Analyzing the Health Benefits of Nebraska Grapes and Wines

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The Power of Polyphenols

What are they good for?
PHENOL

• >100,000 Compounds
• classified according to basic skeletal structure
• acidic
• Participates in oxidation-reduction reactions
Phenol oxidation

\[ \text{Phenol} + \text{H}_2\text{O} \rightarrow \text{Phenol oxide} + \text{H}_2\text{O} \]
Secondary plant metabolite

• Product of $2^\circ$ carbon metabolism

  – not required for basic metabolism (growth & reproduction)

  – Other $2^\circ$ metabolite classes: Terpenes, glycosides, alkaloids
Hydroxybenzoic acids

\[ \text{R}_1 = \text{R}_2 = \text{OH}, \text{R}_3 = \text{H} : \text{Protocatechuic acid} \]

\[ \text{R}_1 = \text{R}_2 = \text{R}_3 = \text{OH} : \text{Gallic acid} \]

Hydroxycinnamic acids

\[ \text{R}_1 = \text{OH} : \text{Coumaric acid} \]

\[ \text{R}_1 = \text{R}_2 = \text{OH} : \text{Caffeic acid} \]

\[ \text{R}_1 = \text{OCH}_3, \text{R}_2 = \text{OH} : \text{Ferulic acid} \]

Flavonoids

See Figure 2

Stilbenes

\[ \text{Resveratrol} \]

Lignans

\[ \text{Secoisolaricresinol} \]
Plant functions

- Reduces photo-destruction – absorbs excess energy
- Antimicrobial
- Protection from herbivores
- Allelopathy
- Antioxidant
Polyphenolic Synthesis

- Present **continuously** or is **induced**
  - Induction by phytophagic or microbial activity
- Affected by **light** exposure (carbon-nutrient relationship?)
- Unaffected by soil nutrients (?)
- Affected by soil **water content**
- Usually increases with **age**
Polyphenolic Classes

• **Tannins**
  - bitterness, herbivore deterrence, pathogen resistance, binds protein (antinutritive),

• **A. Hydrolyzable** -- polymers of phenolic acids, usually gallic acid and sugars

• **B. Condensed** -- polymers of flavonoids. Hydrolyze in strong acid to anthocyanidins
Polyphenolic Classes

- **Flavonoids**
  - Insect deterrent or attractant, feeding stimulant, signal to soil mycorrhiza, UV protection
- **A. Anthocyanidins** -- delphinidin, cyanidin
  - Pigmentation
- **B. Flavonols** — Quercetin, catechin, epicatechin
  - Allelopathic functions
- **C. Stilbenes** — Resveratrol, picead
  - Phytoalexin
The French Paradox

--the French have a diet relatively high in fat, as does America and other European countries, but have decreased incidence of heart disease
## Polyphenol content

<table>
<thead>
<tr>
<th></th>
<th>Total polyphenols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red grape, ave.</td>
<td>5500 mg/kg</td>
</tr>
<tr>
<td>Red wine</td>
<td>700–4000 mg/L</td>
</tr>
<tr>
<td>White grape, ave.</td>
<td>4000 mg/kg</td>
</tr>
<tr>
<td>White wine</td>
<td>150-400 mg/L</td>
</tr>
</tbody>
</table>
Nebraska Grapes

• St. Croix > Frontenac > deChaunac
  ~4900 - 1400 mg/kg whole grapes

• Vignoles & LaCrosse ~ 1400 mg/kg whole grapes
Grapes

- >200 phenolic compounds
- Seeds ~46-69%
- Stems ~22%
- Skin ~12-50%
- Pulp ~1%
Health benefits of wine

- Total phenolic content directly related to antioxidant capacity (anthocyanins)
- Overall decrease in aging disease risk
- 40% decrease in risk of coronary heart disease
Vascular benefits

**Quercetin, catechin, resveratrol**

- Inhibition of platelet aggregation
- Inhibition of LDL oxidation (plaque)
- Vasodilation
- Inhibition of vasoconstriction (tannins)
Anti-carcinogenic properties

- Stilbenes inhibit cell proliferation
- Association with decreased colon cancer
- Inhibition of non-melanoma skin cancer - resveratrol
- Estrogenic effect - resveratrol +/−
Other health benefits

• Improved lung function & lower lung disease — white wine

• Decreased dementia

• Increase in lifespan???
WINE

Processing:

- Grape juice 50% fewer polyphenols
- Red wine > Blush > White wine > Alcohol
Benefits of Alcohol

- Increases HDL levels
- May improve polyphenol absorption
- Synergism?
- Moderation only, <2 drinks daily
Benefits of Wine

- Tartaric acid-enhances the absorption of catechin in rats
- Cultural associations
For the Quiz:

• Polyphenols (anthocyanins) = antioxidants

• Grapes: The Redder the Better!

• Wine: Good for your health, but ONLY IN MODERATION!