



Anthocyanin-Rich New Zealand Blackcurrant: Applications for Exercise and Health

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November 4, 2023



Anthocyanin-Rich New Zealand Blackcurrant: Applications for Exercise and Health

anthocyanins

antioxidant activity



Google search for "anthocyanins". The search bar contains "anthocyanins". Below the search bar are filters for "All", "Images", "Shopping", "Books", "News", and "More". The "Images" filter is selected. Below the filters are several image thumbnails with captions:

- Thumbnail 1: A purple vegetable (possibly cauliflower) with caption "Anthocyanin - Wikipedia".
- Thumbnail 2: A diagram showing various anthocyanin structures (Pelargonidin, Delphinidin, Petanidin, Malvidin, Peonidin, Cyanidin) with caption "Anthocyanins - Definition, Benefits ...".
- Thumbnail 3: A cluster of purple grapes with caption "Health Benefits - Cleveland Clinic".
- Thumbnail 4: A diagram titled "ANTHOCYANIN STRUCTURE" showing a chemical structure with substituents R³, R⁴, R⁵, R⁶, R⁷, and R⁸ with caption "Anthocyanins - Structure, Molecular ...".
- Thumbnail 5: A circular diagram titled "Food Sources Richest in Anthocyanins" showing various fruits and vegetables like Blueberry, Purple corn, Bilberry, Pomegranate, Red grapes, Strawberry, Raspberry, Cherry, Beet, and Purple cabbage with caption "Derivatives through Clay Minerals ...".
- Thumbnail 6: A diagram showing various anthocyanin structures with caption "Foods | Free Full-Text | Anthocyani...".
- Thumbnail 7: A diagram showing various anthocyanin structures with caption "Anthocyanin - an overview ...".

Two black arrows point from the text "antioxidant activity" to the search results. One arrow points to the "ANTHOCYANIN INTAKE" diagram, and the other points to the "ANTHOCYANIN STRUCTURE" diagram.

phenol rings

Polyphenols (>8000)

Phenolic acids

Hydrobenzoic acids
e.g. protocatechuic acid
gallic acid

Hydroxycinnamic acids
e.g. ferulic acid
curcumin

>4000

Flavonoids

Stilbenes
e.g. resveratrol

Lignans

>600

Anthocyanidins
e.g. cyanidin

Flavonols
e.g. quercetin

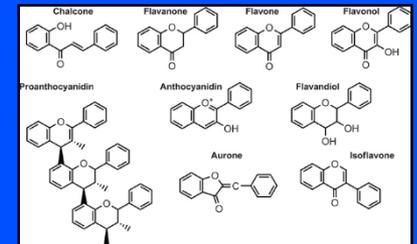
Flavones

Isoflavones

Flavanones

Flavanols
e.g. catechins

anthocyanins are glycosides of anthocyanidins
e.g. cyanidin-3-glucoside



Polyphenol composition



black elderberry



strawberry



black chokeberry



blackcurrant



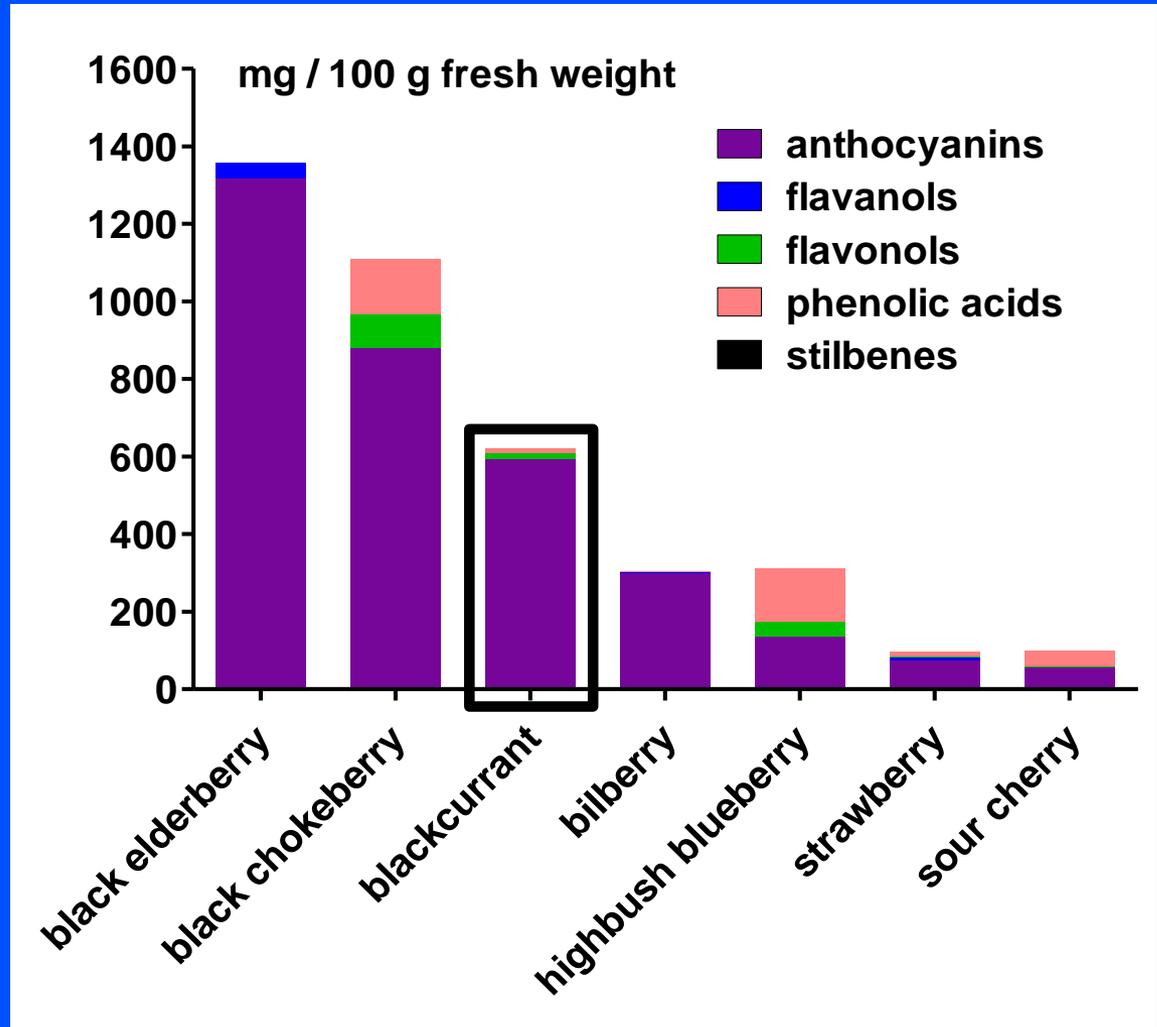
bilberry



sour cherry



highbush blueberry



Anthocyanin composition



black chokeberry



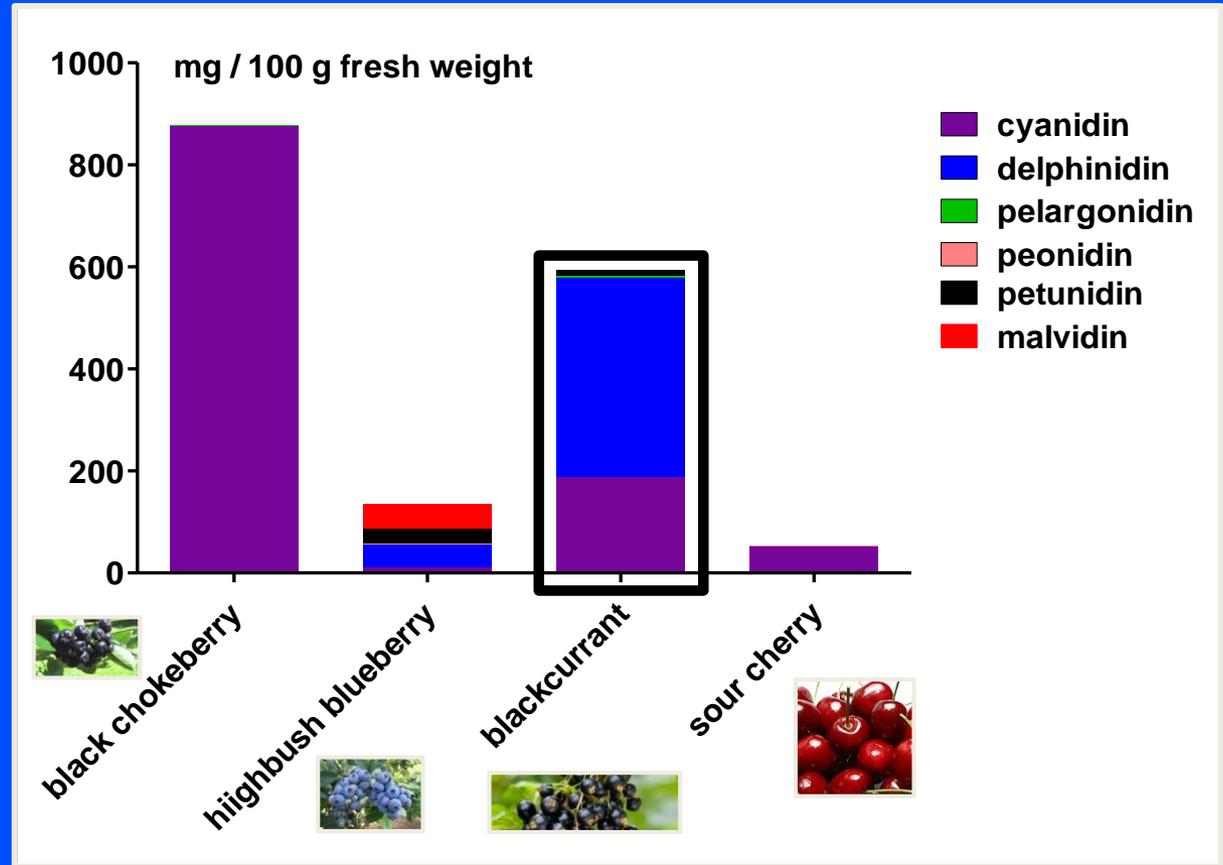
blackcurrant



highbush blueberry



sour cherry



Berries differ in total anthocyanin content and composition

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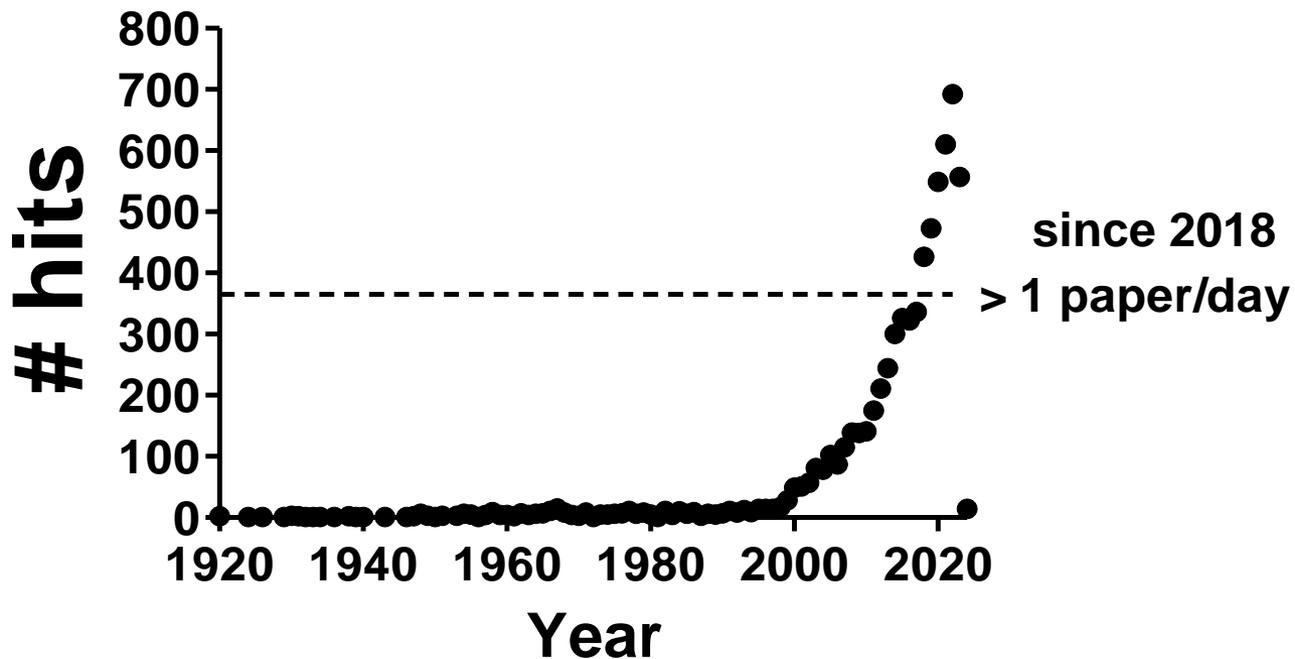
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PubMed: anthocyanins [ti] OR anthocyanins [ti]





Anthocyanin-Rich New Zealand Blackcurrant: Applications for Exercise and Health

Outline

- Why interest in anthocyanin-rich blackcurrant?
- Metabolic and exercise performance effects
- Health-related effects
- Are we there yet?: The unknowns





Anthocyanin-Rich New Zealand Blackcurrant: Applications for Exercise and Health

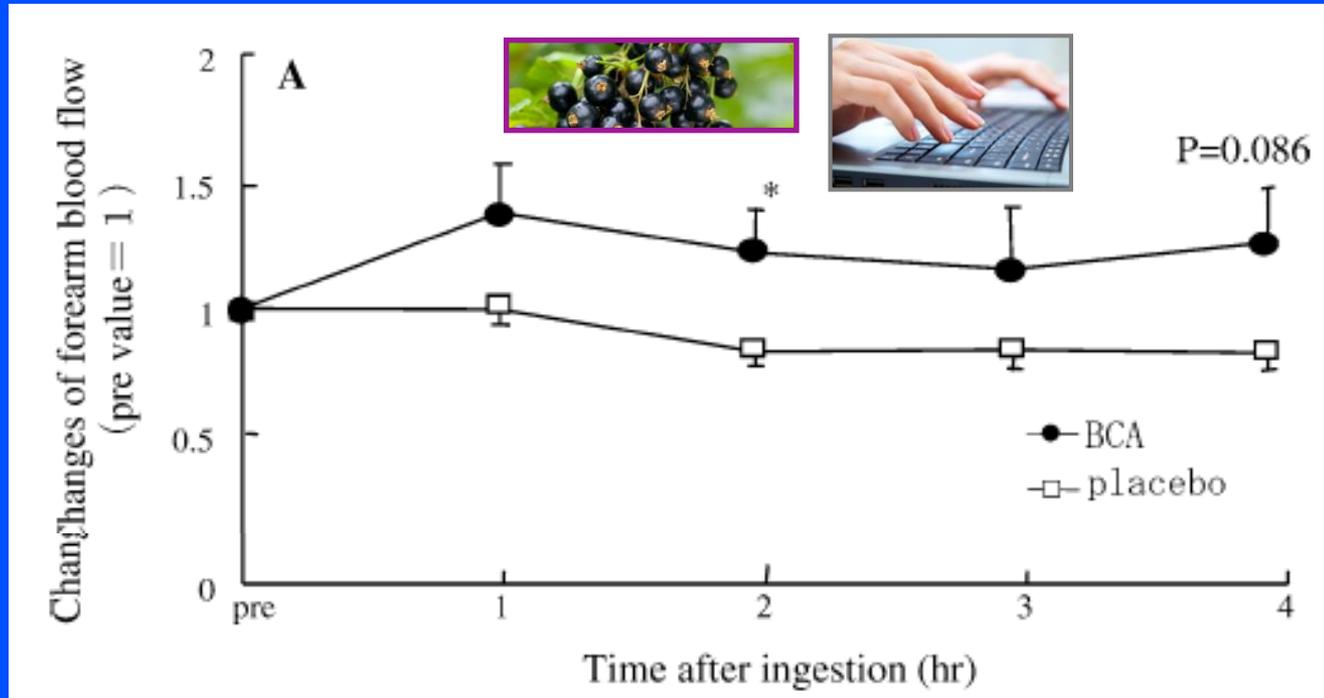
Outline

- **Why interest in anthocyanin-rich blackcurrant?**
- **Metabolic and exercise performance effects**
- **Health-related effects**
- **Are we there yet?: The unknowns**



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

blackcurrant anthocyanin concentrate 17 mg (kg BW)⁻¹ 10.83% anthocyanins



2005

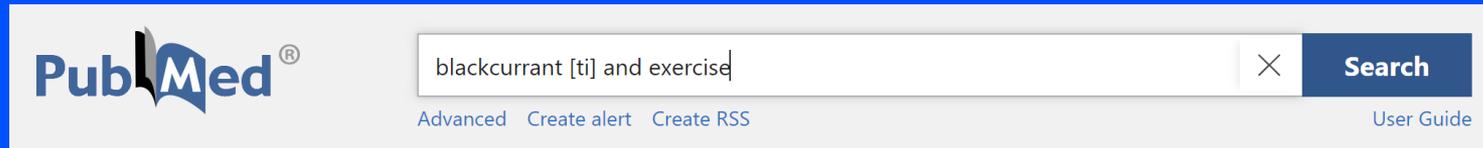
8 males, 3 females
age: 39 ± 12 yr

forearm blood flow
(supine position)

near infrared
spectroscopy

blackcurrant increased blood flow by **22%** (2 hr)

peer-reviewed < 2013: Only one paper!



Found 1 result for *blackcurrant [ti] AND exercise*

Filters applied: From 1900 to 2013/12/31. [Clear all](#)

Clinical Trial > Am J Physiol Regul Integr Comp Physiol. 2009 Jul;297(1):R70-81.
doi: 10.1152/ajpregu.90740.2008. Epub 2009 Apr 29.

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

K A Lyall ¹, S M Hurst, J Cooney, D Jensen, K Lo, R D Hurst, L M Stevenson

2009

Post-exercise observations

30-min indoor rowing

5 males, 5 females

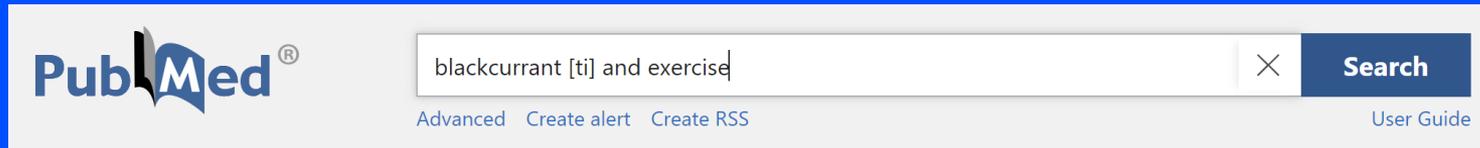
age: 48 ± 3 yr



120 mg anthocyanins before exercise



peer-reviewed < 2013: Only one paper!



Found 1 result for *blackcurrant [ti] AND exercise*

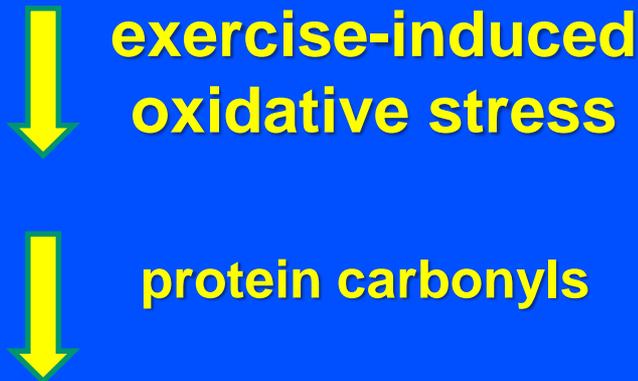
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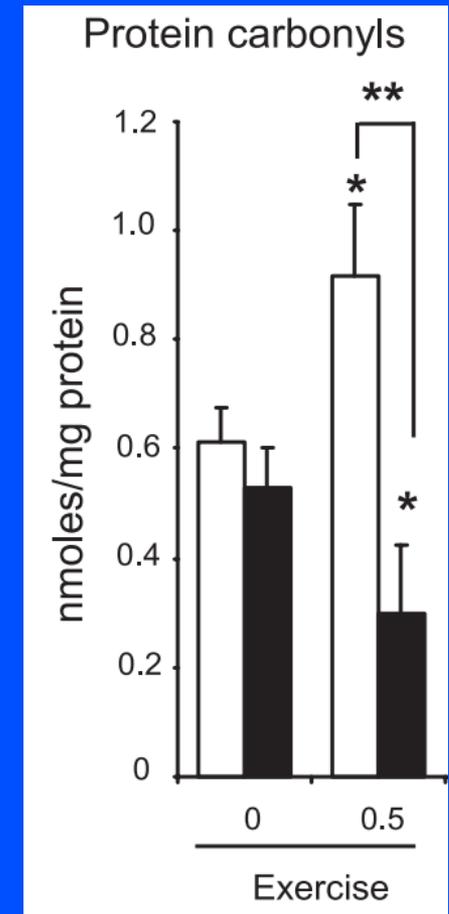
Short-term blackcurrant extract consumption modulates exercise-induced oxidative stress and lipopolysaccharide-stimulated inflammatory responses

K A Lyall¹, S M Hurst, J Cooney, D Jensen, K Lo, R D Hurst, L M Stevenson

2009



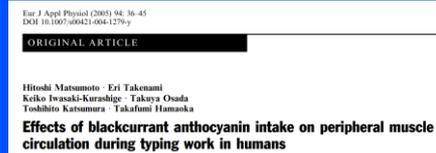
■ blackcurrant





Anthocyanin-rich Blackcurrant

↑ **blood flow**



2005



↓ **exercise-induced oxidative stress**



2009



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Lactate: intermittent incremental cycling (4 min stages, 2 min rest)



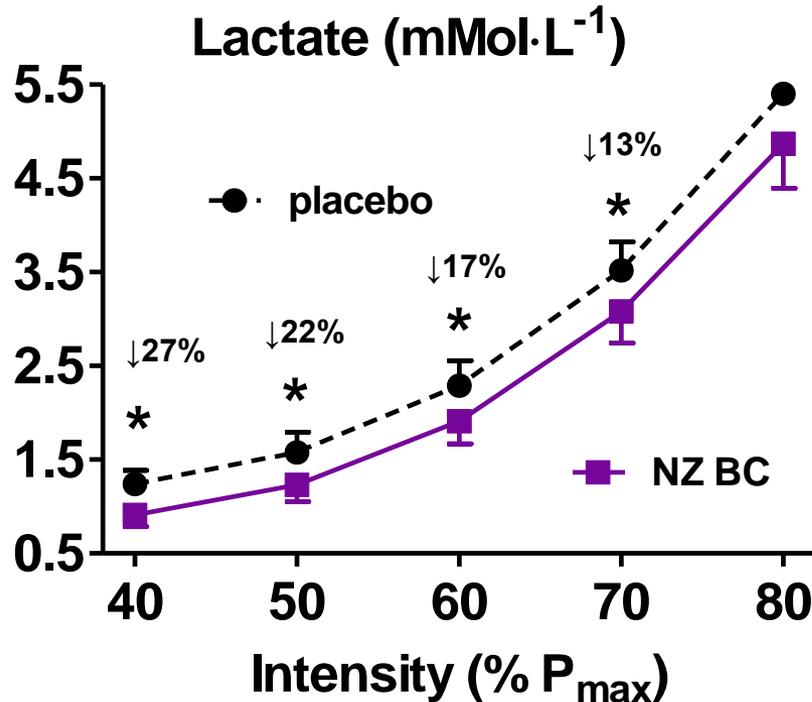
n = 13 (triathletes)



6 gram New Zealand
blackcurrant powder for 7 days

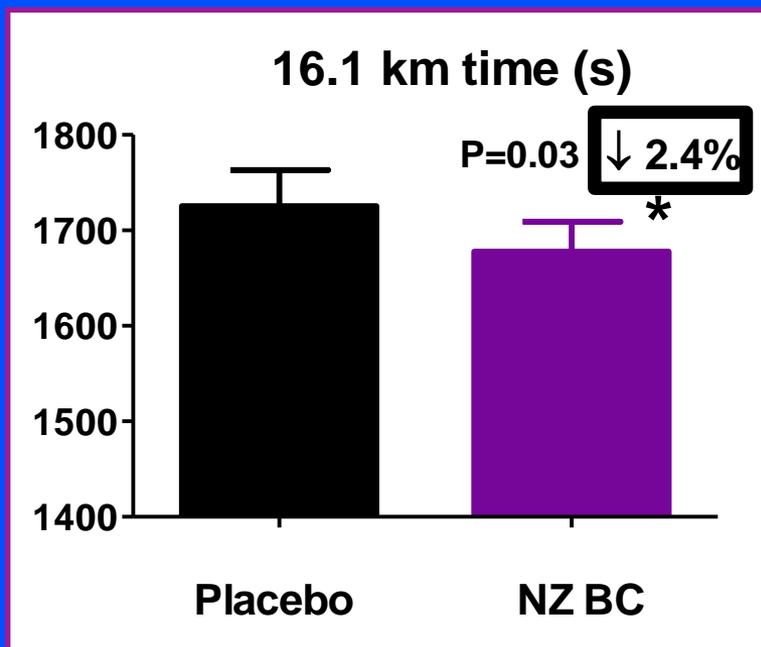
~139 mg anthocyanins/day for 7 days

NZBC – New Zealand blackcurrant



**New Zealand blackcurrant resulted in a shift of
the cycling intensity-lactate curve**

16.1 km cycling time-trial performance



NZBC – New Zealand blackcurrant



1 per day for 7 days



n = 14 (cyclists)

11 did go faster

~105 mg blackcurrant anthocyanins



double-blind placebo controlled cross-over design

two full 16.1 km familiarizations

Acute Dietary Nitrate Supplementation Improves Cycling Time Trial Performance

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

↓ 2.7%



beetroot



- 16.1 km cycling time trial

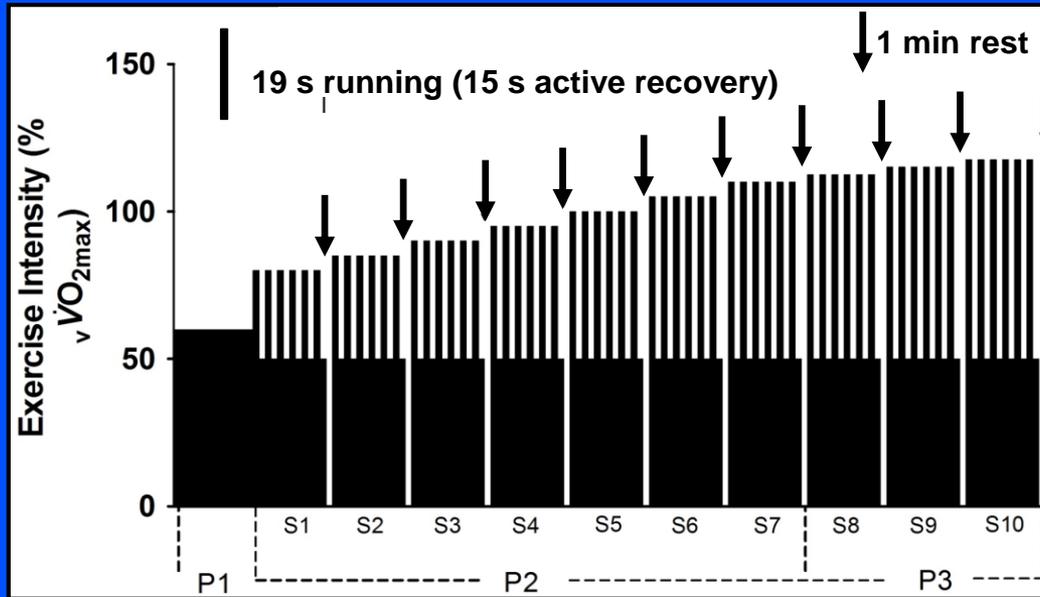
Endurance (aerobic) exercise



What about high intensity (more anaerobic) intermittent exercise?



- high-intensity incremental treadmill running



5 min at 60%

5%
increases

2.5%
increases



n = 13 (recreationally active males)



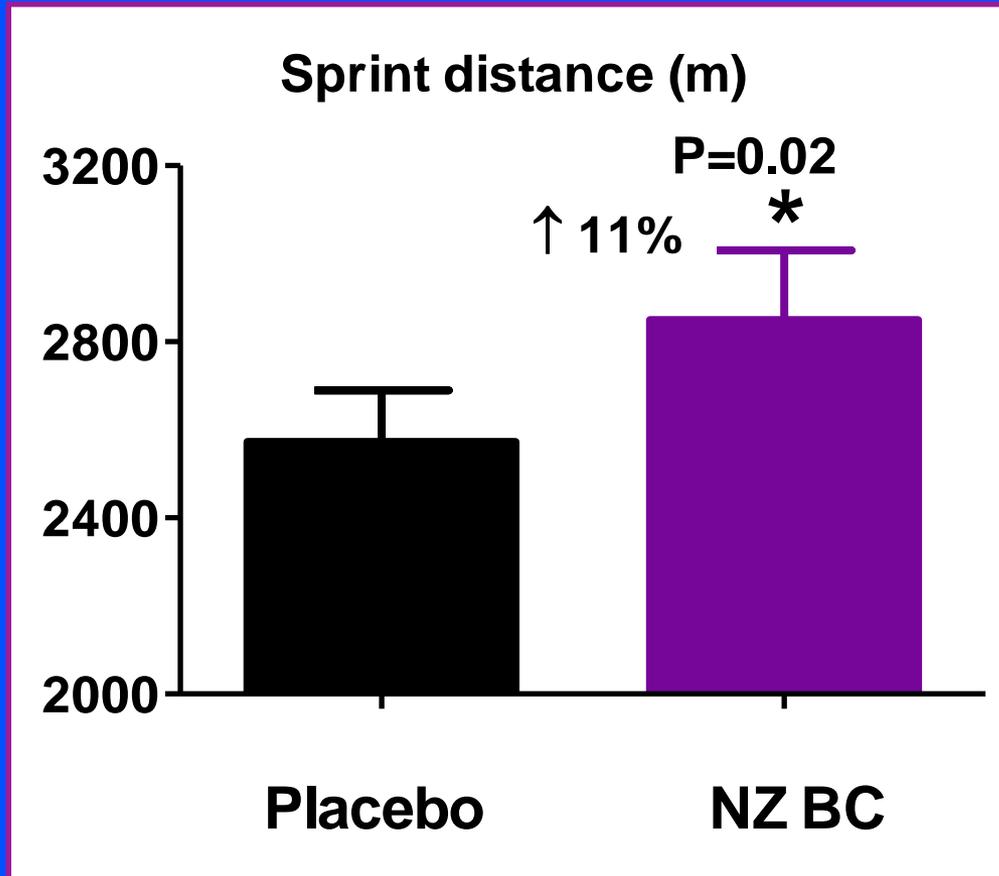
~105 mg anthocyanins/day for 7 days



NZBC – New Zealand blackcurrant



- high-intensity incremental treadmill running



n = 13 (recreationally active males)

9 improved



~105 mg anthocyanins/day for 7 days



NZBC – New Zealand blackcurrant

Intermittent incremental cycling (4 min stages, 2 min rest)



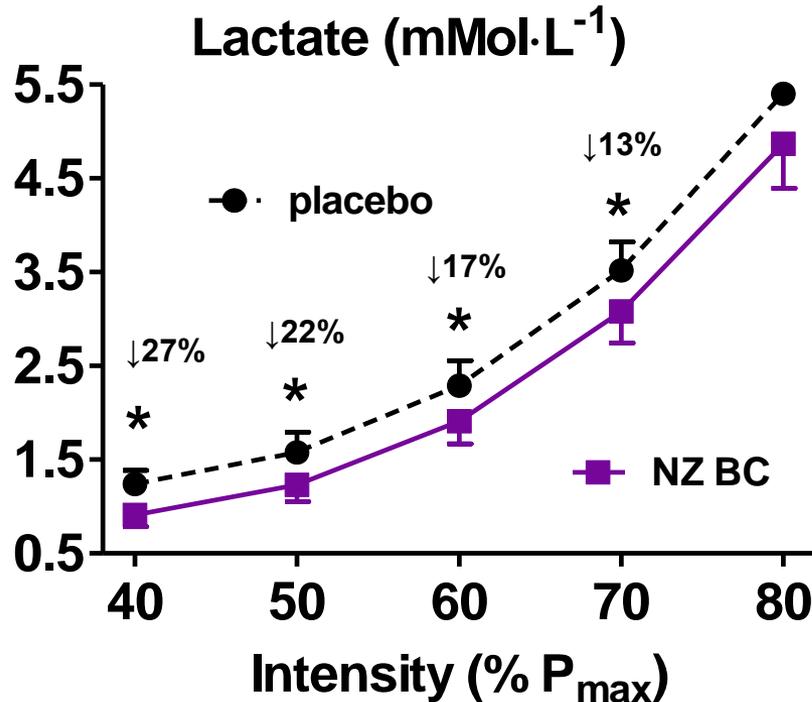
n = 13 (triathletes)



6 gram New Zealand blackcurrant powder for 7 days

~139 mg anthocyanins/day for 7 days

NZBC – New Zealand blackcurrant



New Zealand blackcurrant resulted in a shift of the cycling intensity-lactate curve



ORIGINAL ARTICLE

Dose effects of New Zealand blackcurrant on substrate oxidation and physiological responses during prolonged cycling

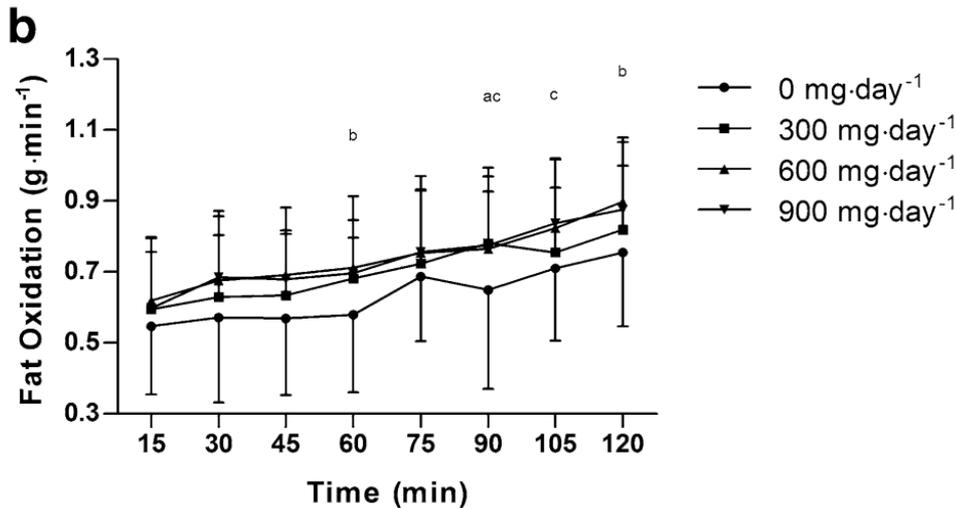
Matthew David Cook^{1,2} · Stephen David Myers¹ · Mandy Lucinda Gault¹ · Victoria Charlotte Edwards¹ · Mark Elisabeth Theodorus Willems¹



male cyclists

2 hr cycling at 65% $\dot{V}O_{2max}$

2 per day for 7 days (~210 mg anthocyanins/day)



fat oxidation

22%



ORIGINAL ARTICLE

Dose effects of New Zealand blackcurrant on substrate oxidation and physiological responses during prolonged cycling

Matthew David Cook^{1,2} · Stephen David Myers¹ · Mandy Lucinda Gault¹ · Victoria Charlotte Edwards¹ · Mark Elisabeth Theodorus Willems¹

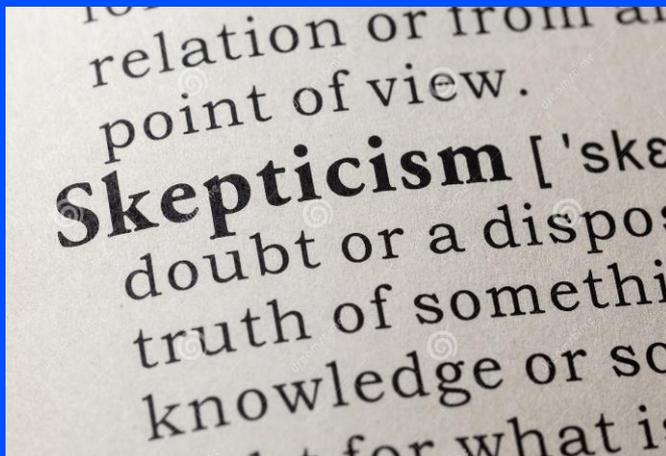


male cyclists

2 hr cycling at 65% $\dot{V}O_{2max}$

2 per day for 7 days (~210 mg anthocyanins/day)

Chichester-based studies



fat oxidation

22%



New Zealand blackcurrant extract enhances fat oxidation during prolonged cycling in endurance-trained females

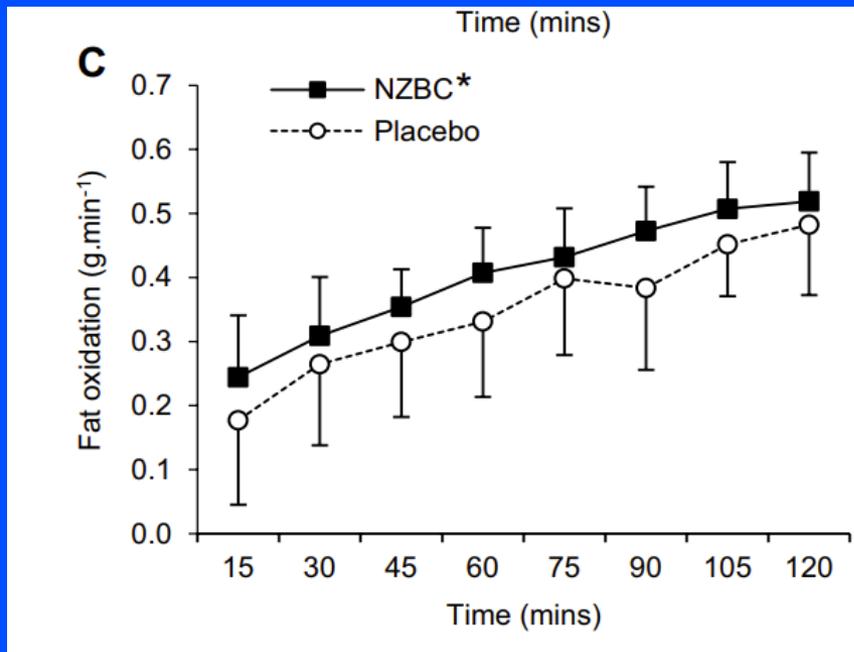
Juliette A. Strauss¹ · Mark E. T. Willems² · Sam O. Shepherd¹



female cyclists

2 hr cycling at 65% $\dot{V}O_{2max}$

2 per day for 7 days (~210 mg anthocyanins/day)



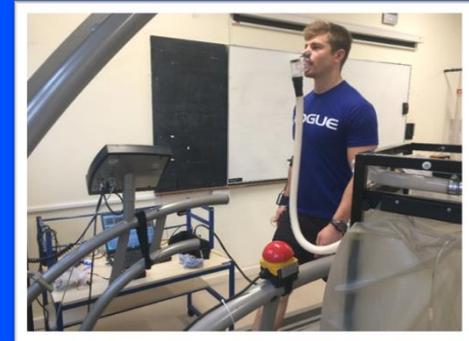
fat oxidation

27%





Do you need to supplement every day to enhance exercise-induced fat oxidation?



16 males, walking at 5-MET for 30 min



2 per day for 14 days
(~210 mg anthocyanins/day)

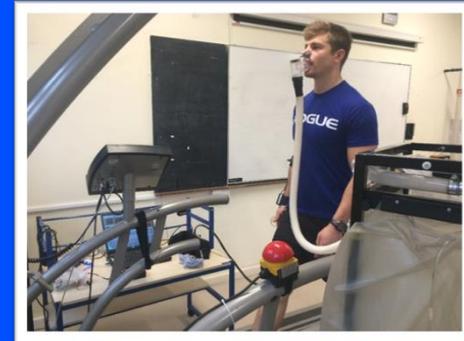
2 every-other-day for 14 days
(~210 mg anthocyanins/day)



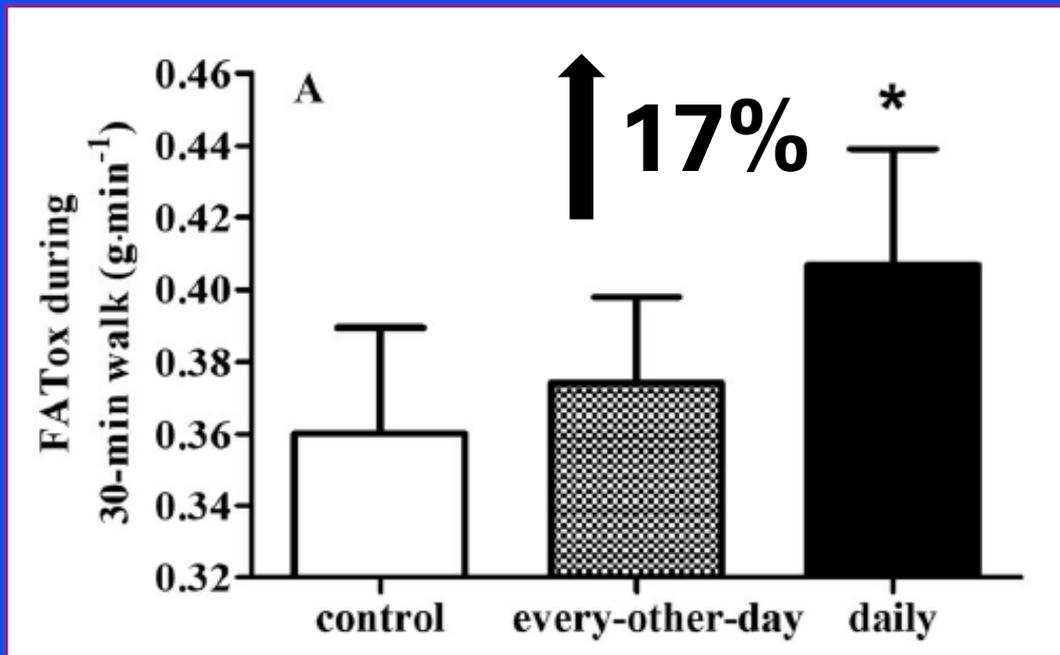
Daily and Not Every-Other-Day Intake of Anthocyanin-Rich New Zealand Blackcurrant Extract Alters Substrate Oxidation during Moderate-Intensity Walking in Adult Males

Mehmet Akif Şahin, PhD^{a,b}, Pelin Bilgiç, PhD^b , Stefano Montanari, MSc^a, and Mark Elisabeth Theodorus Willems, PhD^a 

^aInstitute of Sport, University of Chichester, Chichester, UK; ^bDepartment of Nutrition and Dietetics, Hacettepe University, Ankara, Turkey



16 males, walking at 5-MET for 30 min



2 per day for 14 days (~210 mg anthocyanins/day)

2 every-other-day for 14 days (~210 mg anthocyanins/day)





peer-reviewed < 2013



blackcurrant [ti] exercise



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doi: 10.1152/ajpregu.90740.2008. Epub 2009 Apr 29.

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

FULL TEXT LINKS

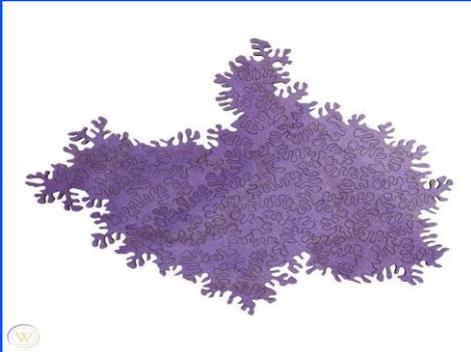


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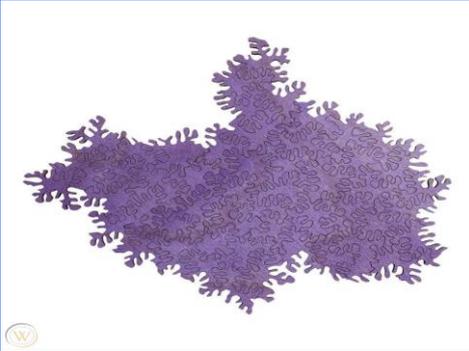
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- Why interest in anthocyanin-rich blackcurrant?
- Metabolic and exercise performance effects
- **Health-related effects**
- Are we there yet?: The unknowns





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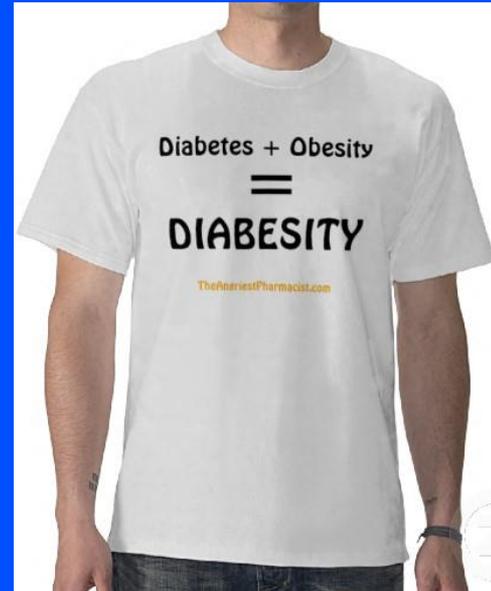


The health benefits of anthocyanins: an umbrella review of systematic reviews and meta-analyses of observational studies and controlled clinical trials

Berner-Andrée Sandoval-Ramírez, Úrsula Catalán , Elisabet Llauredó , Rosa-María Valls, Patricia Salamanca, Laura Rubió, Silvia Yuste, and Rosa Solà

Nutrition Reviews 80(6):1515–1530, 2022

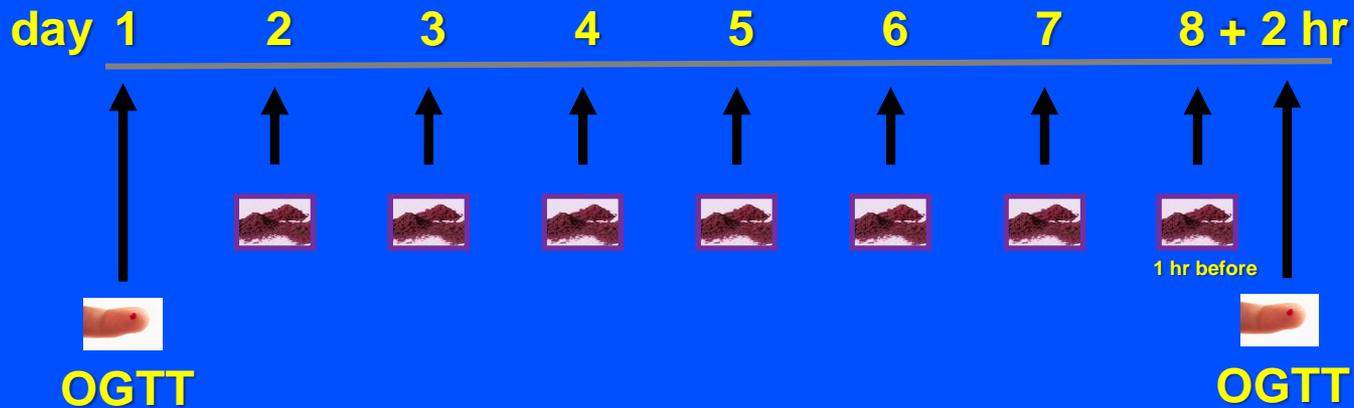
the diabetes epidemic



reduced insulin sensitivity

Beneficial effects on fasting insulin and postprandial responses through 7-day intake of New Zealand blackcurrant powder

Mark Elisabeth Theodorus Willems¹, Jose Dos Santos Silva¹, Matthew David Cook^{1,2}, and Sam David Blacker¹

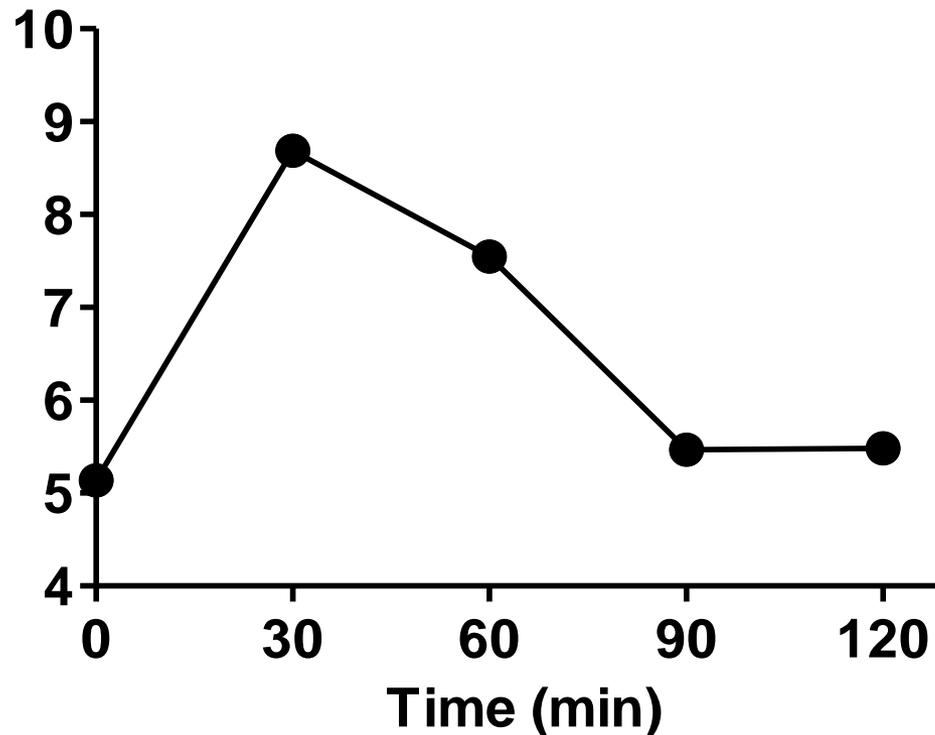


- 17 participants (9 females, 20-53 years)
- 7-days of 6 gram New Zealand blackcurrant powder (6 gram: 138.6 mg anthocyanins, 49 mg vitamin C and 5.2 g of carbohydrates)
- 2 hr OGTT (75 gram glucose) after overnight fast
- glucose-insulin analysis at 0, 30, 60, 90 and 120 min samples

Oral Glucose Tolerance Test

75 gram glucose dissolved in water

Postprandial blood glucose ($\text{mmol} \cdot \text{L}^{-1}$)



- area under the curve



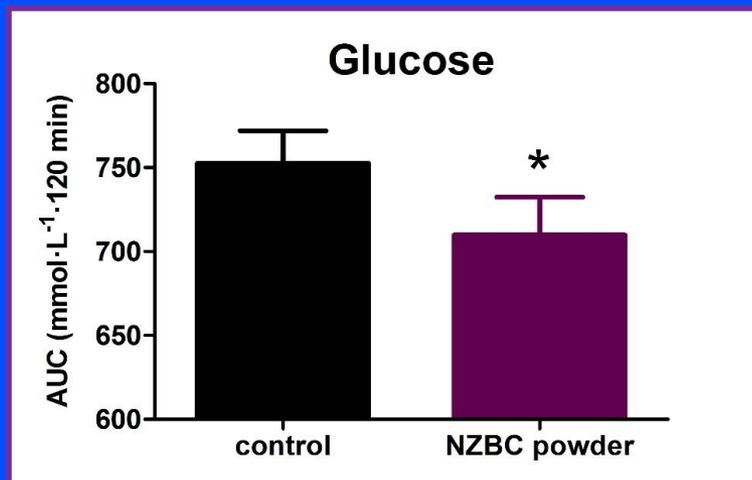
glucose
insulin



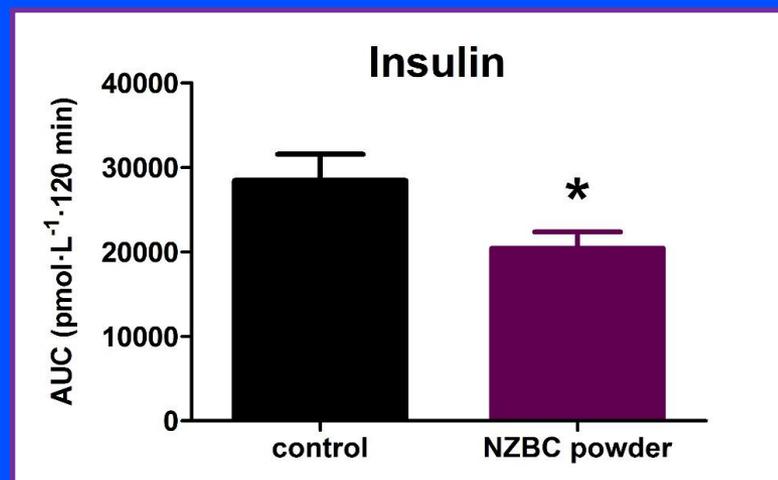
Beneficial effects on fasting insulin and postprandial responses through 7-day intake of New Zealand blackcurrant powder

Mark Elisabeth Theodorus Willems¹, Jose Dos Santos Silva¹, Matthew David Cook^{1,2}, and Sam David Blacker¹

Increased insulin sensitivity



area under the curve ↓ 5.7% (P<0.05)



area under the curve ↓ 31.1% (P<0.05)



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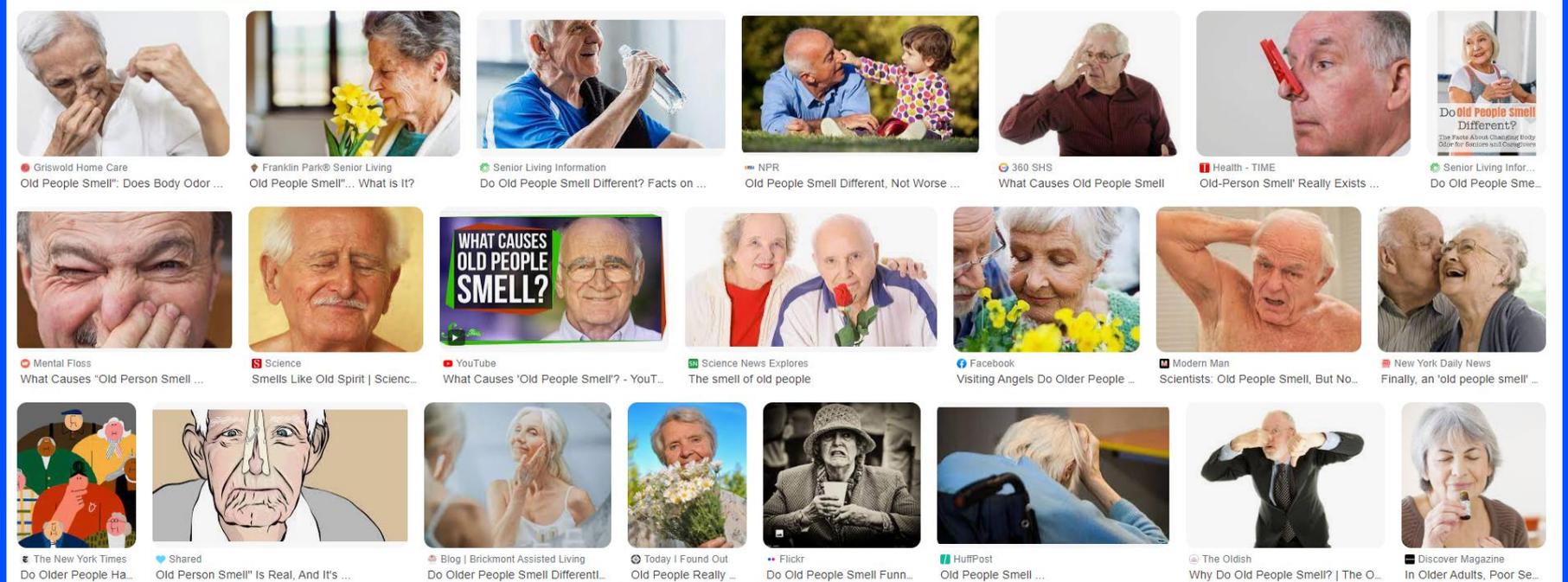
- Why interest in anthocyanin-rich blackcurrant?
- Metabolic and exercise performance effects
- **Health-related effects**
- Are we there yet?: The unknowns



Body odor: Old people smell?

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The search results page displays a grid of 24 items, each with a thumbnail image and a caption. The items include:

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- Franklin Park® Senior Living:** Old People Smell... What is It?
- Senior Living Information:** Do Old People Smell Different? Facts on ...
- NPR:** Old People Smell Different, Not Worse ...
- 360 SHS:** What Causes Old People Smell
- Health - TIME:** Old-Person Smell' Really Exists ...
- Senior Living Infor...:** Do Old People Sme...
- Mental Floss:** What Causes "Old Person Smell" ...
- Science:** Smells Like Old Spirit | Scienc...
- YouTube:** What Causes 'Old People Smell'? - YouT...
- Science News Explores:** The smell of old people
- Facebook:** Visiting Angels Do Older People ...
- Modern Man:** Scientists: Old People Smell, But No...
- New York Daily News:** Finally, an 'old people smell' ...
- The New York Times:** Do Older People Ha...
- Shared:** Old Person Smell" Is Real, And It's ...
- Blog | Brickmont Assisted Living:** Do Older People Smell Different...
- Today I Found Out:** Old People Really ...
- Flickr:** Do Old People Smell Funn...
- HuffPost:** Old People Smell ...
- The Oldish:** Why Do Old People Smell? | The O...
- Discover Magazine:** In Older Adults, Poor Se...



Contents lists available at ScienceDirect

Journal of Chromatography B

journal homepage: www.elsevier.com/locate/chromb



Measurement of 2-nonenal and diacetyl emanating from human skin surface employing passive flux sampler—GCMS system

Keita Kimura^a, Yoshika Sekine^{a,*}, Shota Furukawa^a, Minami Takahashi^a, Daisuke Oikawa^b

^a Graduate School of Science, Tokai University, 4-1-1 Kitakaname, Hiratsuka, Kanagawa 259-1292, Japan

^b AIREX Inc., 2-17-6 Myojincho, Hachioji, Tokyo 192-0046, Japan

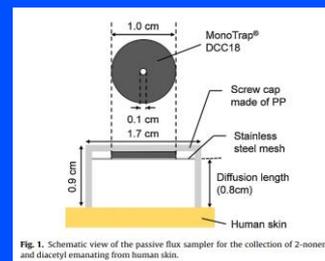
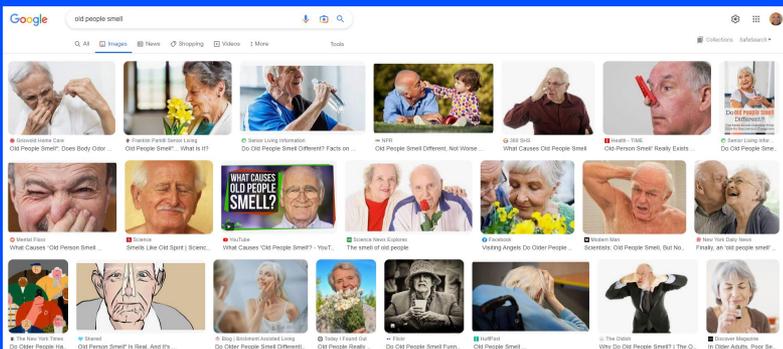


Fig. 1. Schematic view of the passive flux sampler for the collection of 2-nonenal and diacetyl emanating from human skin.



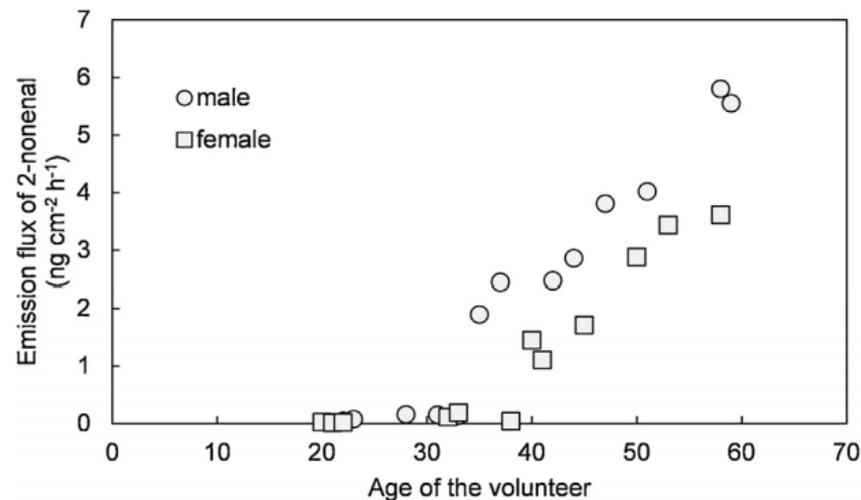
Fig. 2. Sampling of 2-nonenal and diacetyl at the nape of the neck. The PFS was fixed to a piece of medical tape.

2016



That "old person smell" is actually caused by a chemical, called 2-nonenal, that old people secrete through their skin.

überfacts





Measurement of 2-nonenal and diacetyl emanating from human skin surface employing passive flux sampler—GCMS system

Keita Kimura^a, Yoshika Sekine^{a,*}, Shota Furukawa^a, Minami Takahashi^a, Daisuke Oikawa^b

^a Graduate School of Science, Tokai University, 4-1-1 Kitakaname, Hiratsuka, Kanagawa 259-1292, Japan
^b AIREX Inc., 2-17-6 Myojincho, Hachioji, Tokyo 192-0046, Japan

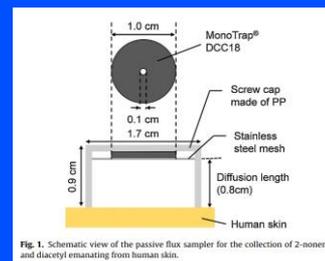


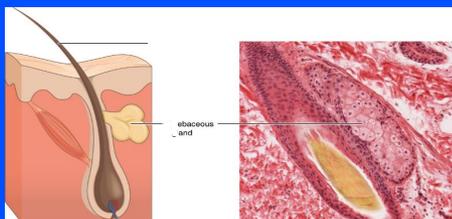
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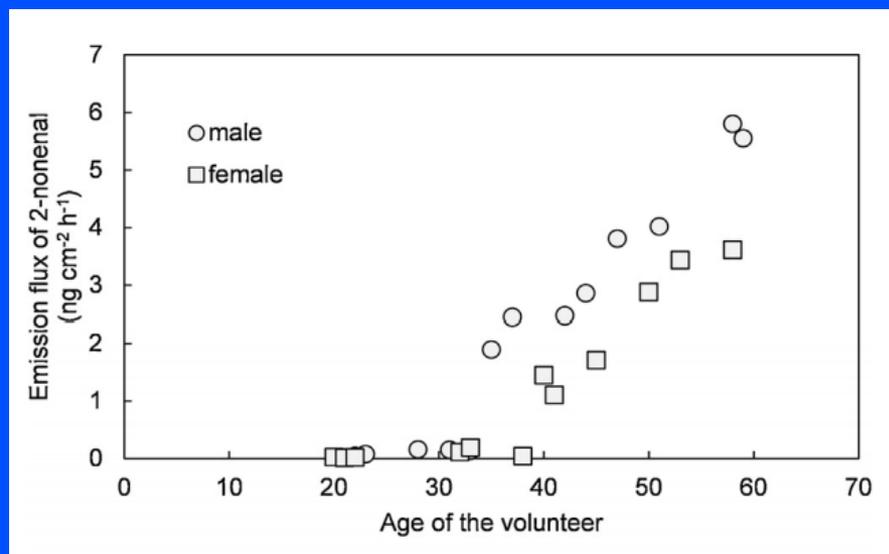
Fig. 2. Sampling of 2-nonenal and diacetyl at the nape of the neck. The PFS was fixed to a piece of medical tape.

2016

2-nonenal is a lipid peroxidation product and the consequence of a decrease in antioxidant defense



sebaceous gland



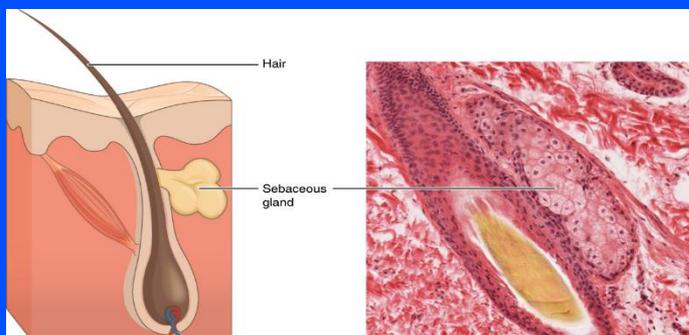


Journal of Dietary Supplements
Intake of New Zealand Blackcurrant Powder Affects Skin-Borne Volatile Organic Compounds in Middle-Aged and Older Adults

M. E. T. Willems, M. Todaka, M. Banic, M. D. Cook & Y. Sekine

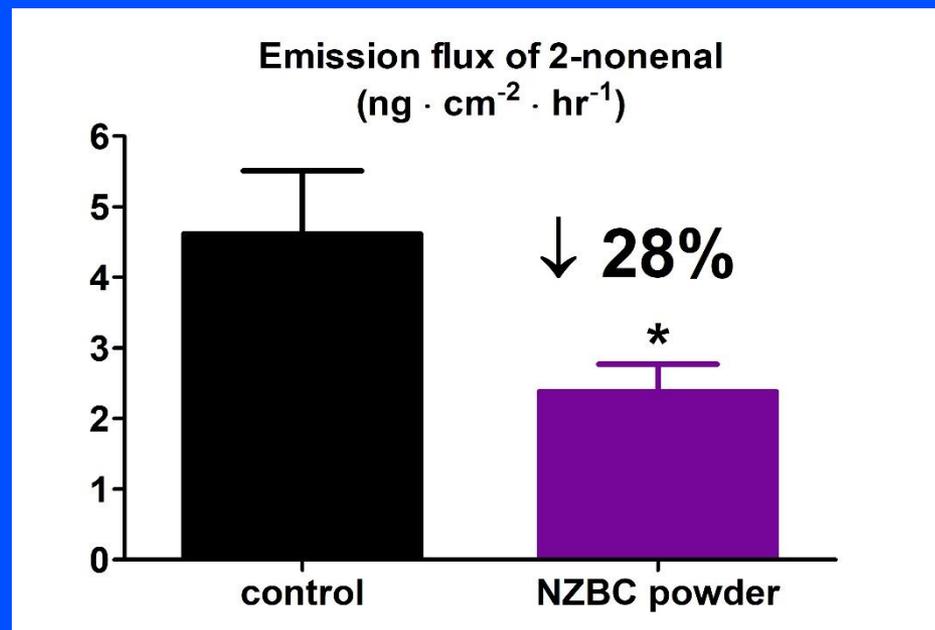
J Diet Suppl. 19(5):603-620, 2022.

- 6 gram NZBC powder per day for 7 days
- 48 no washing of nape of the neck
- 1 hr skin gas collection
- gas chromatography–mass spectrometry



sebaceous gland

2-nonenal is a lipid peroxidation product



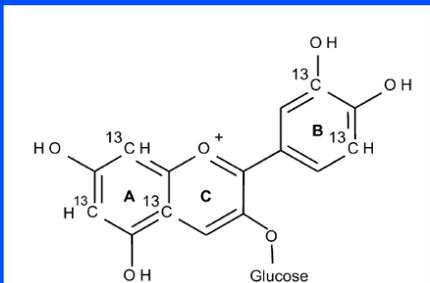


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Cyanidin-3-glucoside



one dose



RESEARCH PAPER

**The pharmacokinetics of
anthocyanins and their
metabolites in humans**

R M de Ferrars^{1*}, C Czank^{1*†}, Q Zhang², N P Botting^{2†}, P A Kroon³,
A Cassidy¹ and C D Kay¹

**16 metabolites
in blood**

- Parent anthocyanins
 - Cyanidin-3-glucoside
- Degradants
 - Protocatechuic acid (PCA)
 - Phloroglucinaldehyde
- Protocatechuic acid derived
 - Benzoic acid-4-glucuronide
 - Methyl-3,4-dihydroxybenzoate
 - PCA-3-glucuronide
 - PCA-4-glucuronide
 - PCA-sulfates^c
 - Vanillic acid (VA)
 - IsoVA
 - VA-4-glucuronide
 - IsoVA-3-glucuronide
 - VA-sulfates^c
 - 4-Hydroxybenzaldehyde
 - Ferulic acid
 - Hippuric acid
- Phloroglucinaldehyde derived
 - Ferulic acid^d

Delphinidin-3-glucoside
Delphinidin-3-rutinoside
Cyanidin-3-rutinoside
Cyanidin-3-glucoside



**New Zealand
blackcurrant
extract**



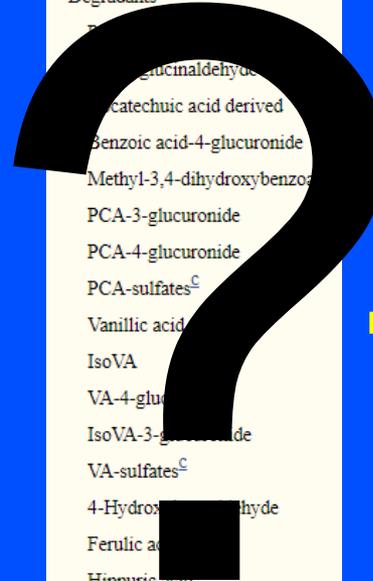
**chronic
dosing**



gut microbiota?

responders / non-responders?

Parent anthocyanins
Cyanidin-3-glucoside
Degradants
Phloroglucinaldehyde
catechuic acid derived
Benzoic acid-4-glucuronide
Methyl-3,4-dihydroxybenzoic acid
PCA-3-glucuronide
PCA-4-glucuronide
PCA-sulfates ^c
Vanillic acid
IsoVA
VA-4-glucuronide
IsoVA-3-glucuronide
VA-sulfates ^c
4-Hydroxybenzoic acid
Ferulic acid
Hippuric acid
Phloroglucinaldehyde derived
Ferulic acid ^d



**cell/tissue
function?**

Future directions



still quite a journey!



- **The anthocyanin composition: Does it matter in humans?**
- **Optimal anthocyanin dosing strategies in different cohorts: Dose and intake duration**
- **Synergistic effects of anthocyanin and other supplements**



exercise

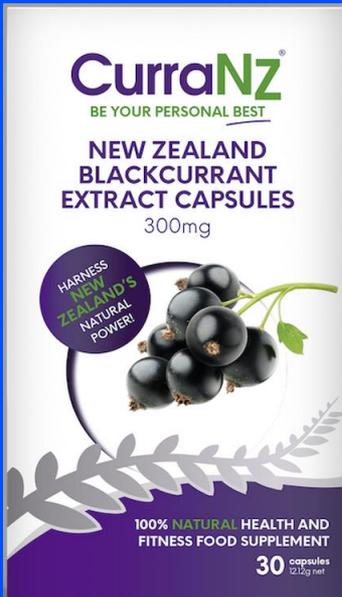


C57BL/6 mouse model of polygenic obesity

In the future!

A competition of berries?





The future is still bright!



<https://www.databridgemarketresearch.com/report/s/global-anthocyanins-market> (16/01/2023)

Global anthocyanin market: Growth at a rate of 4.35% in the forecast period of 2021 to 2028

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Take home message

Intake of anthocyanin-rich New Zealand blackcurrant has enriched the world of sport and exercise nutrition and shown the potential for anthocyanin supplementation



Out last year

frontiers
in Nutrition | Sport and Exercise Nutrition

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THIS ARTICLE IS PART OF THE RESEARCH TOPIC
Insights in Sport and Exercise Nutrition 2022 (view all 4 ARTICLES)

PERSPECTIVE article
Front. Nutr. 12: March 2022 | <https://doi.org/10.3389/fnut.2022.864323>

Anthocyanin-Rich Supplementation: Emerging Evidence of Strong Potential for Sport and Exercise Nutrition

Mark E. T. Willems* and Sam D. Blackler
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Dark-colored fruits, especially berries, have abundant presence of the polyphenol anthocyanin which have been show to provide health benefits. Studies with the berry blackcurrant have provided notable observations with application for athletes and physically active individuals. Alterations in exercise-induced substrate oxidation, exercise performance of repeated high-intensity running and cycling time-trial and cardiovascular function at rest and during exercise were observed with intake of New Zealand blackcurrant. The dynamic plasma bioavailability of the blackcurrant anthocyanins and the anthocyanin-derived metabolites must have changed cell function to provide meaningful *in-vivo* physiological effects. This perspective will reflect on the research studies for obtaining the applied *in-vivo* effects by intake of anthocyanin-rich supplementation, the issue of individual responses, and the emerging strong potential of anthocyanins for sport and exercise nutrition. Future work with repeated intake of known amount and type of anthocyanins, gut microbiota handling of anthocyanins, and coinciding measurements of plasma anthocyanin and anthocyanin-derived metabolites and *in-vivo* cell function will be required to inform our understanding for the unique potential of anthocyanins as a nutritional ergogenic aid for delivering meaningful effects for a wide range of athletes and physically active individuals.

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**ANTHOCYANIN-RICH NEW ZEALAND BLACKCURRANT:
IMPLICATIONS FOR HEALTH**

KEYWORDS: Anthocyanins, New Zealand blackcurrant, fat oxidation, cardiovascular function, insulin sensitivity, body odor, volatile organic compounds, Peer Reviewed.

PEER REVIEWED

ABSTRACT

Regular fruit intake contributes to your health. Studies have reported on the health-providing anti-oxidant and anti-inflammatory effects of many fruit berries. New Zealand blackcurrant is a dark-colored berry rich in the flavonoid polyphenol anthocyanin. The physiological and metabolic responses at rest and during exercise by short-term intake of anthocyanin-rich New Zealand blackcurrant can provide an indication for the potential to promote health. This mini review will cover primarily the findings of some of our studies using New Zealand blackcurrant with meaningful changes on exercise-induced fat oxidation, cardiovascular function during supine rest, insulin sensitivity, and emission of skin volatile organic compounds. Daily intake of New Zealand blackcurrant has the potential to provide benefits for exercise, health and well-being.

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Thank you

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