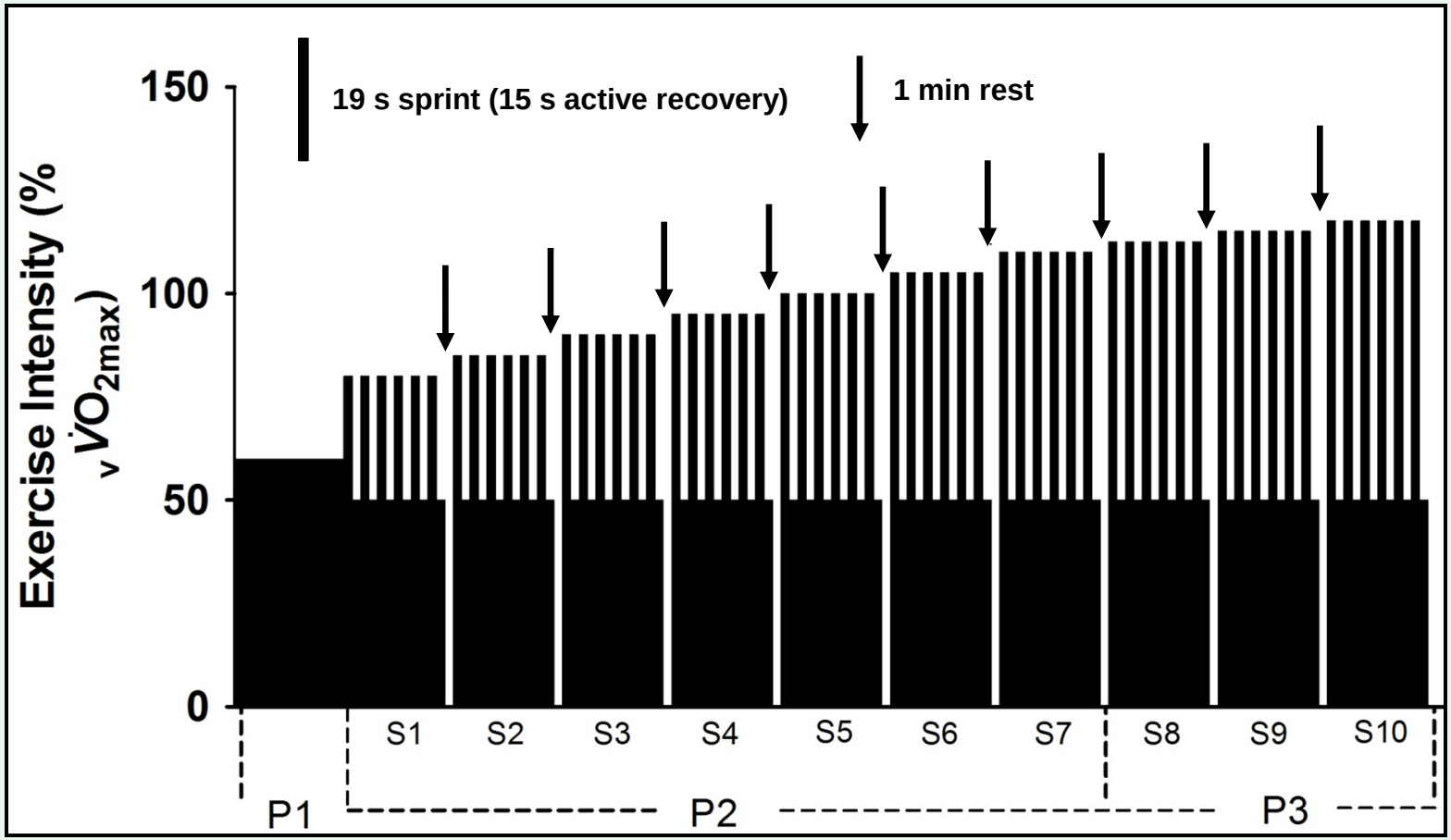
- **running – repeated sprints**



5 min at 60% **5% increases** **2.5% increases**

Perkins et al., *Int J Sport Nutr Exerc Metab* (in press)

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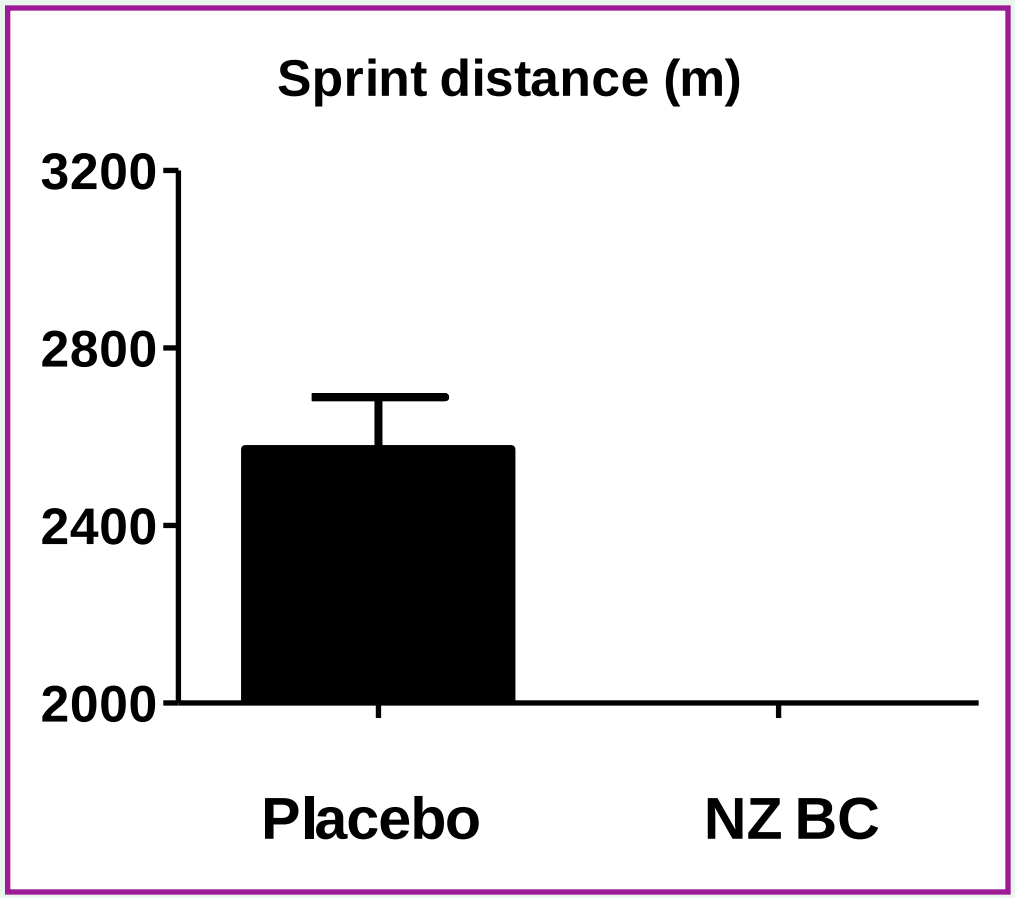
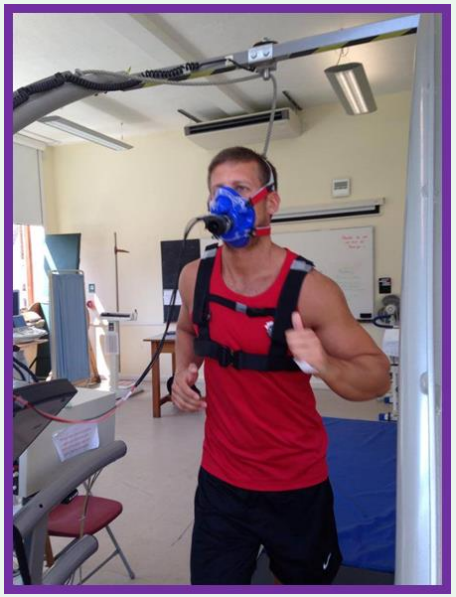
- **running – repeated sprints**





n **= 13 (active males)**

~105 mg anthocyanins/day for 7 days

Perkins et al., *Int J Sport Nutr Exerc Metab* (in press)

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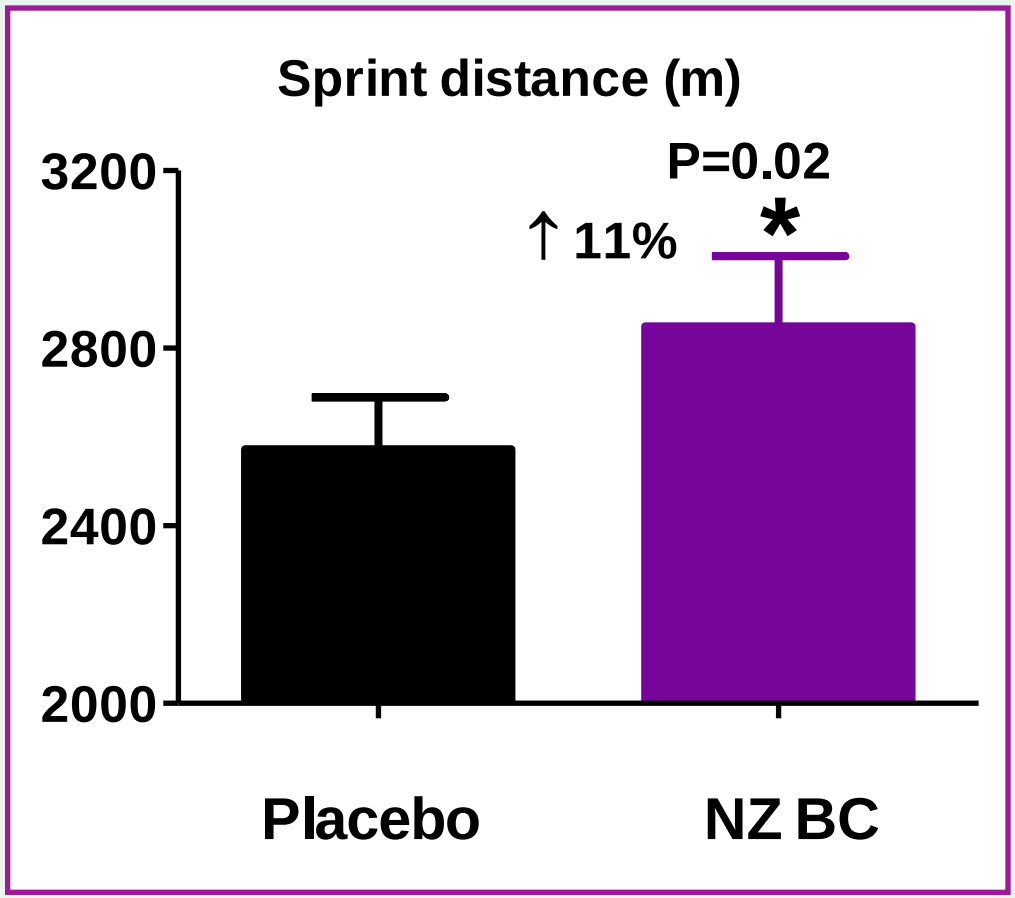
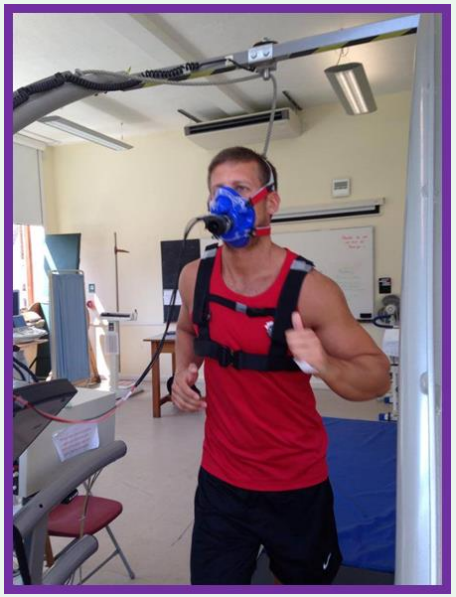
- running – repeated sprints





n = 13 (active males)
9 improved

~105 mg anthocyanins/day for 7 days

Perkins et al., *Int J Sport Nutr Exerc Metab* (in press)

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- **Effects of New Zealand blackcurrant *'anthocyanin'* intake in exercise studies**

APPLICATION

Endurance and team sport athletes may consider intake of New Zealand blackcurrant to beneficially enhance training practice, performance and recovery

Braakhuis et al. Effects of dietary antioxidants on training and performance in female runners. *Eur J Sport Sci*. 14(2):160-8, 2014.

"..blackcurrant may improve performance in the elite."

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All very exciting, but what is causing these effects!

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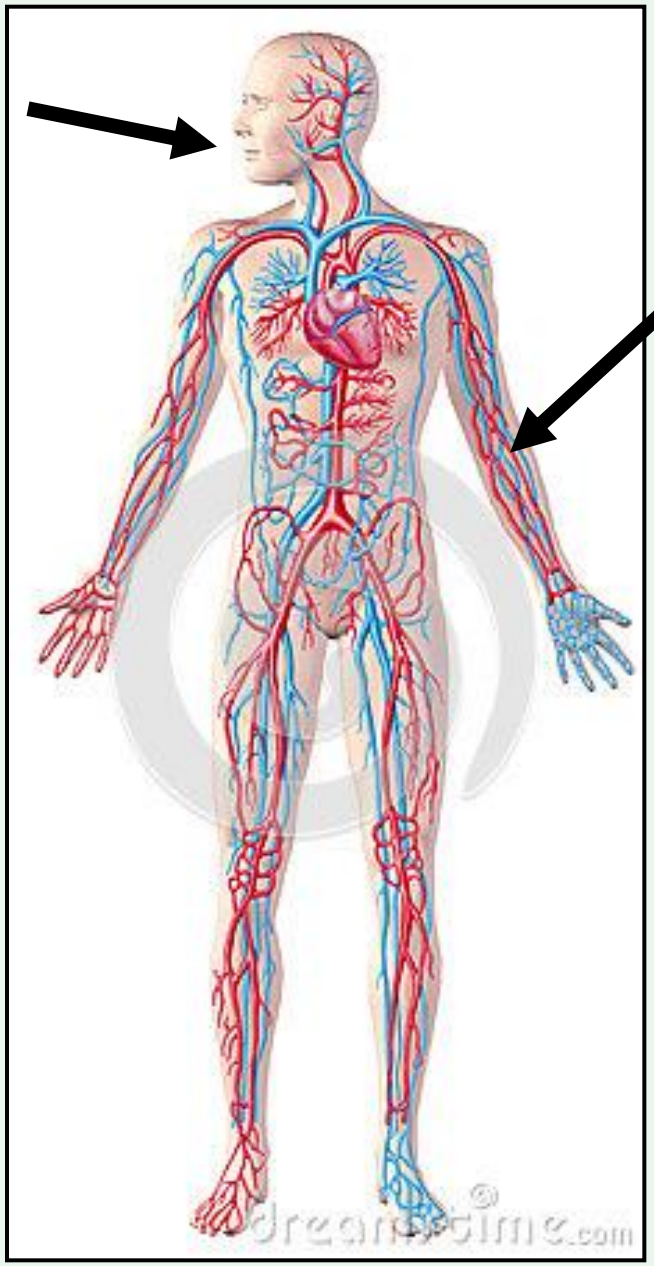

?

compounds

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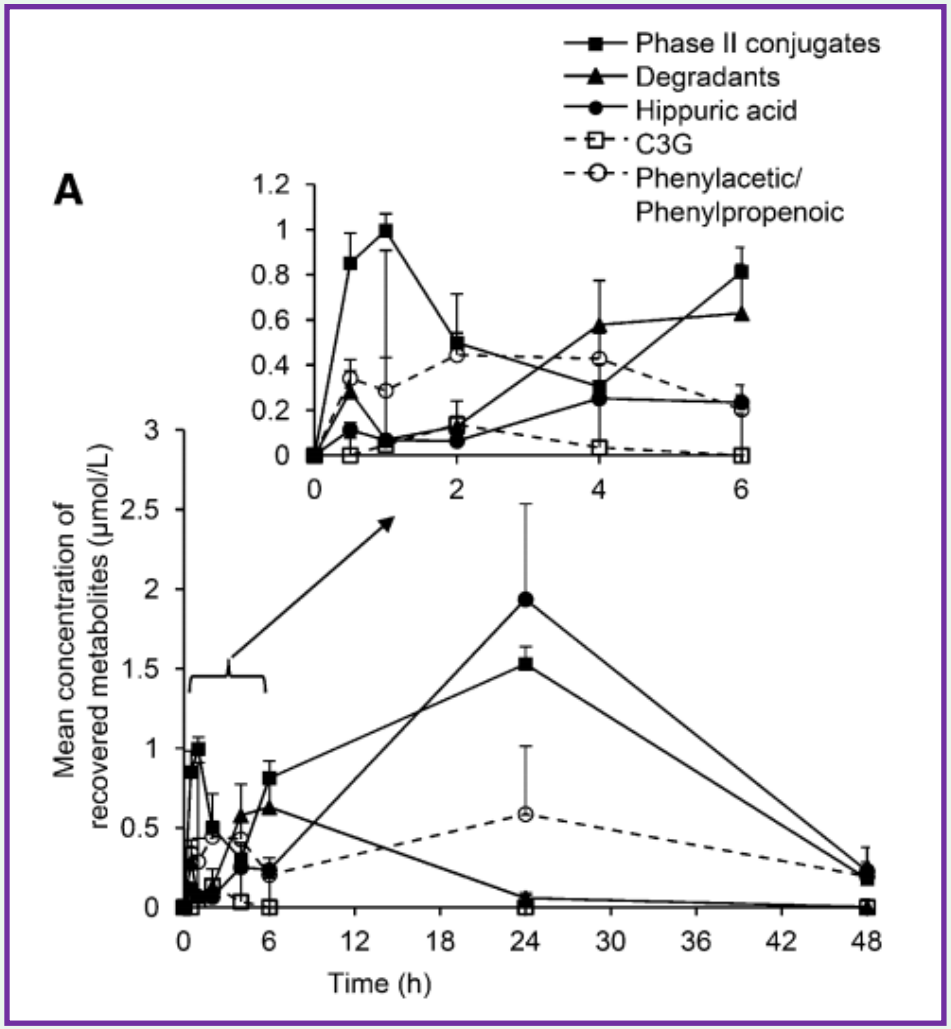
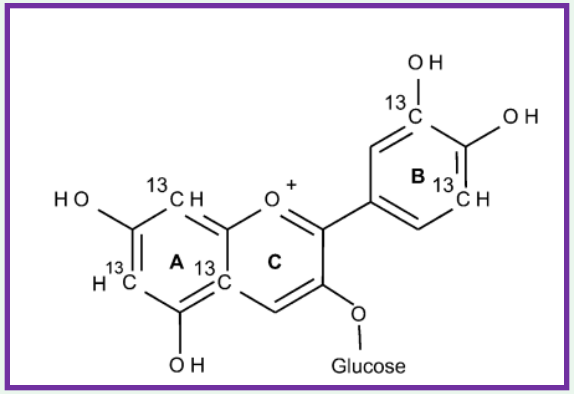
Human metabolism and elimination of the anthocyanin, cyanidin-3-glucoside: a ^{13}C-tracer study[1–3]





500 mg labelled cyanidin-3-glucoside

Concentration of identified metabolites in whole serum

Czank et al., *Am J Clin Nutr* 97: 995-1003, 2013

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Take home prediction

<u>Specific</u> anthocyanin-rich products (e.g. blackcurrant) will emerge as *new* sports nutrition supplements

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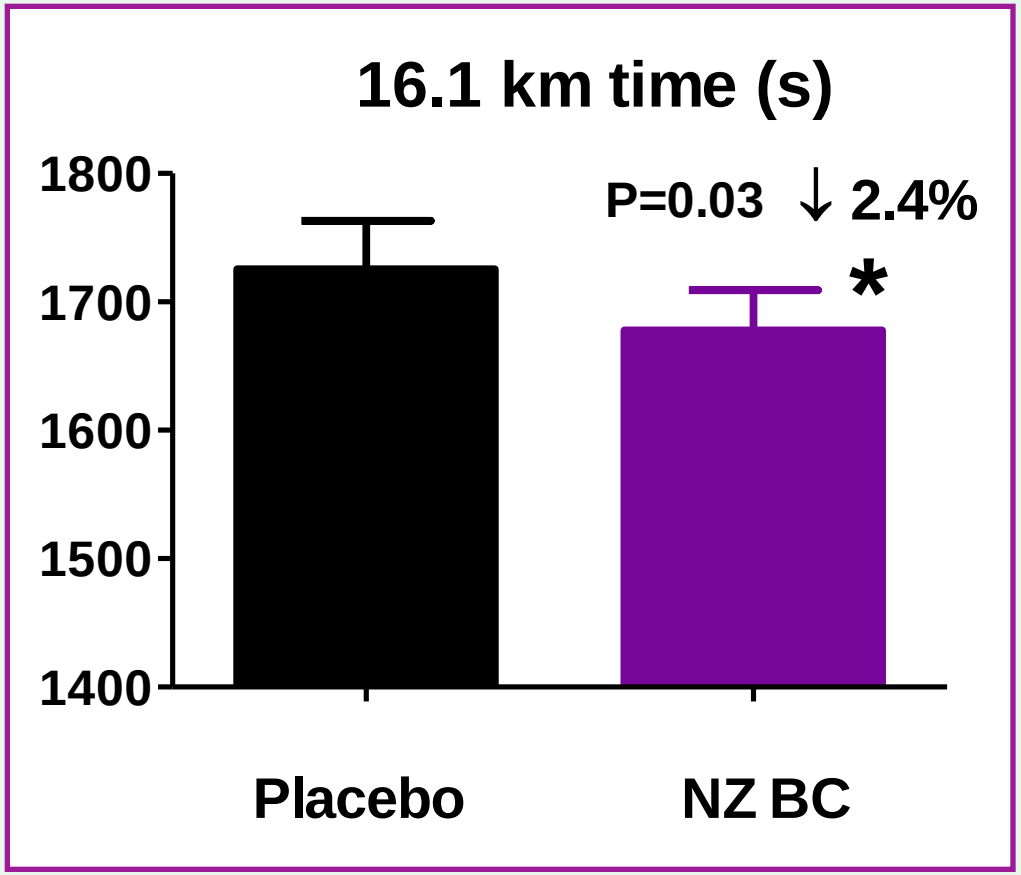
- 16.1 km cycling time-trial performance



Acute Dietary Nitrate Supplementation Improves Cycling Time Trial Performance

Lansley et al., *Med Sci Sports Exerc* 43, 1125-1131, 2011

↓ 2.7%

Cook et al. (ISENC 2014

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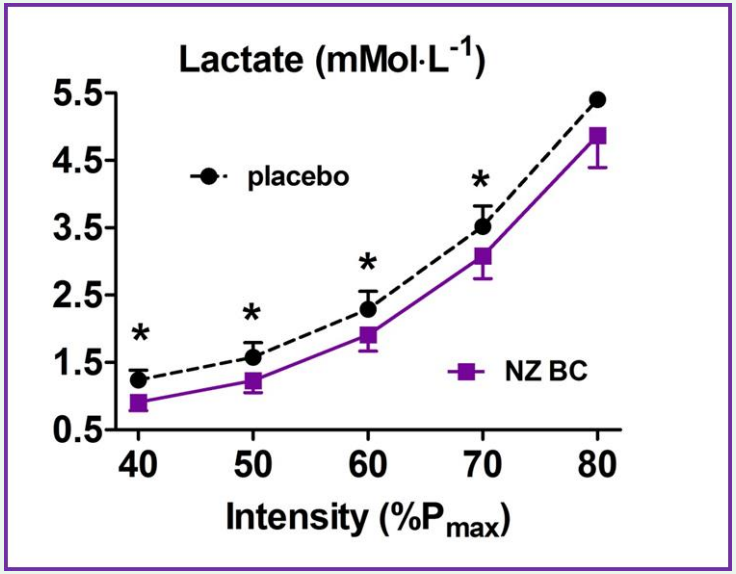
- **the lactate curve**



Willems et al., *Int J Sport Nutr Exerc Metab* (in press)

sodium nitrate
0.1 mmol·kg^{-1}·day^{-1}

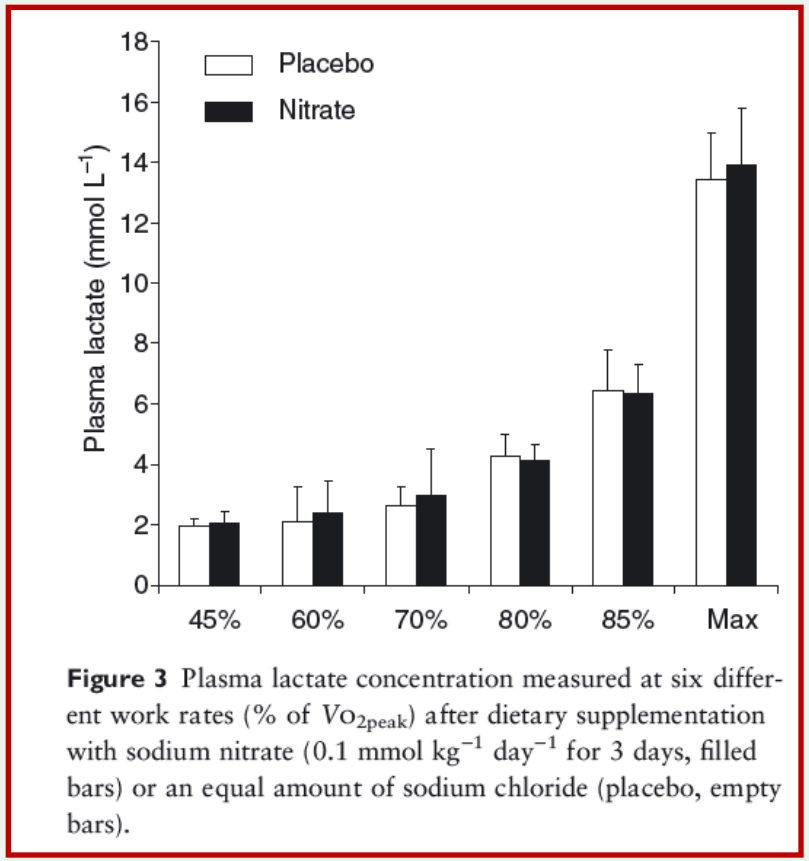


Figure 3 Plasma lactate concentration measured at six different work rates (% of Vo_{2peak}) after dietary supplementation with sodium nitrate (0.1 mmol kg^{-1} day^{-1} for 3 days, filled bars) or an equal amount of sodium chloride (placebo, empty bars).

Larsen et al. *Acta Physiol (Oxf)* 191(1):59-66, 2007

No effect on lactate

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Beetroot became a popular sports nutrition supplement

capsules

drinks

powder

bars

gels

beetroot juice

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Blackcurrant, the new sports nutrition supplement!

The same may happen for blackcurrant

Not only for flavour!

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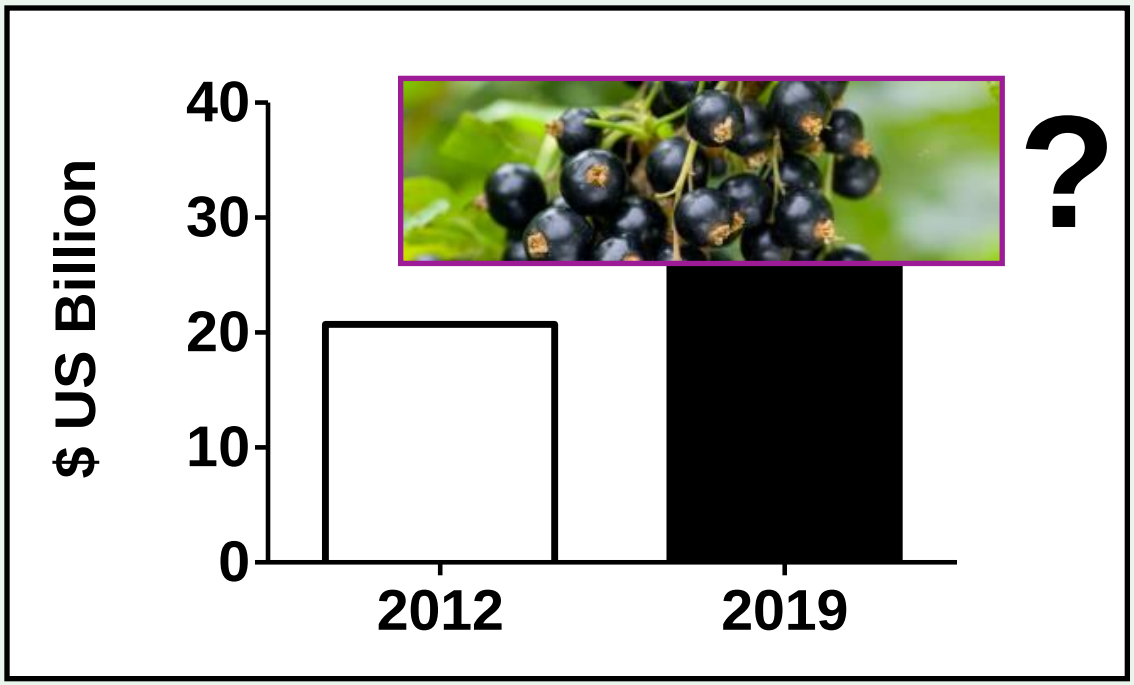
Sports Nutrition Market Will Reach $37.7 Billion in 2019, Globally : Persistence Market Research

supplements

drinks

(functional) foods



www.persistencemarketresearch.com (26/05/2015)

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Some future directions

still quite a journey!

- **Optimal dosing strategy**
- **Effectiveness in various exercise models**
- **Chronic use and training adaptation**
- **Effectiveness in elite athletes (and co-ingestion)**
- **Interaction of blackcurrant with other food components**
- **Effectiveness on performance in older adults and clinical populations**

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Thank you for listening

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we welcome collaborations