NMDM121
MEDICINAL FOOD SCIENCE

Session 25
Alcoholic Beverages
Nutritional Medicine Department
Session Summary

• Discuss the constituents of alcoholic beverages, including key phytochemicals.

• Discuss the benefits and risks associated with the consumption of alcoholic beverages.

Alcohol: Introduction

• Alcohol is the oldest and most widely used psychoactive drug and is legal in most countries.

• Alcohol is fermented from the sugar or other carbohydrates found in grapes and other fruits, vegetables, or grains.

• Ethyl alcohol (ethanol) is the main psychoactive component in all alcoholic beverages.

• Beer made from grain is about 5% alcohol, wine made from grapes and other fruits is about 12% alcohol, and distilled liquor made from grains or wines is about 40% alcohol.
Alcohol: Introduction

- Alcohol is absorbed by the body at different rates depending on weight, gender, age, and other factors.
- It is metabolised, mostly by the liver, and subsequently excreted through urine, sweat, and breath.
- Ethyl alcohol - a substance that can cause drunkenness and changes in consciousness, mood, and emotions.
- Alcohol is responsible for a considerable burden of death, disease and injury in Australia.

(NHMRC 2009)
Alcohol: Introduction

- Around 8% of Australians drink daily, and around 41% drink weekly.
- The mean volume of alcohol consumed has remained relatively stable since 1991, but there have been important changes in the patterns of consumption.
- Preferences in beverage type have shifted towards spirits and pre-mixed drinks, especially among younger drinkers and there is an increased level of informality in drinking styles, such as drinking directly from the container.

(NHMRC 2009)
Alcohol: Standard Drink

• In Australia, a standard drink contains 10 grams of alcohol.

• Examples of one standard drink include:
  – 1 X 375 mL bottle of mid-strength beer (3.5% alcohol)
  – 1 X 100 mL glass of wine (13.5% alcohol)
  – 1 X 30 mL nip of spirits (40% alcohol)
Alcohol: Metabolism

• Alcohol usually starts to affect the brain within about five minutes of being swallowed. The blood alcohol concentration (BAC) reaches its peak about 30–45 minutes after the consumption of one standard drink (10g alcohol).

• Rapid consumption of multiple drinks results in a higher BAC because the liver has a relatively fixed rate of metabolism regardless of how many drinks are consumed.

• It generally takes about an hour for the body to clear one standard drink, although this varies from person to person. The rate of this metabolism depends on several factors including genes, liver size, body mass and composition, and alcohol tolerance.

(NHMRC, 2009)
Alcohol: Metabolism

Alcohol Dehydrogenase (B3 Dependent Enzyme) → Acetaldehyde

Aldehyde Dehydrogenase (B3 Dependent Enzyme) → Acetate
Alcohol: Biological Effects

- Alcohol is a source of energy providing 29 kJ per gram; this can easily be converted to fat.
- Alcohol is a central nervous system depressant.
- Alcohol is a diuretic – it depresses production of antidiuretic hormone (ADH), a hormone produced by the pituitary gland that retains water – thus with less ADH, more water is lost.
- The accumulation of hydrogen ions during alcohol metabolism shifts the body’s acid-base balance towards acid.
- Alcohol disrupts liver metabolic processes.
Liver Detoxification

• Detoxification or biotransformation

• Chemical changes of a xenobiotic, phytochemical or endogenous compound that render it less toxic and/or more readily excreted. (Groff & Gropper 2000)

• Phase I bioactivation
• Phase II conjugation
Phase I Liver Detoxification

- Introduce or expose a functional group on the parent compound, making it more polar.
- May activate inert compounds (e.g. pro-drugs and pro-carcinogens).
- Cytochrome P 450 enzymes initiate actions.
- Generates toxic reaction products: ammonia, hydrogen peroxide, aldehydes.

(Groff & Gropper 2000)
Phase II Liver Detoxification

• Covalent linkage between parent compound functional group and water-soluble moiety.

• Product generally inactive and excreted via bile or urine:
  – Glucuronidation
  – Sulfation
  – Glutathionation
  – Acetylation
  – Peptide conjugation: taurine, glycine, glutamine
  – Methylation

(Groff & Gropper 2000)
Liver Detoxification

**FAT-SOLUBLE TOXINS**

**PHASE I**
[Cytochrome P450 Enzymes]
- Oxidation
- Reduction
- Hydrolysis
- Hydration
- Dehalogenation

**INTERMEDIARY METABOLISM**

**PHASE II**
[Conjugation Pathways]
- Sulfation
- Glucoronidation
- Glutathione Conjugation
- Acetylation
- Amino Acid Conjugation
- Methylation

**WASTE**

Eliminated via:
- Gall Bladder
- and Kidneys

www.balancedconcepts.net/liver_phases_detox_paths.pdf
THE LIVER DETOX PATHWAYS AND ESSENTIAL NUTRIENTS

Detoxification Pathways

Toxins (fat soluble)

STEP 1

Required Nutrients
- B Vitamins
- Folic Acid
- Glutathione
- Antioxidants: eg. Milk Thistle
- Carotenoids
- Vitamin E
- Vitamin C

STEP 2

Required Nutrients
- Amino Acids:
  - Glutamine
  - Glycine
  - Taurine
  - Cysteine
- Sulphurated phytochemicals: eg. found in garlic & cruciferous vegetables

Waste Products (water soluble)

Eliminated from the body via:
- Gall Bladder
  - Bile
  - Bowel actions
- Kidneys
  - Urine

Toxin List
- Metabolic end products
- Micro-organisms
- Contaminants / pollutants
- Insecticides
- Pesticides
- Food additives
- Drugs
- Alcohol

http://www.balancedconcepts.net/liver_phases_detox_paths.pdf

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Alcohol: Protective Compounds

*In-vitro* and animal studies suggest that the following compounds may offer some protection against alcohol-induced damage:

- Lipoic acid associated with gastric protection against alcohol-induced damage (Sehirli 2008).
- Fenugreek seeds prevented alcohol-induced liver damage (Kaviarasan 2008).
- Grape seed extract decreased oxidation associated with high alcohol intake (De Freitas 2004).
- Grapefruit seed extract (Brzozowski 2005) and naringenin (Seo 2003) suppresses PGE2 and increases gastric protection.

(Continued on next slide)
Alcohol: Protective Compounds

- Capsaicin prevented gastric ulceration stimulated by alcohol (Saeki 2000).

- Se and vitamin C (Ozdil 2004) and quercetin (Liu 2008) decreased liver oxidative markers and gastric injury.

- Zn deficiency increases with alcohol intake; is a cofactor for alcohol dehydrogenase; stimulates liver regeneration (Kang 2008).

- B3, (involved with alcohol dehydrogenase) reduces oxidation (Tampier 1999).

- Curcumin found to inhibit lipid peroxidation with high alcohol consumption (Vanisree 2006).
Alcohol: Adverse Effects

Alcohol intoxication can be harmful for a variety of reasons, including:

• Impaired brain function resulting in poor judgment, reduced reaction time, loss of balance and motor skills, or slurred speech.

• Dilation of blood vessels causing a feeling of warmth but resulting in rapid loss of body heat.

• Increased risk of certain cancers, stroke, and liver diseases (e.g., cirrhosis), particularly when excessive amounts of alcohol are consumed over extended periods of time.

• Damage to a developing foetus if consumed by pregnant women.

• Increased risk of motor-vehicle traffic crashes, violence, and other injuries.

• Coma and death can occur if alcohol is consumed rapidly and in large amounts.

(CDC, 2014)
Beer: Introduction

• The ingredients in beer are basically barley, hops, yeasts and water.

• Hops contains:
  – Polyphenols such as quercetin and kaempferol
  – α-bitter acids such as humulone
  – β-bitter acids such as lupulone
  – 8-prenylnaringenin – a phyto-oestrogen

http://www.ctbeverage.com/beers.jpg
Beer: Nutrients

• Vitamin B6 found in higher amounts in beer compared with wine and spirits; thought to be responsible for the lack of effect on homocysteine with beer compared with wine and spirits (van der Gaag 2000).

• Lager style beers contain less thiamin (vitamin B1) than other beers – lager, 35.7 μg/L; ale, 88.3 μg/L; stout/porters, 104.4 μg/L; wheat beers, 130.7 μg/L.

• Cider and wines contain less thiamin and riboflavin than beer.

(Hucker et al., 2011)
# Beer: Nutrients

<table>
<thead>
<tr>
<th></th>
<th>Lager per 100 mL</th>
<th>Stout per 100 mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>153 kJ</td>
<td>226 kJ</td>
</tr>
<tr>
<td>Ethanol</td>
<td>4 g</td>
<td>5.7 g</td>
</tr>
<tr>
<td>Potassium</td>
<td>32 mg</td>
<td>62 mg</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0 mg</td>
<td>0.03 mg</td>
</tr>
<tr>
<td>Niacin</td>
<td>0.44 mg</td>
<td>0.91 mg</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>0.03 mg</td>
<td>0.05 mg</td>
</tr>
<tr>
<td>Folate</td>
<td>0 mcg</td>
<td>6 mcg</td>
</tr>
</tbody>
</table>

(NUTTAB, 2010)
Beer: Research

- In a study of 2,291 patients presenting for colonoscopy screening (US population) there was a higher incidence of significant neoplasia in those who consumed more than eight drinks of spirits alcohol (26.3%; OR = 2.53; 95% CI = 1.10-4.28; p < 0.01) and those who drank more than eight servings of beer per week (21.7%; OR = 2.43; 95% CI = 1.11-5.32; p= 0.02) compared to abstainers (Anderson, 2005).
Beer: Research

• Beer intake is associated with higher incidence of gout, compared with spirits and wine; beer contains purines, which combined with ethanol increases lactic acid and serum uric acid (Yamamoto 2005).

• Found to deplete vitamin C levels more than spirits and wine (van der Gaag 2000).

• Linked to increased incidence of migraines (Leira 1996).

• Full strength beer found to have more antioxidants than light strength or spirits (Ghiselli 2000).
Cider

http://www.recipes4us.co.uk/images/Fotolia_Cider.jpg
Cider: Introduction

• Cider is made by a “producer” rather than a “brewer”. They may use a mixture of bittersweet and bittersharp cider apples or sweet dessert apples, or a mixture of the two to make cider.

• Cider varies in alcohol content from 2% ABV (Alcohol by Volume) to 8.5% ABV or more in traditional English ciders.

• Perry is the correct term for Pear Cider and can only be made from specialised perry pears, which are high in natural tannins.

Cider: Constituents

• Conventional apple cider has been shown to have a relatively high concentration of phenolics, flavonols, and antioxidants, including quercetin.
• This is, in part, because apples themselves have a fairly high concentration of phenolics.
• One analysis identified 16 phenolic compounds including: hydrocaffeic acid, chlorogenic acid, hydrocoumaric acid, procyanidins, vitamins B2 and B5, and high amounts of quercetin.

(Madrera, Lobo, & Valles. 2006)
Cider: Research

• Another study involving Scrumpy Jack® cider showed an increase in polyphenol metabolites such as phlorizin.
  – Phlorizin is an inhibitor of cellular transporter SGLT1 responsible for the transport and uptake of glucose and galactose.
  – This study showed the potential for the blood glucose lowering effects of apple cider, though further studies are required.
  – The relatively new popularity of alcoholic cider renders it immature in the research field and a lot more is required to determine the health benefits, if any.

(DuPont et. al., 2002)
Wine: Introduction

• Wine is made from fermented grape juice. The added yeast ferments the sugar naturally present in grapes to create alcohol.

• Wines can be grouped into six primary categories: white wines, red wines, rosé wines, sparkling wines, dessert wines and fortified wines.

• Most grapes have colourless juice so the red pigmentation in red wine comes from the inclusion of grape skins. Grape skins contain tannins and resveratrol so red wine contains these additional phytochemicals.

• Wine may contain sulphur preservative 220.
Wine: Constituents

• Wine contains a large variety of phytochemicals including:
  – Phenolic acids (from grape pulp)
  – Stilbenes (from grape skins – so present in red wine)
  – Flavonoids (such as anthocyanins and flavan-3-ols, e.g. catechins) – present in red wine.

• Red wine contains more polyphenols than white wine (around 10 fold) because during the wine making process, red wine, unlike white wine, is macerated for weeks with the skin. The concentrations in red wine range from around 1.2 to 3.0 g/L.

• Wines that are aged in oak barrels can contain additional phenolic compounds from the oak barrels.
Red Wine: Resveratrol

• Much of the research interest in red wine has focused on the phytochemical, resveratrol.

• Resveratrol (3,5,4-trihydroxy-trans-stilbene) is a natural polyphenolic compound that exists in Polygonum cuspidatum (Japanese knotweed), grapes, peanuts and berries.

• Polyphenols → Stilbenes – e.g. resveratrol, phenostilbene (i.e. the Stilbenes are a sub-group within the polyphenol group of phytochemicals).
Red Wine: Resveratrol

• Despite the frequent media reporting of the benefits of red wine due to resveratrol, good quality human trials on resveratrol are currently lacking.

• The biological actions of resveratrol identified from *in-vitro* and animal studies have focused on its potential protective effect against cardiovascular disease, ischemia–reperfusion injury and diabetes mellitus.
Red Wine: Resveratrol

*In-vitro* and animal studies suggest that resveratrol exerts its protective effects through modulation of:

- Adipocyte/fibroblast biology
- Platelet activation
- Blood vessel function
- Oxidative stress
- Inflammation
- Serum glucose maintenance
- Cardiomyocyte biology
- Maintenance of cell structure
- Serum lipid activity

(Tang et al., 2014)
# Red Wine: Resveratrol

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Total Resveratrol mg/L</th>
<th>Resveratrol in 150 mL serve (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White wines (Spanish)</td>
<td>0.05-1.8</td>
<td>0.01-0.27</td>
</tr>
<tr>
<td>Rose wines (Spanish)</td>
<td>0.43-3.52</td>
<td>0.06-0.53</td>
</tr>
<tr>
<td>Red wines (Spanish)</td>
<td>1.92-12.59</td>
<td>0.29-1.89</td>
</tr>
<tr>
<td>Red wines (Global)</td>
<td>1.98-7.13</td>
<td>0.30-1.07</td>
</tr>
<tr>
<td>Red grape juice (Spanish)</td>
<td>1.14-8.69</td>
<td>0.17-1.30</td>
</tr>
</tbody>
</table>

1 cup of red grapes provides 0.24-1.25 mg resveratrol.

(Higdon, 2007)
Spirits

• Highest content of ethanol; likely associated with hangover intensity (Woo 2005).

• Congeners, the by-products of individual alcohol preparations, increase the frequency and severity of a hangover. Congeners are found primarily in brandy, wine, tequila, whiskey and other dark liquors, whereas clear liquors such as rum, vodka and gin tend to cause hangover less frequently (Wiese et al., 2009).

• Significant increase in the risk of neoplastic colon cell growth with increased consumption (Anderson 2005).

• Increased ethanol associated with spleen and thymus oxidation via reduction of vitamin C and glutathione (Parthasarathy 2006).
Energy Drink + Alcohol

• The ingestion of Energy Drinks in combination with alcohol has become increasingly popular, especially amongst young people.

• One of the concerns associated with combined use is that users may not feel the symptoms of alcohol intoxication, thus increasing the potential for alcohol-related injury (i.e. caffeine can mask the depressant effects of alcohol - a wide-awake drunk is more of a hazard than a sleepy one).

• Caffeine has no effect on the metabolism of alcohol.
## Alcohol: Health Advice

<table>
<thead>
<tr>
<th>Guideline 1</th>
<th>For healthy men and women, drinking no more than two standard drinks on any day reduces the lifetime risk of harm from alcohol-related disease or injury.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guideline 2</td>
<td>For healthy men and women, drinking no more than four standard drinks on a single occasion reduces the risk of alcohol-related injury arising from that occasion.</td>
</tr>
<tr>
<td>Guideline 3</td>
<td>For children and young people under 18 years of age, not drinking alcohol is the safest option.</td>
</tr>
</tbody>
</table>
| Guideline 4 | Maternal alcohol consumption can harm the developing foetus or breastfeeding baby.  
A) For women who are pregnant or planning a pregnancy, not drinking is the safest option.  
B) For women who are breastfeeding, not drinking is the safest option. |

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**NHMRC, 2009. ‘Australian guidelines to reduce health risks from drinking alcohol.’**
Alcohol: Health Advice

Given the constituents and biological actions of alcoholic beverages, consider recommending reduced intake or avoidance for those suffering from:

- Overweight, obesity
- Liver disease – e.g. fatty liver, hepatitis
- Gastro-oesophageal reflux disease; peptic ulcer; inflammatory bowel disease
- Menopausal hot flushes and night sweats
- Inflammatory skin conditions such as acne rosacea, eczema, psoriasis
- Gout
- Histamine intolerance; migraine; headaches
- Anxiety, depression, insomnia, mental health conditions
- Preconception, pregnancy and breastfeeding.
Alcohol: Health Advice

Based on the current evidence available:

• Light to moderate drinkers (1-2 standard drinks per day), without medical complications, could continue their current consumption.

• The evidence is not strong enough to advise abstainers to start drinking – abstainers could continue abstaining.

• The Mediterranean diet includes the consumption of 1-2 glasses of red wine per day with a meal.

• Further research is required to clarify health advice regarding alcohol consumption.
Alcohol: Health Advice

According to the Cancer Council Australia (2014):

- There is convincing evidence that drinking alcohol increases the risk of cancers of the bowel, breast, mouth, throat, voice box, oesophagus and liver.

- Even drinking small amounts of alcohol increases your cancer risk. The more you drink, the greater the risk. If you choose to drink, limit your intake.

- The type of alcohol you drink doesn’t make any difference. Beer, wine and spirits all increase your risk of cancer. Even at low intake, alcohol contains a lot of energy (kilojoules or calories) so it can easily contribute to weight gain. Being overweight or obese also increases your cancer risk.
Session Summary

- Discuss the constituents of alcoholic beverages, including key phytochemicals.
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