Alcohol

part of Western civilization for millenia

De Lorgeril, Barcelona
Adverse health effects of alcohol

• polyneuritis
• cirrhosis / hepatitis
• encephalopathy
• cardiomyopathy
• malnutrition / vitamin B1 deficiency

...
When I read about the evils of drinking, I decided to give up reading.

Mark Twain (1835-1910)
Risks and benefits of alcohol

490,000 individuals
prospective 9 year follow-up study

Alcohol use ⇒

**higher** risk:
cirrhosis
cancer (*breast, mouth, esophagus, pharynx, larynx, liver*)
injury (*traffic accidents etc*)

**lower** risk:
cardiocascular death lower by 30-40%
less diabetes, osteoporosis, progression of renal disease, cognitive impairment

Which is the greater miracle?

Wedding of Kanaan

*(John 1:1-12)* — conversion of water into wine

or

Brueghel P. (1525-1569)
Which is the greater miracle?

but:

the Kidney –

*even converts wine into water*
Medical use of alcohol

Hippokrates of Kos (439-377 BC)

Wine  Tranquilizer
       Analgesic
       Diuretic
       Antidiarrhoic
       Treatment of wounds

New Testament (Luke 10; 30-37)

Treatment of wounds:
The Good Samaritan
A certain man went down from Jerusalem to Jericho and fell among thieves which stripped him of his raiment and wounded him, and departed, leaving him half dead... a Samaritan... went to him, and bound up his wounds, pouring in oil and wine...

Luke; 10: 30-37
Medical use of alcohol

Julius Caesar (100-44 BC)

Troops – wine (1.5L/day) with meals to prevent gastrointestinal infections

won battles not only by strategic skill, but also by healthier defecation

Claudius Galenus,
Pergamon (130-200 AC)

Red wine → GI disease
Adstringent (tannin rich) wine → internal bleeding
Regimen Sanitatis Salernitani
Arnoldo de Villanueva
1235-1311

“... during meals drink wine happily little but often...”
“...avoid harming the body - never drink between meals...”


School of Salerno
Medical use of wine

Paracelsus

(Philippus Aurelius Theophrastus Bombastus von Hohenhain; 1493-1541)

"Weingeist" (Spiritus)

active ingredient of wine (= alcohol)

derived: spirits, Sprit

other ingredients inert contaminants

effects of wine: dosis facit venenum
French Paradox for Coronary Artery Disease

Dairy Fat 1980-1985 [Calories]

CHD Mortality (1987, men + women)

r=0.73 p<0.001

"French paradox"

- in all countries tight correlation between consumption of animal fat and coronary mortality, except

- in France and Switzerland:
  coronary mortality low in relation to consumption of animal fat


  *De Lorgeril, Circulation (2002) 106: 1465*

Hypothesis
Wine antagonises adverse effects of animal fat
Ethanol and wine ethanol consumption - relation to coronary heart disease mortality

\[ y = 273.7 - 10.7 \times R \quad R = -0.39 \]

\[ y = 238.7 - 19.6 \times R \quad R = -0.66 \]

Criqui and Ringel, Lancet (1994) 344: 1719
### Risk factors and myocardial infarction – worldwide analysis

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Sex</th>
<th>Control (%)</th>
<th>Case (%)</th>
<th>Odds ratio (99% CI)</th>
<th>PAR (99% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current smoking</td>
<td>F</td>
<td>9.3</td>
<td>20.1</td>
<td>2.86 (2.36–3.48)</td>
<td>15.8% (12.9–19.3)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>33.0</td>
<td>53.1</td>
<td>3.05 (2.78–3.33)</td>
<td>44.0% (40.9–47.2)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>F</td>
<td>7.9</td>
<td>25.5</td>
<td>4.26 (3.51–5.18)</td>
<td>19.1% (16.8–21.7)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>7.4</td>
<td>16.2</td>
<td>2.67 (2.36–3.02)</td>
<td>10.1% (8.9–11.4)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>F</td>
<td>28.3</td>
<td>53.0</td>
<td>2.95 (2.57–3.39)</td>
<td>35.8% (32.1–39.6)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>19.7</td>
<td>34.6</td>
<td>2.32 (2.12–2.53)</td>
<td>19.5% (17.7–21.5)</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>F</td>
<td>33.3</td>
<td>45.6</td>
<td>2.26 (1.90–2.68)</td>
<td>35.9% (28.9–43.6)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>33.3</td>
<td>46.5</td>
<td>2.24 (2.03–2.47)</td>
<td>32.1% (28.0–36.5)</td>
</tr>
<tr>
<td>Psychosocial index</td>
<td>F</td>
<td>–</td>
<td>–</td>
<td>3.49 (2.41–5.04)</td>
<td>40.0% (28.6–52.6)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>–</td>
<td>–</td>
<td>2.58 (2.11–3.14)</td>
<td>25.3% (18.2–34.0)</td>
</tr>
<tr>
<td>Fruits/veg</td>
<td>F</td>
<td>50.3</td>
<td>39.4</td>
<td>0.58 (0.48–0.71)</td>
<td>17.8% (12.9–24.1)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>39.6</td>
<td>34.7</td>
<td>0.74 (0.66–0.83)</td>
<td>10.3% (6.9–15.2)</td>
</tr>
<tr>
<td>Exercise</td>
<td>F</td>
<td>16.5</td>
<td>93</td>
<td>0.48 (0.39–0.59)</td>
<td>37.3% (26.1–50.0)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>20.3</td>
<td>15.8</td>
<td>0.77 (0.69–0.85)</td>
<td>22.9% (16.9–30.2)</td>
</tr>
<tr>
<td>Alcohol</td>
<td>F</td>
<td>11.2</td>
<td>6.3</td>
<td>0.41 (0.32–0.53)</td>
<td>46.9% (34.3–60.0)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>29.1</td>
<td>29.6</td>
<td>0.88 (0.81–0.96)</td>
<td>10.5% (6.1–17.5)</td>
</tr>
<tr>
<td>ApoB/ApoA1 ratio</td>
<td>F</td>
<td>14.1</td>
<td>27.0</td>
<td>4.42 (3.43–5.70)</td>
<td>52.1% (44.0–60.2)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>21.9</td>
<td>35.5</td>
<td>3.76 (3.23–4.38)</td>
<td>53.8% (48.3–59.2)</td>
</tr>
</tbody>
</table>

Health professional follow up study

50,000 men
→ 5-30 g alcohol per day
reduction of CV mortality by ∼ 25%

_Rinn et al._
_Wine, beer and spirits._
_Are they really horses of a different colour?_
Alcohol consumption and cardiovascular death in hypertensive men – Physicians’ health study

14,125 / 88,882 hypertensives

<table>
<thead>
<tr>
<th>Alcohol Consumption</th>
<th>CV Mortality</th>
<th>Overall Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>never</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>monthly</td>
<td>0.82</td>
<td>0.86</td>
</tr>
<tr>
<td>weekly</td>
<td>0.64</td>
<td>0.72</td>
</tr>
<tr>
<td>daily</td>
<td>0.56</td>
<td>0.73</td>
</tr>
</tbody>
</table>

LIFE study: regression of left ventricular hypertrophy (ECG) effect of treatment (Losartan or Atenolol) and of alcohol consumption

Alcohol Consumption (drinks/week): None 1-7 ≥8

Sokolow-Lyon Voltage Δ(mm)

Losartan

-4.2

-4.8

-5.7

Atenolol

-2.2

-3.0

-4.1

LIFE study: cardiovascular events by alcohol consumption – the U-shaped relationship

Alcohol consumption (drinks/week):
- None
- 1-4
- 5-7
- 8-10
- >10

Reims, J Hum Hypertens (2004) 18: 381
Relative risk of death in Eastern France – both no and high alcohol consumption → adverse effects

34,014 young men follow-up 1978-1983

- Smokers (n=14390)
- Ex-smokers (n=11238)
- Non-smokers (n=8386)

34,014 young men
Follow-up 1978-1983
Why U-shaped relationship?

Study 34014 young men in France 1978-1993

High alcohol intake
- cirrhosis
- colorectal, gastroesophageal carcinoma
- traffic accidents

but,

for alcohol consumption > 50 g/day
also increased CV risk ↑

Copenhagen Heart Study

U-shaped relation between units of alcohol/day (30 g) and stroke

- 2 Units 40% reduction
- > 5 Units increased risk

Truelsen, Stroke (1998) 29: 2467
**LIFE study:**  
*primary composite endpoint rate by alcohol consumption*

Endpoint rates (1/1000 yrs) according to reported weekly alcohol consumption.

*Reims, J Hum Hypertens (2004) 18: 381*
Alcohol consumption and all cause mortality

R.Kloner and S.Rezkalla

To Drink or Not to Drink? That Is the Question

Circulation (2007) 116:1306
To drink or not to drink? That is the question –

relative risk of nonfatal myocardial infarction

An alcoholic can be defined as a man who drinks more than his own doctor

A.L. Barach
How often and how much?
## Alcohol Consumption and Risk of Major Coronary Event *(Patients with MI)*

<table>
<thead>
<tr>
<th>Drinks per day</th>
<th>Days per week</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Don't drink</td>
<td>Don't drink</td>
<td>1.00</td>
</tr>
<tr>
<td>1 or 2 Units</td>
<td>Rarely &lt;1 1 or 2 3 or 4 5 or 6 Daily</td>
<td>1.01 0.99 0.93 0.75 0.36 1.20</td>
</tr>
<tr>
<td>3 or 4</td>
<td>0.65 0.44 0.91 0.56 0.46 0.87</td>
<td></td>
</tr>
<tr>
<td>5 to 8</td>
<td>0.80 1.13 1.00 0.46 0.50 0.83</td>
<td></td>
</tr>
<tr>
<td>&gt;9</td>
<td>0.99 2.62 1.93 2.22 2.40</td>
<td></td>
</tr>
<tr>
<td>Former drinker</td>
<td>1.06</td>
<td></td>
</tr>
</tbody>
</table>

Case Control Study
11511 acute myocardial infarctions
6077 controls

*McElduff; BMJ 1997; 314: 1159*
Benefits other than cardiovascular?
Risks and benefits of alcohol

490,000 individuals
prospective 9 year follow-up study

Alcohol use ⇒

**lower** risk:
  - cardiovascular death lower by 30-40%
  - less diabetes,
  - osteoporosis,
  - cognitive impairment
  - progression of renal disease

Alcohol and the risk to develop type 2 diabetes

Nurses health study
84,941 nurses, follow-up 1980-1996
3,300 new cases of type 2 diabetes

<table>
<thead>
<tr>
<th>Daily alcohol consumption (g)</th>
<th>Number of cases with type 2 diabetes</th>
<th>Relative risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0g</td>
<td>1715</td>
<td>1.0</td>
</tr>
<tr>
<td>0.1 - 5.0g</td>
<td>1034</td>
<td>0.78 (0.72-0.84)</td>
</tr>
<tr>
<td>5.1 - 10.0g</td>
<td>189</td>
<td>0.56 (0.48-0.65)</td>
</tr>
<tr>
<td>&gt;10g</td>
<td>358</td>
<td>0.59 (0.52-0.66)</td>
</tr>
</tbody>
</table>

Moderate alcohol consumption – lower risk of diabetes 
*(Hoorn study)*

• in 1989 alcohol intake by questionnaire in 2393 subjects

• non-drinkers vs up to 10g/day vs 10-30 g/day vs > 30g/day

• lowest mortality → up to 10 g/day

• risk to develop diabetes:
  8.0% in moderate drinkers vs 12.9% for nondrinkers

alcohol (1-2 drinks/day) ⇒ lower risk of osteoporosis

higher alcohol consumption ⇒ more osteoporosis

Bainbridge, Osteoporosis Int. (2004) 15: 439
Moderate alcohol consumption – less cognitive impairment

- Nurses Health Study

- Gruppo Italiano di Pharmacovigilanza nell’Anziano (GIFA)

- Hale Project (mediterranean diet and life style changes in the elderly)
  *Knoops, JAMA (2004) 292:1433*
Wein wirkt stärkend auf den Geisteszustand den er vorfindet – er macht die Dummen dümmer und die Klugen klüger

(wine reinforces the state of mind which is present – it makes the stupid one even more stupid but the intelligent one also more intelligent)

J.W.von Goethe
1749 - 1832
IDNT study – alcohol consumption and risk of progression of diabetic nephropathy

<table>
<thead>
<tr>
<th>Renal Endpoint</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n=462)</td>
<td>23 %</td>
<td>28 %</td>
</tr>
<tr>
<td>Alcohol</td>
<td>23 %</td>
<td>28 %</td>
</tr>
</tbody>
</table>

p (univariate analysis) = 0.02

Alcohol and progression of renal disease

experimental data

- adriamycin model
  alcohol ⇒ less nephrotic syndrome

  *Tesar, Alcohol (1995) 30:47*

- red wine and alcohol free red wine
  ⇒ less lipid peroxydation in kidney

  *Araya, Lipids (2003) 38:275*
Hypothesis

kidney rich in polyunsaturated fatty acids
vulnerable to damage by reactive oxygen species (ROS)

⇒ benefit from moderate consumption of red wine via more potent antioxidant defenses

# polyphenols → ROS scavengers and metal chelators
# ethanol → activity of antioxidant enzymes

Alcohol and progression of renal disease

decline of renal function and alcohol
prospective 11 year study in 1658 nurses

odds ratio > 25 % decrease GFR
normotensive hypertensive

<table>
<thead>
<tr>
<th>Alcohol Intake</th>
<th>Normotensive</th>
<th>Hypertensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4.9 g/day</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>5 - 14</td>
<td>0.83</td>
<td>0.62</td>
</tr>
<tr>
<td>15 - 60</td>
<td>0.81</td>
<td>0.53</td>
</tr>
</tbody>
</table>

chronic kidney disease – potential benefit from alcohol

Knight, NephrolDialTranspl (2003) 18:1549
Alcohol consumption – less endstage renal disease

65,601 Chinese men follow-up 9 years

Reynolds, Kid.Internat.(2008) 73:870
Incidence of all-cause endstage renal disease
(per 100,000 person years standardized by age)

Reynolds, Kid.Internat.(2008) 73:870
Chronic Kidney Disease – impact on risk conferred by traditional and novel CV risk factors

Shlipak, JAMA (2005) 293:1737
Alcohol increases blood pressure in Paris Gendarmes

- Sobres
- Moyens buveurs
- Grands buveurs
- Très grands buveurs

Hypertension (%)
Are all alcoholic beverages similarly beneficial with respect to coronary events?

Copenhagen Heart Study
prospective 12 year study,
6000 males, 7000 females

inverse correlation between alcohol consumption and total mortality
→ only for consumption of wine, not beer and spirits


in Bavaria diuresis sign of virility
Monica study – Augsburg (Bavaria)

U-shaped relation between alcohol (including beer) consumption and total mortality in a beer drinking population

Keil, Epidemiology (1997) 8: 150
Alcohol in general vs wine:

Inverse correlation alcohol consumption and coronary mortality \( (r = -0.39) \)
better correlation wine consumption and coronary mortality \( (r = 0.66) \)

Criqui and Ringel
Does diet or alcohol explain the French paradox?
Lancet (1994) 344: 1719

\( \Rightarrow \) alcohol coronary protection
constituents of wine additional coronary protection
alcohol – coronary protection
wine – additional coronary protection

metaanalysis
200,000 subjects

# beer consumption    risk reduction    - 20%
# wine consumption    risk reduction    - 32%

Di Castelnuovo
Circulation (2002) 105: 2836

confirmed:

Klatsky
Women and alcohol
(Nurses Health Study)

*a priori:*

Higher blood alcohol levels
Higher risk of mammary carcinoma
Impact on CV risk dependent on age (menopausal state)

→ prospective study of 45,709 nurses

alcohol:

• CV risk *increased* in young women with low baseline CV risk even at low alcohol intake
• small *decrease* of CV risk only at *age ≥ 50 years*


*but,*

even young (30 y) women at high CV risk (e.g. type 2 diabetes)
26% risk reduction with alcohol (0.1-4.9 g/day)

Different CV benefit from alcohol in men and women
R.Kloner and S.Rezkalla
To Drink or Not to Drink? That Is the Question
Circulation (2007) 116:1306
Extra benefit in high risk populations ?
Risk reduction – dependent on baseline risk

→ pronounced in smokers, less in non-smokers

RR

<table>
<thead>
<tr>
<th></th>
<th>0 g alcohol</th>
<th>22-32 g alcohol/day</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>smoker</td>
<td>2.8</td>
<td>1.9</td>
<td>0.9</td>
</tr>
<tr>
<td>non-smoker</td>
<td>1</td>
<td>0.7</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Renaud
History of myocardial infarction and alcohol

improved survival and less coronary complications with moderate alcohol intake

(no significant difference wine, beer, spirits)


Alcohol consumption following myocardial infarction

Moderate alcohol consumption and mortality in heart failure (EF < 35 %)

SOLVD, ~1 drink/d

overall mortality

myocardial infarction

Rate of incident heart failure by alcohol consumption
(Cardiovascular Health Study)

Alcohol consumption reduces restenosis rate after coronary angioplasty + stent – the Heidelberg experience

225 consecutive pat. PTCA + stent

> 50 g alcohol / week ⇒ lower:

- rate of loss of lumen
  - $1.1 \pm 0.79$ vs $1.45 \pm 0.82$ mm, $p < 0.002$
- restenosis within stented segment
  - $33.7\%$ vs $42.5\%$, $p < 0.002$
- repeat angioplasty
  - $23.3\%$ vs $42.5\%$

→ independent predictor

Niroomand, Heart (2004) 90:1189
How does alcohol / wine achieve cardiovascular (and potentially other) benefit?
Effects of alcohol potentially improving CV risk

- **low HDL cholesterol** ↑

- **hemostasis through reduction of platelet function and fibrinogen levels**

- **insulin resistance** ↓ .....

- **new aspects**:

  - direct protective effect on the ischemic myocardium
    *Guiraud, Journal Molecular Cardiology (2004), 36:561*

  - increased omega3 fatty acids, important because:
    *De Lorgeril, American Heart Journal (2008) 155:175*

**Omega 3 fatty acids highly effective in secondary prevention**
*Gissi, Lancet (1999) 354:457*
Cardioprotective actions of alcohol / wine –
new aspects (ctd)

- lowering of oxygen radicals (ROS)
- antithrombotic action
- endothelial-dependent vasodilation/NO
- antiproliferative effect (antagonism ANG II, PDGF)
Impact of Red Wine on Serum Antioxidant Activity in Healthy Volunteers

Antioxidant Activity [µmol trolox equivalent / l]

Time (min)

Standard meal alone or with 5.7 ml Bordeaux / kg

Maxwell, Lancet 1994; 344: 193-194
Endothelial effects of wine

Red wine, but not vodka, increases coronary flow reserve


Small amounts of alcohol increase postischemic forearm blood flow in CHD patients specifically (nitrate as control negative)

Endothelial effects of wine

In isolated human coronary arteries:

red wine (Châteauneuf du Pape),
but not white wine (Mosel Riesling) or ethanol

→ endothelial cell dependent vasodilatation,
  effect NO-dependent (inhibited by L-NMMA)

Human Coronary Artery Effects of Red and White Wine

- Chateuneuf du Pape
- Chateauneuf du Pape (- Endothelium)
- Mosel-Riesling
- Ethanol

PE
Cha L-NMMA

PE
Cha

PE
Rie

PE
E

NO effect
endothelial dependent

10 mN
5 min
Vascular Effects of Red and White Wine

(Flesch, Am J Physiol 1998)
Are all red wines created equal?

Barrique matured wines in oak vats vs wines matured in steel tanks

→ only heavy **barrique matured** red wines effective, contain higher concentrations of phenolic substances in vitro effect reproduced by Tannin and Quercetin

# Quantitative Analysis of Polyphenolics in Red Wine vs. White Wine

<table>
<thead>
<tr>
<th></th>
<th>Red Wine (Chateauneuf-du-Pape)</th>
<th>White Wine (Riesling Kabinett)</th>
</tr>
</thead>
<tbody>
<tr>
<td>cis-Piceid</td>
<td>5,1</td>
<td>0,0</td>
</tr>
<tr>
<td><em>trans</em>-Resveratrol</td>
<td>1,6</td>
<td>0,0</td>
</tr>
<tr>
<td>Quercetin</td>
<td>0,0</td>
<td>0,0</td>
</tr>
<tr>
<td>Catechin</td>
<td>37,3</td>
<td>5,2</td>
</tr>
<tr>
<td>Epicatechin</td>
<td>12,0</td>
<td>1,6</td>
</tr>
<tr>
<td>Procyanidin B2</td>
<td>9,7</td>
<td>0,0</td>
</tr>
<tr>
<td>Gallic Acid</td>
<td>44,9</td>
<td>0,9</td>
</tr>
<tr>
<td>Cafteric Acid</td>
<td>24,8</td>
<td>37,9</td>
</tr>
<tr>
<td>Coffee Acid</td>
<td>7,0</td>
<td>16,7</td>
</tr>
<tr>
<td>p-Coumaric Acid</td>
<td>23,5</td>
<td>6,8</td>
</tr>
<tr>
<td>Total Polyphenolics</td>
<td>2113</td>
<td>350 [mg/l]</td>
</tr>
</tbody>
</table>
Virgin Mary offering the Christ child red wine

Joos van Cleve
1491-1541
Toasts pointing to wellbeing and health provided by alcohol

<table>
<thead>
<tr>
<th>Language</th>
<th>Toast</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prosit !</td>
</tr>
<tr>
<td></td>
<td>zum Wohl !</td>
</tr>
<tr>
<td>English</td>
<td>cheers !</td>
</tr>
<tr>
<td>Estonian</td>
<td>terviseks !</td>
</tr>
<tr>
<td>Finnish</td>
<td>terveydeksi !</td>
</tr>
<tr>
<td>Greek</td>
<td>για μας !</td>
</tr>
<tr>
<td>Polish</td>
<td>na zdrowie !</td>
</tr>
<tr>
<td>French</td>
<td>santé !</td>
</tr>
<tr>
<td>Italian</td>
<td>salute !</td>
</tr>
<tr>
<td>Spanish</td>
<td>salud !</td>
</tr>
<tr>
<td>Hungarian</td>
<td>egésszégére</td>
</tr>
</tbody>
</table>

To your / our wellbeing

To your health
Antiinflammatory effect of moderate consumption of either wine or beer

- MONICA study (Augsburg, Glasgow, Lille)
- self reported moderate (<40g/day) intake of alcohol compared to nondrinking or heavy drinking

\[ \Rightarrow \text{lower CRP} \]
- fibrinogen
- plasma viscosity
- white blood cell count

Alcohol consumption effect amplifies that of leisure time physical activity – hazard of fatal ischemic heart disease

Hazard ratio

Physical activity

- inactive
- low
- moderate to high

<1 drink | 1-14 drinks | >15 drinks per week

Adverse health effects of alcohol

- polyneuritis
- cirrhosis / alcohol hepatitis
- encephalopathy
- cardiomyopathy
- malnutrition / vitamin B1 deficiency

...
When I read about the evils of drinking, I decided to give up reading

Mark Twain
(1835-1910)
Which is the greater miracle?

Wedding of Kanaan
*(John 1:1-12)* –
conversion of water into wine

or

Brueghel P. (1525-1569)
Which is the greater miracle?

Wedding of Kanaan – conversion of water into wine

or

the Kidney – converts wine into water
Medical use of alcohol

Hippokrates of Kos (439-377 BC)

Wine  Tranquilizer
      Analgesic
      Diuretic
      Antidiarrhoic
      Treatment of wounds

New Testament (Luke 10; 30-37)
      The Good Samaritan
A certain man went down from Jerusalem to Jericho and fell among thieves which stripped him of his raiment and wounded him, and departed, leaving him half dead... a Samaritan... went to him, and bound up his wounds, pouring in oil and wine...

Luke; 10: 30-37

V. van Gogh
Medical use of alcohol

G. Julius Caesar (100-44 BC)

Troops – 1.5L of wine with meals to prevent gastrointestinal infections

Claudius Galenus, Pergamon (130-200 AC)

GI disease → red wine
Internal bleeding → adstringent (tannin rich) wine
Medical use of wine

Paracelsus
(Philippus Aurelius Theophaustus
Bombastus von Hohenhain; 1493-1541)

active volatile ingredient of wine (= alcohol) :
”Weingeist” (Spiritus)

derived: spirits, Spiritus, Sprit

effects of wine: dosis facit venenum
Medical use of alcohol

18th century
Dr. Brown (Scotland)

⇒ popular cure for 32 indications
within 4 hours:
  • 2-3 bottles of red wine
  • half a bottle of Champagne
  • a quart of Cognac

⇒ exceeding the drinking capacity of all but the Scots
French Paradox for Coronary Artery Disease

Dairy Fat 1980-1985 [Calories]

CHD Mortality (1987, men + women)

Portugal
Spain
Yugoslavia
Italy
Austria
Belgium
Netherlands
Germany
Finland
Ireland
Sweden
Norway
U.K.
Denmark
France
Netherlands
Australia
U.K.

r=0.73
p<0.001

“French paradox”

- in all countries tight correlation between consumption of animal fat and coronary mortality, except

- in France and Switzerland: coronary mortality low despite high consumption of animal fat


**Hypothesis**

Wine antagonises adverse effects of animal fat
Alcohol and cardiovascular mortality

→ 60 retrospective and prospective epidemiological studies (pubmed)
Ethanol and wine ethanol consumption - relation to coronary heart disease mortality

\[ y = 273.7 - 10.7 \times R = -0.39 \]

\[ y = 238.7 - 19.6 \times R = -0.66 \]

Health professional follow up study

50,000 men
→ 5-30 g alcohol per day
reduction of CV mortality by ~ 25%

Rinn et al.
Wine, beer and spirits.
Are they really horses of a different colour?
Alcohol consumption and cardiovascular death in hypertensive men – *Physicians’ health study*

14,125 / 88,882 hypertensives

<table>
<thead>
<tr>
<th>Alcohol consumption</th>
<th>Relative risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>never</td>
<td>1.0</td>
</tr>
<tr>
<td>monthly</td>
<td>0.82</td>
</tr>
<tr>
<td>weekly</td>
<td>0.64</td>
</tr>
<tr>
<td>daily</td>
<td>0.56</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CV mortality</th>
<th>1.0</th>
<th>0.82</th>
<th>0.64</th>
<th>0.56</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall mortality</td>
<td>1.0</td>
<td>0.86</td>
<td>0.72</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Relative risk of death in Eastern France

Why U-shaped relationship?

Study 34014 young men in France 1978-1993

high alcohol intake →
  cirrhosis
  colorectal, gastroesophageal carcinoma
  traffic accidents

but,

for alcohol consumption > 50 g/day (“alcoholic”)
  also increased CV risk

To drink or not to drink? That is the question – relative risk of total mortality

To drink or not to drink? That is the question –

*relative risk of total mortality males vs females*

To drink or not to drink? That is the question –
relative risk of nonfatal myocardial infarction

To drink or not to drink? That is the question – relative risk of congestive heart failure

An alcoholic can be defined as a man who drinks more than his own doctor

A.L. Barach
## Alcohol Consumption and Risk of Major Coronary Event

<table>
<thead>
<tr>
<th>Drinks per day</th>
<th>Don't drink</th>
<th>Rarely</th>
<th>&lt;1</th>
<th>1 or 2</th>
<th>3 or 4</th>
<th>5 or 6</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don't drink</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 or 2</td>
<td>1.01</td>
<td>0.99</td>
<td>0.93</td>
<td>0.75</td>
<td>0.36</td>
<td>1.20</td>
<td></td>
</tr>
<tr>
<td>3 or 4</td>
<td>0.65</td>
<td>0.44</td>
<td>0.91</td>
<td>0.56</td>
<td>0.46</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>5 to 8</td>
<td>0.80</td>
<td>1.13</td>
<td>1.00</td>
<td>0.46</td>
<td>0.50</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>&gt;9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former drinker</td>
<td>1.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Case Control Study
11511 acute myocardial infarctions
6077 controls

McElduff; BMJ 1997; 314: 1159
LIFE study:
medical history by alcohol consumption

Alcohol consumption (drinks/week):
- None
- 1-4
- 5-7
- 8-10
- >10

Reims, J Hum Hypertens (2004) 18: 381
LIFE study:
regression of left ventricular hypertrophy (ECG)
effect of treatment (Losartan or Atenolol) and of alcohol consumption

Alcohol Consumption (drinks/week): None 1-7 ≥8

Sokolow-Lyon Voltage $\Delta$(mm)

Losartan: -4.2 -4.8 -5.7

Atenolol: -2.2 -3.0 -4.1

LIFE study: primary composite endpoint rate by alcohol consumption

Endpoint rates (1/1000 yrs) according to reported weekly alcohol consumption.

Reims, J Hum Hypertens (2004) 18: 381
Copenhagen Heart Study

U-shaped relation between units of alcohol/day (30 g) and stroke

- 2 U → reduction by 40%
- > 5 U → progressive increase

Truelsen, Stroke (1998) 29: 2467
## Alcohol and the risk to develop type 2 diabetes

### Nurses health study

84,941 nurses, follow-up 1980-1996

3,300 new cases of type 2 diabetes

<table>
<thead>
<tr>
<th>Daily alcohol consumption</th>
<th>number of cases with type 2 diabetes</th>
<th>relative risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 g</td>
<td>1715</td>
<td>1.0</td>
</tr>
<tr>
<td>0.1 - 5.0 g</td>
<td>1034</td>
<td>0.78 (0.72-0.84)</td>
</tr>
<tr>
<td>5.1 - 10.0 g</td>
<td>189</td>
<td>0.56 (0.48-0.65)</td>
</tr>
<tr>
<td>&gt;10 g</td>
<td>358</td>
<td>0.59 (0.52-0.66)</td>
</tr>
</tbody>
</table>

*Hu, NEJM (2001) 345: 790*
Moderate alcohol consumption –
lower risk of diabetes
*(Hoorn study)*

- in 1989 alcohol intake by questionnaire in 2393 subjects
- non-drinkers vs up to 10g/day vs 10-30 g/day vs > 30g/day
- lowest *mortality* → up to 10 g/day
- lowest risk to *develop diabetes* → up to 10 g/day
  (8.0% vs 12.9% for nondrinkers)

alcohol (1-2 drinks/day)
\[\Rightarrow lower \text{ risk of } osteoporosis\]
higher alcohol consumption
\[\Rightarrow more \text{ osteoporosis}\]

Bainbridge, Osteoporosis Int. (2004) 15: 439
Moderate alcohol consumption – less cognitive impairment

• Nurses Health Study

• Gruppo Italiano di Pharmacovigilanza nell’ Anziano (GIFA)

• Hale Project
  (mediterranean diet and life style changes in the elderly)
Wein wirkt stärkend auf den Geisteszustand
den er vorfindet –
er macht die Dummen dümmer
und die Klugen klüger

(wine reinforces the state of mind which is present –
it makes the stupid one even more stupid
but the intelligent one also more intelligent)

J.W.von Goethe
1749 - 1832
IDNT study – *alcohol consumption and risk of progressive diabetic nephropathy*

<table>
<thead>
<tr>
<th>renal endpoint (n=462)</th>
<th>no renal endpoint (n=1253)</th>
</tr>
</thead>
<tbody>
<tr>
<td>alcohol consumption: yes</td>
<td>23 %</td>
</tr>
<tr>
<td><strong>p (univariate analysis)</strong></td>
<td><strong>0.02</strong></td>
</tr>
</tbody>
</table>

Alcohol – progression of renal disease

# animal data

- moderate alcohol intake ⇒
  no impact on acute or chronic thy1- glomerulonephritis
  

- adriamycin model
  alcohol ⇒ less nephrotic syndrome
  
  *Tesar, Alcohol (1995) 30:47*

- red wine and alcohol free red wine
  ⇒ less lipid peroxydation in kidney
  
  *Araya, Lipids (2003) 38:275*
Hypothesis

kidney rich in polyunsaturated fatty acids $\rightarrow$ vulnerable to damage by reactive oxygen species (ROS)

benefit from moderate consumption of red wine $\uparrow$
  $\uparrow$antioxidant defense

# polyphenols $\rightarrow$ *scavenge ROS and chelate metals*

# ethanol $\rightarrow$ *activity of antioxidant enzymes $\uparrow$*

Alcohol and progression of renal disease

decline of renal function and alcohol
prospective 11 year study in 1658 nurses

odds ratio > 25 % decrease GFR
normotensive  hypertensive

<table>
<thead>
<tr>
<th></th>
<th>normotensive</th>
<th>hypertensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4.9 g/day</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>5 - 14</td>
<td>0.83</td>
<td>0.62</td>
</tr>
<tr>
<td>15 - 60</td>
<td>0.81</td>
<td>0.53</td>
</tr>
</tbody>
</table>

chronic kidney disease –
potential benefit from alcohol

Knight, Nephrol Dial Transpl (2003) 18:1549
Alcohol consumption – less endstage renal disease

65,601 Chinese men follow-up 9 years

Reynolds, Kid.Internat.(2008) 73:870
Incidence of all-cause endstage renal disease
(per 100,000 person years standardized by age)

Reynolds, Kid.Internat.(2008) 73:870
Chronic Kidney Disease – traditional and novel CV risk factors

Shlipak, JAMA (2005) 293:1737
Cardioprotection – although alcohol increases blood pressure

Paris Gendarmes
Are all alcoholic beverages similar with respect to benefit on coronary events?

Copenhagen Heart Study
prospective 12 year study,
6000 males, 7000 females

inverse correlation between alcohol consumption and total mortality
→ only for consumption of wine, not beer and spirits

in Bavaria diuresis sign of virility
Beer drinking and total mortality

# Copenhagen Heart Study:
  decreased relative risk only for wine,
  but slightly increased for beer and spirits


# Monica study – Augsburg (Bavaria):
  U-shaped relation between alcohol (including beer)
  consumption and total mortality in a
  beer drinking population

  Keil, Epidemiology (1997) 8: 150
Antiinflammatory effect of moderate consumption of either wine or beer

- MONICA study (Augsburg, Glasgow, Lille)
- self reported moderate (<40g/day) intake of alcohol compared to nondrinking or heavy drinking

⇒ lower CRP
  fibrinogen
  plasma viscosity
  white blood cell count

Between countries:

Inverse correlation alcohol consumption and coronary mortality \( (r = -0.39) \)

better correlation wine consumption and coronary mortality \( (r = 0.66) \)

*Criqui and Ringel*

*Does diet or alcohol explain the French paradox?*

*Lancet (1994) 344: 1719*

\( \Rightarrow \) alcohol coronary protection

constituents of wine additional coronary protection
alcohol – coronary protection
wine – additional coronary protection

metaanalysis
200,000 subjects

# beer consumption  risk reduction  - 20%
# wine consumption  risk reduction  - 32%

confirmed:

Women and alcohol

Higher blood alcohol levels
Higher risk of mammary carcinoma
Impact on CV risk dependent on age (menopausal state)

→ prospective study of 45,709 nurses

alcohol:

• CV risk increased in young women with low baseline CV risk even at low alcohol intake
• small decrease of CV risk only at age ≥ 50 years


but,

even young (30 y) women at high CV risk (e.g. type 2 diabetes) 26% risk reduction with alcohol (0.1-4.9 g/day)

Risk reduction —
*dependent on baseline risk*

→ pronounced in *smokers*,

less in non-smokers

<table>
<thead>
<tr>
<th></th>
<th>22-32 g alcohol/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>smoker</td>
<td>2.8</td>
</tr>
<tr>
<td>non-smoker</td>
<td>1</td>
</tr>
</tbody>
</table>

Risks and benefits of alcohol

490,000 individuals
prospective 9 year follow-up study
alcohol use ⇒

**higher** risk:
- cirrhosis
- cancer (breast, mouth, esophagus, pharynx, larynx, liver)
- injury

**lower** risk:
- cardiovascular death (lower by 30-40%)
- diabetes,
- osteoporosis,
- progression of renal disease,
- cognitive impairment

Myocardial infarction and alcohol

• improved survival
• less coronary complications
in individuals with moderate alcohol intake

(no significant difference wine, beer, spirits)

Alcohol consumption following myocardial infarction


Years after myocardial infarction

Part of survivors

≥7 drinks a week

≤7 drinks a week

Non-drinkers
Moderate alcohol consumption and mortality in heart failure (EF < 35 %) from ischemic cardiomyopathy
SOLVD study

Overall mortality

<table>
<thead>
<tr>
<th>Relative Risk</th>
<th>No Alcohol</th>
<th>Alcohol ICM</th>
<th>Alcohol DCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Myocardial infarction

<table>
<thead>
<tr>
<th>Relative Risk</th>
<th>No Alcohol</th>
<th>Alcohol ICM</th>
<th>Alcohol DCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>

* Denotes statistical significance

Alcohol consumption reduces restenosis rate after coronary angioplasty + stent – the Heidelberg experience

225 consecutive pat. PTCA + stent

> 50 g alcohol / week ⇒ lower:

rate of loss of lumen  
1.1 ± 0.79 vs 1.45 ± 0.82 mm, \( p < 0.002 \)

restenosis within stented segment  
33.7 % vs 42.5 %, \( p < 0.002 \)

repeat angioplasty  
23.3 % vs 42.5 %

alcohol consumption → independent predictor

Niroomand, Heart (2004) 90:1189
Mechanisms of cardioprotective actions of alcohol / wine

- serum lipid profile
- antithrombotic action
- lowering of oxygen radicals (ROS)
- endothelial-dependent vasodilation/NO
- antiproliferative effect (antagonism ANG II, PDGF)
Inhibition of ADP-Induced Platelet Aggregation in vitro

<table>
<thead>
<tr>
<th>Concentration [µmol/l]</th>
<th>% Inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>1000</td>
<td>100</td>
</tr>
</tbody>
</table>

trans-Resveratrol

Red Wine Phenolics

Pace-Asciak, Clin Chem Acta 1005;235:207
Inhibition of platelet aggregation + eicosanoid synthesis

**In vitro:**
phenoles in red wine (trans-resveratrol, quercetin)


**In vivo:**
fresh grape juice,
but not orange or grape fruit juice

*Keevil, J Nutr (2000) 130: 53*
Impact of Red Wine on Serum Antioxidant Activity in Healthy Volunteers

Standard meal alone or with 5.7 ml Bordeaux / kg

Maxwell, Lancet 1994; 344: 193

Antioxidant Activity [µmol trolox equivalent / l]

Time (min)

Control (n=10)
Red wine (n=10)
Effects of wine on endothelial cells

- NO generation
- shear stress induced vasodilatation
- adhesion of mononuclear cells/platelets

red wine phenols (resveratrol) increase expression and activity of endothelial NO synthase (eNOS)

Endothelial effects of wine

Red wine, but not vodka, increases coronary flow reserve


Small amounts of alcohol specific increase of postischemic forearm blood flow in CHD patients (nitrate as control negative)

Endothelial effects of wine

In isolated human coronary arteries red wine (Châteauneuf du Pape), but not white wine (Mosel Riesling) or ethanol

→ endothelial cell dependent vasodilatation, effect NO-dependent (inhibited by L-NMMA)

Human Coronary Artery
Effects of Red and White Wine

Chateuneuf du Pape
PE
Cha L-NMMA
Chateuneuf du Pape (- Endothelium)
PE
Chateuneuf
PE
Riesling
Mosel-Riesling
PE
Ethanol
Ethanol

10 mNewton
5 min
Antiproliferative effect of red wine

Vascular smooth muscle cells

ANG II- and PDGF-induced proliferation inhibited by red, but not white, wine by quercetin and tannin


inhibits ligand activated tyrosine phosphorylation of β-PDGF receptor and postreceptor signalling

Are all red wines created equal?

Barrique matured wines in *oak vats* vs wines matured in *steel tanks*

→ only heavy barrique matured red wines effective, contain higher concentrations of phenolic substances in vitro effect reproduced by Tannin and Quercetin

Resveratrol is a phytoalexin (defense against fungi) found in grapes (skin), raspberries, mulberries, peanuts, and in red wine through fermentation (red wine with white wine without skins) in red wine up to 15 mg/L.


See also: [Resveratrol on en.wikipedia.org](http://en.wikipedia.org/wiki/Resveratrol)
Resveratrol

- *extends lifespan in* *sacharomyces*
  

- *prolongs lifespan of Caenorhabditis elegans and Drosophila melanogaster*
  

- *extends lifespan and reduces aging features in the short-lived fish* *Nothobranchius furzeri*
  

- *improves health and survival of mice on a high calorie diet acting via the histone deacetylase SIRT1*
  

▶ in America marketed as a nutritional supplement
Resveratrol – effect on survival in obese mice

Resveratrol –
effect on insulin in obese mice

Rosy prospect? A compound found in red wine might help to protect against the health problems associated with obesity.

**A votre santé: now in pill form?**

*Chek, Nature (2006) 444:11*
Moderate drinking: social lubricant, major characteristic of European lifestyle ("joie de vivre")
"I mix three kraters only for those who are wise.

One is for good health, which they drink first.
The second is for love and pleasure.
The third is for sleep, and when they have drunk it those who are wise wander homewards.
The fourth is no longer ours, but belongs to arrogance.
The fifth leads to shouting.
The sixth to a drunken revel.
The seventh to black eyes.
The eighth to a summons.
The ninth to bile.
The tenth to madness, in that it makes

poet Eubulos
4th century B.C.

“Semele”
(mother of Dionysos)
after how many “glasses”?

<table>
<thead>
<tr>
<th>Greek</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Υγίεια</td>
<td>(Hygeia/health)</td>
</tr>
<tr>
<td>ἔρως καὶ ἡδονή</td>
<td>(love and pleasure)</td>
</tr>
<tr>
<td>ὑπνός</td>
<td>(sleep)</td>
</tr>
<tr>
<td>ὑβρις</td>
<td>(hubris)</td>
</tr>
<tr>
<td>βοή</td>
<td>(shouting)</td>
</tr>
<tr>
<td>κώμος</td>
<td>(drunken revels)</td>
</tr>
<tr>
<td>ὑπώπτια</td>
<td>(black eyes)</td>
</tr>
<tr>
<td>κλητήρ</td>
<td>(witness)</td>
</tr>
<tr>
<td>χολή</td>
<td>(anger)</td>
</tr>
<tr>
<td>μανία</td>
<td>(mania)</td>
</tr>
</tbody>
</table>
Virgin Mary with the wine drinking Christ child

Joos van Cleve
1491-1541
Notions about benefits of alcohol

german  
Prosit !  
zum Wohl !

english  
cheers !

estonian  
terviseks !

finnish  
terveydeksi !
greek  
για μας !

drinks  
to your / our  
wellbeing

drinks  
to your  
health

french  
santé !

italian  
salute !

spanish  
salud !
hungarian  
egésszégére
No one should talk longer in public than he is prepared to make love in private

Francois La Rochefoucauld,
Prince de Marcillac
1613-1680
Effects of Moderate Alcohol Consumption on Cognitive Function in Women

Meir J. Stampfer, M.D., Jae Hee Kang, Sc.D., Jennifer Chen, M.P.H., Rebecca Cherry, M.D., and Francine Grodstein, Sc.D.

ABSTRACT

BACKGROUND
The adverse effects of excess alcohol intake on cognitive function are well established, but the effect of moderate consumption is uncertain.

METHODS
Between 1995 and 2001, we evaluated cognitive function in 12,480 participants in the Nurses’ Health Study who were 70 to 81 years old, with follow-up assessments in 11,102 two years later. The level of alcohol consumption was ascertained regularly beginning in 1980. We calculated multivariate-adjusted mean cognitive scores and multivariate-adjusted risks of cognitive impairment (defined as the lowest 10 percent of the scores) and a substantial decline in cognitive function over time (defined as a change that was in the worst 10 percent of the distribution of the decline). We also stratified analyses according to the apolipoprotein E genotype in a subgroup of women.

RESULTS
After multivariate adjustment, moderate drinkers (those who consumed less than 15.0 g of alcohol per day [about one drink]) had better mean cognitive scores than nondrinkers. Among moderate drinkers, as compared with nondrinkers, the relative risk of impairment was 0.77 on our test of general cognition (95 percent confidence interval, 0.67 to 0.88) and 0.81 on the basis of a global cognitive score combining the results of

2005; 352: 245-53
Red wine polyphenols, in the absence of alcohol, reduce lipid peroxylative stress in smoking subjects

• phenolic compounds in red wine → antioxidant effect on in vitro lipoprotein oxidation
• evidence by prospective study in smokers of in vivo antioxidant effect

• 18 male smokers in random order red wine, white wine or dealcoholized red wine for 2 weeks
• read out plasma and urinary F2 isoprostane

• significant decrease of F2 isoprostane without any change in known antioxidants (α,γ-tocopherol, vitamin C)

Alcohol consumption lowers $\text{NF}_\kappa\text{B}$ and MCP 1

Blanco-Colio, Atherosclerosis, e-pub Sept 2006
Alcohol consumption lowers $\text{NF}_\kappa\text{B}$ and MCP 1

MCP1 (% change)

Blanco-Colio, Atherosclerosis, e-pub Sept 2006
Heiss et al

Chocolate and blood pressure in elderly subjects with isolated systolic hypertension

JAMA (2003) 290:1030
Heiss et al

Chocolate and blood pressure in elderly subjects with isolated systolic hypertension

JAMA (2003) 290:1030

Figure 1. Time Course of Flow-Mediated Dilation After Ingestion of 100 mL of Cocoa Drink Containing High (176 mg mL; n=6) or Low (<10 mg mL; n=3) Amounts of Flavan-3-ols
Vascular Effects of Red and White Wine

(Flesch, Am J Physiol 1998)
Cost-effectiveness of **BEER** versus **RED WINE** for the prevention of symptomatic coronary artery disease

Fig. 1: The double-blind nature of the study was maintained throughout the trial. Dr. Innes is shown sitting.

Innes, CMAJ (1998) 159:1463
# Quantitative Analysis of Polyphenolics in Red Wine vs. White Wine

<table>
<thead>
<tr>
<th></th>
<th>Red Wine</th>
<th>White Wine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Chateauneuf-du-Pape)</td>
<td>(Riesling Kabinett)</td>
</tr>
<tr>
<td>cis-Piceid</td>
<td>5,1</td>
<td>0,0</td>
</tr>
<tr>
<td>trans-Resveratrol</td>
<td>1,6</td>
<td>0,0</td>
</tr>
<tr>
<td>Quercetin</td>
<td>0,0</td>
<td>0,0</td>
</tr>
<tr>
<td>Catechin</td>
<td>37,3</td>
<td>5,2</td>
</tr>
<tr>
<td>Epicatechin</td>
<td>12,0</td>
<td>1,6</td>
</tr>
<tr>
<td>Procyanidin B2</td>
<td>9,7</td>
<td>0,0</td>
</tr>
<tr>
<td>Gallic Acid</td>
<td>44,9</td>
<td>0,9</td>
</tr>
<tr>
<td>Caferic Acid</td>
<td>24,8</td>
<td>37,9</td>
</tr>
<tr>
<td>Coffee Acid</td>
<td>7,0</td>
<td>16,7</td>
</tr>
<tr>
<td>p-Coumaric Acid</td>
<td>23,5</td>
<td>6,8</td>
</tr>
<tr>
<td>Total Polyphenolics</td>
<td>2113</td>
<td>350 [mg/l]</td>
</tr>
</tbody>
</table>