Phytochemicals

Background

Phytochemicals are non-nutritive active compounds found in plant foods, and are inclusive of but not limited to:

- Stilbenes
- Flavonoids
- Isoflavones
- Isothiocyanates
- Phytoestrogens
- Phenolics
- Carotenoids

(Golzarand et al., 2015)
Resveratrol

Phytochemicals - Resveratrol

Background

*Contributed to the “French Paradox”*

**Definition:** A stilbene found in 72 plant species. Trans and cis form
Fat soluble

**Sources:** Peanuts, red wine, grape skins, bilberries, japanese knotweed (*Polygonum cuspidatum* rad), white hellebore (*Veratrum grandiflorum*)

**Actions:** Cardioprotective, may mitigate inflammation and oxidative stress, enhance endothelial function & vasotonicity, may inhibit platelet aggregation, may modulate lipoproteins
Resveratrol Recycling

Schematic of conjugation-deconjugation of resveratrol

(Singh et al., 2015)
Resveratrol

Preclinical evidence promised positive effects of resveratrol on cardiovascular disease, cancer and type 2 diabetes.

Unfortunately these results have not translated effectively in human clinical trials. More long term trials are required

- Variability in clinical data
- Dosage; sample size; study length
- Co-variable and confounder influence
- Lack of understanding of resveratrol metabolism & half life
Resveratrol and Cancer

- Potentially chemopreventive
- Potentially chemotherapeutic
- Inhibits tumour growth in vivo, at dependent dose and durations
- Strong animal model and in vitro evidence
- More human clinical trial evidence required
## Phytochemicals - Resveratrol

### Related Clinical Research

<table>
<thead>
<tr>
<th>Author(s) (year)</th>
<th>Study Design</th>
<th># Participants</th>
<th>Intervention (dose/duration)</th>
<th>Results (means ± SD)</th>
</tr>
</thead>
</table>
| Bhatt et al (2012) | Prospective open-label RCT. T2D randomised control and intervention groups. Aged 30-70 years. | 28 Intervention 29 Control | Intervention - 250mg/day resveratrol + oral hypoglycaemic drug) vs Control - oral hypoglycemic drug only | **HbA1c**: 9.99 ± 1.50 vs 9.65 ± 1.54; p < .05  
**Systolic BP**: 139.71 ± 16.10 vs 127.92 ± 15.37; p < .05  
**Total cholesterol**: 4.70 ± 0.90 vs 4.33 ± 0.76; p < .05  
No significant changes in body weight and high-density lipoprotein and low density lipoprotein cholesterols were observed |

**Discussion**: No statistically significant result  
Sample size may have contributed to low P values however mean change in primary outcomes was not clinically significant. Consider looking for studies of higher dose or longer duration.

(Golzarand et al., 2015)
Resveratrol

Dosage and Side Effects

- No side effects from 1000mg per day short term
- Side effects are variable and are dependent on health of patient
- Safe and well tolerate at up to 5000mg/day in single or split dosage regime in healthy individuals
- Reports of 2500mg/day resulting in diarrhoea, vomiting, nausea and liver dysfunction in patients with non-alcoholic fatty liver disease*
- Reports 5000mg/day resulting in unexpected renal toxicity in multiple myeloma patients**
Australian Indigenous Foods

(Kakadu plums - Cherikoff, 2015)
Davidson Plum & Quandong

Davidson Plum
_Davidsonia pruriens or jerseyana_

Quandong
_Santalum acuminatum_

(Cherikoff, 2015)
# Phytochemicals Constituents

## Davidson Plum

### Phenolics
- Ellagic acid
- Ellagi-tannins
- Dephninidin sambubiose
- Cyanidin sambubiose
- Peonidin sambubiose

### Flavonoids
- Myricetin
- Quercetin
- Rutin
- Anthocyanins

## Quandong

### Phenolics
- Hydroxycinnamic acids
- Cyanidin-3-glucoside
- Chlorogenic acid
- Coumaric acid
- Pelargonidin-3-glucoside
- Quercetin rutinoside
- Kaempferol

### Flavonoids
- Quercetin

(Cherikoff, 2015; Sakulnarmrat, 2014)
### Australian Indigenous Foods

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Total phenolics (mg GA E/ g FW)</th>
<th>Total reducing capacity (FRAP) (µmol Fe+2/ g FW)</th>
<th>ORAC-T (µmol TE/gFW)</th>
<th>ORAC-H (%)</th>
<th>ORAC-L (µmol TE/gFW) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desert Lime</td>
<td>1.83 ± 0.07*</td>
<td>34.8 ± 2.3</td>
<td>56.8</td>
<td>44.88 ± 5.13</td>
<td>79.04 ± 0.17</td>
</tr>
<tr>
<td>Kakadu Plum</td>
<td>27.1 ± 2.1*</td>
<td>690.5 ± 48.4**</td>
<td>430.0</td>
<td>315.40 ± 33.7</td>
<td>73.34 ± 11.44</td>
</tr>
<tr>
<td>Lemon Aspen</td>
<td>1.62 ± 0.05</td>
<td>14.0 ± 2.4</td>
<td>184.8</td>
<td>131.49 ± 11.4</td>
<td>71.16 ± 3.53</td>
</tr>
<tr>
<td>Davidson Plum (D. pruriens)</td>
<td>2.6 ± 0.04**</td>
<td>53.9 ± 4.0**</td>
<td>100.9</td>
<td>83.10 ± 10.9**</td>
<td>82.36 ± 0.01**</td>
</tr>
<tr>
<td>Davidson Plum (D. jerseyana)</td>
<td>1.39 ± 0.04**</td>
<td>41.6 ± 1.4**</td>
<td>59.0</td>
<td>47.63 ± 7.62**</td>
<td>80.7 ± 0.03**</td>
</tr>
<tr>
<td>Finger Lime (green)</td>
<td>1.16 ± 0.06</td>
<td>12.6 ± 0.5</td>
<td>57.8</td>
<td>45.95 ± 6.6</td>
<td>79.49 ± 1.25</td>
</tr>
<tr>
<td>Finger Lime (pink)</td>
<td>1.56 ± 0.08</td>
<td>23.2 ± 0.8</td>
<td>88.8</td>
<td>65.09 ± 12.8</td>
<td>73.28 ± 0.75</td>
</tr>
<tr>
<td>Riberry</td>
<td>1.27 ± 0.11</td>
<td>33.2 ± 1.9</td>
<td>72.0</td>
<td>49.89 ± 6.4</td>
<td>69.25 ± 0.86</td>
</tr>
<tr>
<td>Quandong (Fresh)</td>
<td>8.57 ± 0.61</td>
<td>123.0 ± 0.6</td>
<td>531.7</td>
<td>500.06 ± 64.0</td>
<td>94.21 ± 0.30</td>
</tr>
<tr>
<td>Blueberry</td>
<td>4.51 ± 0.10</td>
<td>52.4 ± 2.78</td>
<td>65.5</td>
<td>65.2 ± 0.10</td>
<td>99.51 ± 0.36</td>
</tr>
</tbody>
</table>

(Cherikoff, 2015. pp. 134)
Indigenous plants’ modulation of endogenous enzymes in the prevention and treatment of Metabolic Syndrome


**Methodology:** Invitro evaluation of the modulation of enzymes commonly involved in Metabolic Syndrome of Davidson’s Plum and Quandong vs control (Rabbit Eye (plant) and Southern Highbush Blueberries)
The colour scale from light to dark indicates the following concentrations:

- 0.1; 0.5; 1.0; 2.0; 4.0 mg/mL

(Sakulnarmrat, 2014)
Sakulnarmrat et al, 2014 results cont/d

**angiotensin converting enzyme**

<table>
<thead>
<tr>
<th>Fruits</th>
<th>Inhibition(^b) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP</td>
<td>91.3 ± 1.4(^a)</td>
</tr>
<tr>
<td>QD</td>
<td>22.2 ± 1.4(^b)</td>
</tr>
<tr>
<td>REB</td>
<td>ND</td>
</tr>
<tr>
<td>SHB</td>
<td>ND</td>
</tr>
</tbody>
</table>

- Both fruit fractions at a concentration of 1.0mg/mL inhibited the activity of isolated ACE.
- DP inhibition was impressive
Critical Appraisal Considerations:

- Relevance of study design, interventions (form, dose, duration)
- Statistical Analysis
- Clinical Relevance of Results
- Further Considerations?

Limitations:

- In-vitro only and may not translate to in-vivo
- Selection of controls
- Does not assess full impact on other aspects metabolic syndrome
Phenolics - Ginger

- 6-gingerol
- 6-Paradol
- 6-Shogaol
- Zingerone

(Haniadka et al., 2012. pp 441)

Phenolics in Ginger

*Zingiber officinale* – Common name ginger, rhizome (rhiz)

- Phenolics extracted from the oleoresin of the plant’s rhizome.
- Potency can differ between dried and fresh root.
- Most studies consider the action of ginger’s phenolics as part of the whole food, rather than in isolation.
- Major phenolics include 6-gingerol and 6-shogaol.
- Minor phenolics include cinnamic acid, p-coumaric acid.
Indications

• Premenstrual Syndrome
• Nausea
• Chemotherapy-induced nausea and vomiting (CINV)
• Gastric ulcer
• Helicobacter pylori
• Osteoarthritis
• Muscle pain

Contraindications

Caution with concomitant anti-coagulant, anti-platelet and cyclophosphamide therapies

(Braun & Cohen, 2010)
Phenolic Actions

6-gingerol
- Antioxidant
- Anti-emetic
- Anti-spasmodic
- Anti-ulcer activity - potent proton pump inhibitor
- Synergistic effect with H. Pylori antibiotic
- Anti-inflammatory - modulation of prostaglandins
- Anti-proliferative

(Haniadka et al., 2012; Braun & Cohen, 2010; Khayat et al., 2014; Siddaraju Dharmesh, 2007)

6-shogaol
- Antioxidant – free radical scavenger
- Anti-emetic
- Anti-ulcer activity – potent proton pump inhibitor & anti-H. pylori properties
- Anti-inflammatory – inhibits iNOS and COX-2 proteins
- Anti-proliferative

(Haniadka et al., 2012; Braun & Cohen, 2010; Khayat et al., 2014; Siddaraju Dharmesh, 2007)
## Ginger

### Related Clinical Research

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Design</th>
<th>Intervention (dose/duration)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gundala et al</td>
<td>In vivo and in vitro multi-series trial</td>
<td>Considered absorption, elimination and anti-proliferative effect on prostate cancer xenograft in nude mice.</td>
<td><strong>• Ginger phenolics exert maximum therapeutic properties when part of whole extract than phenolic mix</strong>&lt;br&gt;<strong>• Elimination: The GE exhibited longer ½ life, through liver bypass metabolism.</strong>&lt;br&gt;<strong>• Enhanced bioavailability of the ginger extract at the target prostate-cancer site resulted in 40% superior efficacy of tumor growth-inhibition compared to the ginger phenolic mix after 4 weeks.</strong></td>
</tr>
<tr>
<td>(2014)</td>
<td>6, 8, 10-gingerol &amp; 6-shogaol phenolic mix compared to whole ginger extract (GE)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Phytosomes

Definition: PHYTO – Plant + SOME – Cell like
• Standardised phytochemicals are bound to phospholipids
• a Novel drug delivery system (NDDS), patented process
• Phytophospholipid covalent complex resembling a small cell
  (Manthena et al., 2010)

Actions: ↑ solubility, ↑ bioavailability, protection from toxicity, ↑ pharmacological activity, hepatoprotective (Phosphotidylcholine)
Phytosomes

Video: Let’s Revisit Medication Absorption

Phytosomes

Major difference between liposome and phytosome

Covalent bonding

(Semalty et al., 2010)
Curcumin

- Hydrophobic polyphenol from the rhizome of *Curcuma longa*
- Very low toxicity

**Actions**

- Antioxidant
- Anti-inflammatory
- Anti-microbial
- Inhibits amyloid pathology
- Anti-neoplastic
- Neuroprotective
- Anti-depressant

https://upload.wikimedia.org/wikipedia/commons/3/37/Curcuma.jpg
https://upload.wikimedia.org/wikipedia/commons/6/66/Turmeric_%28Curcuma_longa%29.jpg
Curcumin Bioavailability

Phytosome curcumin (Meriva) displays bioavailability fivefold higher than the equivalent values seen in unformulated curcumin.

Table 1  Estimated plasma peak levels ($C_{\text{max}}$), time of peak levels ($T_{\text{max}}$) and AUC values for unformulated and curcumin phospholipid complex (Meriva)

<table>
<thead>
<tr>
<th></th>
<th>$C_{\text{max}}$ (nM)</th>
<th>$T_{\text{max}}$ (min)</th>
<th>AUC ($\mu$g min/ml)$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unformulated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curcumin</td>
<td>6.5 ± 4.5</td>
<td>30</td>
<td>4.8</td>
</tr>
<tr>
<td>Curcumin glucuronide</td>
<td>225 ± 0.6</td>
<td>30</td>
<td>200.7</td>
</tr>
<tr>
<td>Curcumin sulfate</td>
<td>7.0 ± 11.5</td>
<td>60</td>
<td>15.5</td>
</tr>
<tr>
<td>Meriva</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curcumin</td>
<td>33.4 ± 7.1</td>
<td>15</td>
<td>26.7</td>
</tr>
<tr>
<td>Curcumin glucuronide</td>
<td>4,420 ± 292</td>
<td>30</td>
<td>4,764.7</td>
</tr>
<tr>
<td>Curcumin sulfate</td>
<td>21.2 ± 3.9</td>
<td>60</td>
<td>24.8</td>
</tr>
</tbody>
</table>

$^a$ AUC was calculated using WinNonLin and employing a non-compartmental model.

Marczylo et al. (2007)
## Curcumin

### Related Clinical Research

<table>
<thead>
<tr>
<th>Authors (year)</th>
<th>Study Design (# participants)</th>
<th>Intervention (dose/duration)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cox et al (2015)</td>
<td>Randomized, double-blind, placebo-controlled, parallel-groups design trial (n = 60, 22 males 38 females)</td>
<td><strong>Intervention</strong> <em>(n=30) – 400mg Longvida ® Optimized Curcumin (80mg curcumin in a solid lipid formulation - phytosome)</em>&lt;br&gt;<strong>Control</strong> <em>(n=30) – Dextrin and small amount of tartrazine (E102) for colouring to visually match the active treatment</em></td>
<td>Acute (1 h and 3 h after single dose); chronic (4 weeks) and acute-on-chronic (1 h and 3 h after single dose, a single dose following 4-week treatment) effects of curcumin treatment&lt;br&gt;Significant effect of four weeks of chronic curcumin treatment on state-non-specific fatigue. *p&lt;0.05</td>
</tr>
</tbody>
</table>
### Table 1. Demographic and characteristic data of placebo and curcumin groups.

<table>
<thead>
<tr>
<th></th>
<th>Placebo</th>
<th>Curcumin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>69.43 (6.579)</td>
<td>67.56 (4.479)</td>
</tr>
<tr>
<td>Males</td>
<td>40.0%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Body mass index</td>
<td>27.23 (4.818)</td>
<td>25.54 (3.481)</td>
</tr>
<tr>
<td>Education years</td>
<td>14.93 (3.685)</td>
<td>14.33 (4.816)</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>3.3%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Secondary</td>
<td>30.0%</td>
<td>26.7%</td>
</tr>
<tr>
<td>Tertiary</td>
<td>46.7%</td>
<td>46.7%</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>20.0%</td>
<td>23.3%</td>
</tr>
<tr>
<td>Occupational status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td>3.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Part time / casual</td>
<td>46.7%</td>
<td>56.7%</td>
</tr>
<tr>
<td>Studying</td>
<td>0.0%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Retired</td>
<td>50%</td>
<td>40.0%</td>
</tr>
<tr>
<td>MMSE</td>
<td>28.90 (1.398)</td>
<td>28.93 (1.048)</td>
</tr>
<tr>
<td>TICS-M</td>
<td>28.30 (4.284)</td>
<td>27.87 (3.910)</td>
</tr>
<tr>
<td>BDI-II</td>
<td>4.27 (3.352)</td>
<td>4.20 (3.899)</td>
</tr>
<tr>
<td>STAI-T</td>
<td>32.23 (7.040)</td>
<td>30.47 (7.403)</td>
</tr>
<tr>
<td>NART</td>
<td>38.13 (7.357)</td>
<td>39.97 (5.881)</td>
</tr>
</tbody>
</table>

Mean (standard error) or percentage. BDI-II: Beck Depression Inventory-II; MMSE: Mini-Mental State Exam; NART: National Adult Reading Test; STAI-T: State-Trait Anxiety Inventory trait scale; TICS-M: Modified Telephone Interview for Cognitive Status.

(Cox et al., 2015)
Effect of chronic treatment on change in mood following mental change at follow-up (28 days), Pre dose assessment. P-<0.05

(Cox et al., 2015)
Lipid measures significantly affected by chronic treatment *p<0.05

(Cox et al., 2015)
Nutraceuticals

“A term used to describe a medicinal or nutritional component that includes a food, plant or naturally occurring material which may be purified or concentrated, and that is used for the improvement of health, by preventing or treating a disease”.

(Lockwood, 2007. pp1)
N-Acetyl Cysteine

Background

Definition: NAC is a thiol and mucolytic agent Pre-cursor of L-cysteine and glutathione (GSH) an endogenous free oxygen radical scavenger

Actions: Antioxidant (precursor to Glutathione) Precursor for glutamatergic reaction (related to reward seeking repetitive behaviours)

Indications: Tinnitus, psychiatric disorders, anti-inflammatory and immune support, damage to hepatic cells (can downregulate elevated AST, ALT and ALP); T2DM, neurotoxicity, fertility, CVD, heavy metal toxicity.

(Santus et al., 2014; Sansone & Sansone, 2011)
Mechanisms of Action of NAC on the respiratory system

(Santus et al., 2014)
NAC and Respiratory Health

- Recommended Dosage: 400-1200mg/day – split doses recommended
- Half life 5.6 hours. 30% of NAC is excreted renally
- Safety: No serious adverse events were reported in clinical trials utilising 600mg BD for 12 months
- Chronic use of 2000mg daily was also well tolerated
- Indications: acute and chronic bronchitis, chronic obstructive pulmonary disease, tinnitus, cystic fibrosis, acute respiratory tract infections
**N-Acetyl Cysteine**


**Clinical Research**

<table>
<thead>
<tr>
<th>Authors (year)</th>
<th>Study Design (# participants)</th>
<th>Intervention (dose/duration)</th>
<th>Results</th>
</tr>
</thead>
</table>
| Bridgeman et al, (1991) | Open randomised trial n=34. (p<0.05 1-3 hours after the last dose of NAC) | *Intervention* - n=24, oral administration of NAC 600mg/day for 5 days  
*Controls* - n=10, did not receive NAC | Treatment group had significantly increased GSH concentrations in the bronchoalveolar lavage fluid compared with controls |
| Tse et al (2013) | RDBPCT (n=120 patients with stable COPD) | *Intervention* - n=59 NAC 600mg/bid treated for 12 months  
*Control* - placebo, n=62 | Decrease in exacerbation frequency of COPD. Results: NAC group 0.96 episodes per year; Placebo 1.71 episodes per year (p=0.019) |
Pathogenic Role of Oxidative Stress in COPD

(Santus et al., 2014)
NAC and Substance Dependence

- NAC restores extracellular glutamate stores
- Glutamate is an excitatory neurotransmitter
- Cysteine influences the reward-reinforcement-relapse pathway of the glutamatergic system
- Lowered glutamate concentrations can lead to dysfunction of synaptic glutamate receptors (specifically mGluR2/3).
- NAC may decrease cravings for cocaine, marijuana, pathological gambling and number of cigarettes smoked
- Consider for substance withdrawal, addictive behaviour, behavioural concerns and some psychological illnesses.

(Schmaal et al., 2011; Sansone & Sansone, 2011)
NAC Interactions and Cautions

- Chemotherapy agents including doxorubicin, oxaxaphosphorines, bleomycin, cyclophosphamide, ifosfamide, oxaliplatin
- AIDS medications including AZT
- Angina medications including nitroglycerin
- Side effects may include drowsiness, stomatitis, clamminess, rhinorrhea, hemoptysis. Rare reports of renal stone formation.
- Category B pregnancy risk
- Caution with absence of significant oxidative stress, as NAC may act as a pro-oxidant (Samuni et al., 2013)
Glucosamine & Chondroitin

Glucosamine by Yongjiet (2008)
https://www.flickr.com/photos/yongjiet/2406378311/
Attribution, Non Commercial (http://creativecommons.org/licenses/by-nc/2.0/)
Photo Attribution by PhotosForClass.com
Glucosamine & Chondroitin

**Chondroitin:** A sulphated glycosaminoglycan (GAG)
Contains sulfur-containing amino acids which are essential building blocks of human cartilage – proteoglycans and hyaluronic acid
Mechanism of action: stops degradation of cartilage and restores lost cartilage – action on chondrocytes and anti-inflammatory in nature

**Glucosamine:** An amino monosaccharide that is synthesized naturally. Is important for the formation of glycolipids, proteoglycans and glycosaminoglycans. The latter being major components of joint cartilage.
Glucosamine & Chondroitin
Osteoarthritis

- Osteoarthritis is a degenerative disease of the joints
- Joints will lose cartilage and bone grows to try and repair the damage.
- The extra bone growth may worsen the physical function and pain, creating joint instability
Chondroitin Cochrane Review 2015


Plain Language Summary:
A review of the effects of chondroitin sulfate for people with osteoarthritis mostly of the knee. Reviewed 43 studies with n=9110. Studies length ranged from 1 month to 3 years. Several studies were funded by makers of chondroitin
Findings show chondroitin may:
• Improve pain slightly in the short term (< 6 mths)
• Improves knee pain by 20%
• Probably improves quality of life
• Has little or no difference in adverse and serious adverse events vs other agents
• Slightly slows down the narrowing of joint space on X-rays of the affected joint
## Cochrane Review X-rays

**Chondroitin versus placebo for osteoarthritis**

**Patient or population:** patients with osteoarthritis  
**Settings:** international inpatient and outpatient clinics, hospitals, and research centers  
**Intervention:** Chondroitin versus placebo

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of Participants (studies)</th>
<th>Quality of the evidence</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assumed risk</td>
<td>Corresponding risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Chondroitin versus Placebo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Radiographic Outcome:** Reduction in Minimum Joint Space Width (JSW) in mm - Long-term studies (≥ 6 months)-dose ≥ 800 mg/d  
**Scale:** millimeters (smaller decrease in reduction in minimum joint space width is better)  
**Follow-up:** 3 to 24 months  

The mean reduction in JSW in the control group was 0.3 mm  
The mean reduction in JSW in the intervention groups was 0.18 mm lower (0.06 to 0.30 lower)

- 922 (2 studies)  
- ✪✪✪✪ high  

Absolute risk difference not calculable because no range is provided for this measure.  
Relative risk difference: 4.7% (95% CI, 1.6% to 7.8%)  
NNTB = 7 (95% CI 5 to 13)

(Singh et al., 2015)
Safety, Adverse Side Effects and Interactions


This project aimed to increase paracetamol bioavailability by dosing concurrently with glucosamine

- Mixed glucosamine with paracetamol ratio of 4:1
- Paracetamol dose 10mg/kg in rats
- Analysed bioavailability and hepatotoxicity biomarkers
Safety, Adverse Side Effects and Interactions

Absorption curve of paracetamol vs combination

Qinna et al, 2015
Safety, Adverse Side Effects and Interactions

Serum levels of ALP and GGT following increasing doses of paracetamol (70, 700, 2800mg/kg) without and with oral preadministration of glucosamine

(Qinna et al., 2015)
Safety, Adverse Side Effects and Interactions

Glucosamine sulfate

• Dosage 1500mg/day (500mg TDS)
• No toxicity – considered as safe as placebo
• Diabetes monitor blood sugar closely
• Usually extracted from shellfish – caution anaphylaxis
• Better clinical effects when used in conjunction with chondroitin sulfate

(Braun & Cohen, 2010)
Safety, Adverse Side Effects and Interactions

Chondroitin sulfate

- Dosage range 800-1200mg/day in single or divided doses
- 800mg/day may be effective range for OA
- May have additive effect with anti-coagulants
- May enhance effectiveness of NSAIDs
- Not suitable for vegetarians or vegans

(Braun & Cohen, 2010)


References


References:


References

Images Reference

Phytochemicals present in ginger:


Resveratrol

dependenthttps://upload.wikimedia.org/wikipedia/commons/thumb/b/bd/Breast_cancer_cell_%282%29.jpg/585px-Breast_cancer_cell_%282%29.jpg


Australian Indigenous Foods


Phospholipid Structure

NAC

Glucosamine & Chondroitin sulfate
http://photosforclass.com/search?text=glucosamine
SMART Imagebase – Osteoarthritis of the knee
http://ebsco.smartimagebase.com.ezproxy.endeavour.edu.au/?TOKEN=EBSCO-83404797d6dc21c2ae09c328ddd6ce37&custid=s4585983
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