Catherine has had an extensive and varied career in science. Since graduating from the University of Witwatersrand, South Africa, with a Masters in Microbiology she has worked as a consulting industrial microbiologist both in South Africa and New Zealand.

She enjoyed her time as a research associate for Genesis Research and Development, New Zealand, looking for novel therapeutics for new drug therapies. Since coming to Australia she has lectured in the fields of biochemistry, microbiology, pharmacology and laboratory techniques.

Over the years she has developed an interest in nutrition and the prevention of disease and she has combined this interest with her love of science in a PhD looking at the effects of dietary factors on nitric oxide and its functional outcomes in relation to cardiovascular disease, which is the leading cause of death in Australia.
Heart health benefits of apples

By Catherine Bondonno

Supervisors: Prof Jonathan Hodgson; Prof Kevin Croft; Assoc Prof Michael Considine
Heart health benefits of apples

First study to show flavonoid-rich apples improve nitric oxide status and endothelial function

Cardiovascular health

Natural and low cost approach
Acknowledgements

Supervisors:
- Prof Jonathan Hodgson
- Prof Kevin Croft
- Dr Michael Considine

Clinicians:
- Prof Ian Puddey
- Prof Trevor Redgrave

Flow mediated dilatation:
- Lisa Rich

Nurse:
- Claude Backory

Lab measurements:
- Robin Xingbin
- Adeline Indrawan
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- ARC Linkage
- NHMRC
- Australian National Apple Breeding Program

Volunteers
Heart health benefits of apples
Heart health benefits of apples

Cardiovascular disease (CVD):

- Leading cause of death in Australia
- Quality of life
- Australia’s economy
- Epidemiological studies
- Phytochemicals, esp flavonoids
Heart health benefits of apples

Flavonoids:

- Phytonutrient
- Secondary plant metabolites
- Polyphenols

Positive effect on:
- endothelial function
- blood pressure
- atherosclerosis
- reduction in risk of CVD
Heart health benefits of apples

**Endothelium:**

- Nitric Oxide (NO)
- S-nitrosothiols and nitrite
- 20-HETE
- Endothelin-1
Heart health benefits of apples

Endothelial function and nitric oxide:

- Endothelial dysfunction
- Nitric oxide (NO)
- Dietary flavonoids
  - augment NO status
  - enhance endothelial function
  - improve cardiovascular health
Heart health benefits of apples

Apples:

- Source of flavonoids (esp. in skin)
- Popular
- Major contributor
- (-) – epicatechin and quercetin glycosides
- Improved endothelial function and NO status?
Heart health benefits of apples

Aim:

to investigate the acute effect of flavonoid-rich apples on endothelial function and NO status in healthy men and women
Participants

Healthy volunteers

Exclusion criteria

Telephone screening

Face to face screening
Baseline characteristics

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>47.3 ± 13.6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>66.4 ± 10.8</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>23.6 ± 3.4</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>112.2 ± 11.5</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>68.3 ± 7.8</td>
</tr>
<tr>
<td>Total cholesterol (mmol/L)</td>
<td>5.1 ± 0.7</td>
</tr>
<tr>
<td>Triglyceride (mmol/L)</td>
<td>1.0 ± 0.4</td>
</tr>
<tr>
<td>High density lipoprotein cholesterol (mmol/L)</td>
<td>1.6 ± 0.36</td>
</tr>
<tr>
<td>Low density lipoprotein cholesterol (mmol/L)</td>
<td>3.1 ± 0.6</td>
</tr>
<tr>
<td>Fasting plasma glucose (mmol/L)</td>
<td>5.1 ± 0.4</td>
</tr>
</tbody>
</table>
Study design

Randomised, controlled, cross-over trial

High flavonoid active

Low flavonoid control

Low flavonoid control

High flavonoid active
## Flavonoid composition of apple

<table>
<thead>
<tr>
<th>Polyphenol</th>
<th>Apple control (apple flesh) mg/dose (500 kJ)</th>
<th>Apple active (apple flesh+skin) mg/dose (500 kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quercetin glycosides</td>
<td>2</td>
<td>180</td>
</tr>
<tr>
<td>Free Quercetin</td>
<td>&lt;0.1</td>
<td>4</td>
</tr>
<tr>
<td>Total Quercetin</td>
<td>2</td>
<td>184</td>
</tr>
<tr>
<td>(-)-Epicatechin</td>
<td>2</td>
<td>180</td>
</tr>
<tr>
<td>Chlorogenic acid</td>
<td>44</td>
<td>44</td>
</tr>
</tbody>
</table>
Study day plan

8:00  Breakfast + apple

12:00  Lunch + apple

1:40  Blood pressure (100 min)

2:00  Flow mediated dilatation

2:20  Blood sample

2:30  Blood pressure (150 min)

3:20  Blood pressure (200 min)

• S-nitrosothiols
• Nitrite
• 20-HETE
• Endothelin-1
Flow mediated dilatation
Nitric Oxide Status

Plasma S-nitrosothiols

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Apple</th>
</tr>
</thead>
<tbody>
<tr>
<td>nmol/L</td>
<td></td>
<td></td>
</tr>
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</tbody>
</table>

P < 0.001
Nitric Oxide Status

Plasma nitrite

P<0.001

Control                      Apple

Plasma nitrite (nmol/L)

- Control: 30 nmol/L
- Apple: 70 nmol/L

Difference: Apple > Control
Flow mediated dilatation

%}

Control Apple

P<0.05

Time (seconds)
Blood pressure

### Systolic blood pressure
- Control: 110 mm Hg
- Apple: 112 mm Hg

### Diastolic blood pressure
- Control: 65 mm Hg
- Apple: 69 mm Hg

### Pulse pressure
- Control: 44 mm Hg
- Apple: 42 mm Hg
20-HETE and Endothelin-1

20-HETE

Endothelin-1

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Apple</th>
<th></th>
<th>Control</th>
<th>Apple</th>
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</thead>
<tbody>
<tr>
<td>pmol/L</td>
<td>350</td>
<td>360</td>
<td>pg/mL</td>
<td>2</td>
<td>2.1</td>
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</tr>
</tbody>
</table>
Heart health benefits of apples

Conclusions:

- Flavonoid-rich apples improve nitric oxide status and endothelial function
- Factors which may benefit cardiovascular health
- Natural and low cost approach to reducing the cardiovascular risk profile of the general population