A look at the history and science of the alcoholic beverage

JOHN KRISINGER, DEPT. BIOLOGY & NURSING

NWC C TERRACE

JKRISINGER@XPLORENET.CA
The alcoholic beverage History

- Early experience with fermenting fruits likely accidental
  - Observed in animals as well
- First alcoholic beverage probably wine
- Chemical analysis of jars from a Neolithic village in China
  - Traces of organic compounds absorbed and preserved characteristic of fermented fruits (no actual ethanol - too volatile!)
- Published in PNAS
- Analysis: residue fermented drink made of grapes, hawthorn berries, honey, and rice produced in 7000-6650 BC
- Approximately same time when barley beer and grape wine were beginning to be made in the Middle East
The alcoholic beverage History

- Earliest firm evidence of wine production: 5,400 BC in Iran
- Medicinal use of alcohol mentioned in Sumerian and Egyptian texts about 2,100 BC
- Hebrew Bible recommends giving alcoholic drinks to those who are dying or depressed, so that they can forget their misery (Proverbs 31:6-7).
- “Give strong drink to him who is perishing, and wine to those in bitter distress, let them drink and forget their poverty and remember their misery no more.”
Psalm 104:15 (Old Testament)

...So that he may bring forth food from the earth, And wine which makes man's heart glad,...


These people are not drunk, as you suppose. It’s only nine in the morning!

Evidence for the 5’o clock rule?
The Beer History

- Before 6,000 BC beer made in Sumer and Babylonia.
- Reliefs on Egyptian tombs dating from 2,400 BC show the process.
- Techniques came to Europe from the Middle East.
- Roman historians Pliny (23-79 AD) and Tacitus (56-117 AD) reported that Saxons, Celts, and Nordic and Germanic tribes drank ale.
- Many of the English terms used in brewing (malt, mash, wort, ale) are Anglo-Saxon in origin.
- During the Middle Ages the monastic orders preserved brewing as a craft.
The Beer History

- Europe during Middle Ages, beer, often of very low strength everyday drink for all classes and ages of people.
- A document from that time mentions nuns having an allowance of six pints of ale each day (2.8 l = 8 beers!)
- Cider (apples) and pomace (mainly grape skin after juice removal) wine were also widely available.
- Grape wine was the prerogative of the higher classes.
Benedictine *Weihenstephan* Abbey, founded 725, oldest still operating brewery in the world (1040) 1,000th anniversary coming up
Yeasts: Unicellular Fungi

- Yeasts reproduce by fission or budding, allowing rapid growth
- *Saccharomyces* ("sugar fungus")

*Saccharomyces cerevisiae* (A Budding Yeast)

- Bud
- Parent cell
Yeasts: the Unicellular Fungi

- Yeasts reproduce by fission or budding, allowing rapid growth
- Yeasts grow in moist environments
- *Saccharomyces* is important in research and food production

*Saccharomyces cerevisiae*

(A Budding Yeast)

Parent cell

Bud

Parent cell

Bud

Bud

Bud

Bud
Production of Alcoholic Beverages

- Many plants - high carbohydrate content
- Fermentation with yeast (low $O_2$ levels - yeast switches to ethanol fermentation)
- Possible up to 10-18% ethanol
Alcoholic fermentation in yeast

- If sufficient $O_2$ – glucose completely oxidized to $CO_2$
Alcoholic fermentation in yeast

- **Insufficient O₂ - Fermentation**
- “Emergency metabolism” to re-generate NAD⁺ - ethanol is a by-product
- FYI: glucose: 4 Cal/g ethanol: 7Cal/g – “wasted” in the eyes of the poor yeast (pun intended)
History of grape vine

- Wild grapes native to Armenia, Azerbaijan, Georgia, Levant, Turkey, Iran
- With invention of pottery (11,000 BC) and sedentary life style, agriculture and wine domestication
- Wine production possible
- First firm record: Georgia 6,000 BC
History of grape vine

- Widespread use in ancient world
- As beverage, medicine and ceremonial drink
- Middle Ages, wine the common drink of all social classes in the South, where grapes were cultivated (30-50° latitude)
- In the North few if any grapes were grown, beer and ale usual beverages
- Wine necessary, the celebration of the Catholic Mass
Benedictine monks one of the largest producers of wine in France and Germany

Vineyards in Champagne, Burgundy, and Bordeaux (France 1792)

Rheingau and Franconia (Germany 1815)

1435 Count John IV wealthy member of the Holy Roman Empire first to plant Riesling, the most important German grape
Great French Wine Blight

- Severe blight in 19th century destroyed many vineyards in France & nearby European countries
- Caused by an aphid (Daktulosphaira vitifoliae), originated in North America
- Transferred by ship in 1850s
- Grafting of resistant American stock to French scion – still done today in nearly ALL vineyards worldwide (exceptions in Chile & South Australia)
Grafting

- Common technique in horticulture
- Tissues from one plant inserted into another joining vascular tissues
- One plant selected for its roots (stock)
- Other plant selected for its stems, leaves, flowers, or fruits (scion)
- Common in vineyards
  - French grapes, American roots
- Grafting used for thousands of years
Wines

Typically grown on poor soil (compared to other crops)
most species: Genus Vitis sp. Climate, weather, elevation, aspect

- **White**
  - May be made from non-colored or black-skinned grapes (skin removed upon pressing) fermented at 12-15°C

Riesling (Rhein Germany)

Gewürtztraminer (France)

Pino Noire (France)
Wines

- **Red**
  - 100s of varieties worldwide
  - Black-skinned grapes - skin and seeds left in contact throughout fermentation (20-29°C)
  - Extraction of anthocyanins & phenolics (tannins) from skin & seeds

- **Rosé**
  - Produced with skin contact method
  - Black-skinned grapes crushed and skins allowed in contact with juice 1-3 days duration determine final color
  - Must pressed & skins discarded followed by fermentation
Modern production of wine

- **Wine** starts from **GRAPE JUICE!** (simple beginning)
  - Complex fine tuning and during and after fermentation
  - Time of harvest crucial, ripening stops after harvest
- **Beer** starts from **MALT (complex starting material)**
  - Less sophisticated fine tuning during and after fermentation
Wine Production

<table>
<thead>
<tr>
<th>Processing step</th>
<th>Biological change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterilization, Yeast addition</td>
<td>Elimination of contaminants, Addition of desired organisms</td>
</tr>
<tr>
<td>Fermentation of must</td>
<td>Alcohol production from sugars</td>
</tr>
<tr>
<td>Settling vat</td>
<td>Excess yeast</td>
</tr>
<tr>
<td>Malolactic fermentation</td>
<td>Development of final wine bouquet</td>
</tr>
<tr>
<td>Bottling</td>
<td></td>
</tr>
</tbody>
</table>
Why a ‘Malolactic Fermentation’ (MLF)?

**Microbial stability**

Malic acid is a substrate for different species of wild bacteria: *Oenococcus, Pediococcus, Lactobacillus*...
Its consumption stabilizes the wine avoiding fermentation to occur in bottles and/or spoilages and wine downgrading.

**Flavours & mouth-feel**

Malic Acid gives a harsh sensation in wines. Its conversion by fermentation into Lactic Acid decreases acidic sensation in mouth: pH increases, mouth-feel is softer and rounder...

... while producing additional typical and classical fermentation flavours: fresh cream, butter, crème caramel...
‘Wine’ is all about controlled fermentations!

Alcoholic fermentation

Managed by yeasts

Sugar (Glucose)  Alcohol (Ethanol)

100% of the wines

Malolactic fermentation

Managed by lactic acid bacteria

Malic acid  Lactic acid

Most of RED wines
Some WHITE & ROSÉ wines
Use of Sulfur Dioxide (SO$_2$)

- Used by the Romans in winemaking, discovered that burning sulfur candles inside empty wine vessels keeps them fresh and free from vinegar smell (acetic acid)
- Antimicrobial and anti-oxidant properties
- Prevents growth of acetic acid bacteria
Wine aging

- Very complex chemistry changing composition of wines
- Influence of vessel (barrels)
- Exposure to oak during fermentation or after (during barrel aging) more phenolic compounds
- Aging continues in bottles
Aging in Oak barrels
<table>
<thead>
<tr>
<th></th>
<th>LIGHT TOAST</th>
<th>MEDIUM TOAST</th>
<th>HEAVY TOAST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMERICAN OAK</strong></td>
<td>vanilla, dill, coconut</td>
<td>vanilla, honey, caramel, toast, roasted</td>
<td>strong roast coffee, espresso, caramelized sugar,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>nut aromas, strong coconut, roast coffee,</td>
<td>tiramisu, wood smoke and vanilla</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and cocoa</td>
<td></td>
</tr>
<tr>
<td><strong>FRENCH OAK</strong></td>
<td>vanilla bean, caramel, holiday spice</td>
<td>cedar, cigar box, milk chocolate and</td>
<td>crème Brûlée, cedar, charcoal, and Asian spices</td>
</tr>
<tr>
<td></td>
<td>flavors like nutmeg, clove, allspice</td>
<td>baking spice</td>
<td>like cinnamon, ginger and clove</td>
</tr>
<tr>
<td></td>
<td>and dried ginger</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HUNGARIAN OAK</strong></td>
<td>vanilla, herbal flavors, sweet spice</td>
<td>stronger butterscotch, banana, sarsaparilla</td>
<td>strong spice, vanilla, butterscotch, toffee and</td>
</tr>
<tr>
<td></td>
<td>flavors like clove and cinnamon</td>
<td>and sweet spice</td>
<td>molasses</td>
</tr>
</tbody>
</table>
Wine’s sweetness

- At harvest b/w 15 -25% sugar content of grapes simple sugars (glucose & fructose)
- Very high sugar content kills yeast via (high) alcohol content during fermentation
- No wine ever fermented completely "dry" (meaning without any residual sugar)
Wine’s sweetness

- At harvest [glucose] = [fructose]
- Grape over ripened [glucose] < [fructose] sweeter!
- Dessert wines
  - glucose fermented first
  - Fermentation can be stopped (either by temperature control or the addition of ethanol (fortification) wine high in fructose
Major anthocyanin in black grapes: Malvidin-3-glucoside (Oenin)

Members of the class of Flavonoids (plant secondary metabolites common in fruits & vegetables)
Does drinking red wine protect against heart disease?
Does drinking red wine protect against heart disease?

Evidence very weak! – Drugs work better!
Modern day production of beer
American Bud: made with 30% rice

Czech Republic (town of Budvar)

**German (Bavarian) Purity Law: 1516:**
Beer shall contain ONLY: Water, barely and hops
500th anniversary here!
Malting

- Barley seeds allowed to germinate as in nature
- **Steeping**
  - immersing barley in water at 12 to 15 °C 40 to 50 hours
  - grain imbibes water white root sheath breaks through the husk
- **Germination**
  - Root embryo - gibberellic acid - synthesis of \( \alpha \)-amylase - conversion of starch into sugars
- **Proteases & \( \beta \)-glucanases**
  - proteins & complex sugars into soluble amino acids and glucose
Malting

- **Kilning**
  - Green malt dried 5% moisture in lager & 2% ale malts
  - Drying arrests enzyme activity preserving 40-60% in an active state
  - Curing at higher temperatures → reaction between amino acids and sugars → melanoidins (Maillard Reaction) - colour and flavour to malt
  - Kilning high flow of dry air at 50 °C for lager malt and 65 °C for ale malt
  - Temperature rising to 70–75 °C
  - Curing stage: temperature to 75–90 °C for lager and 90-105 °C for ale
  - Finished malt screened to remove rootlets
Beer colour

- **Standard Reference Method**
- **Light absorption @ 430 nm (blue/purple) * 12.7**

<table>
<thead>
<tr>
<th>SRM</th>
<th>STYLE</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>PALE LAGER</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>MAIBOCK</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>WEISSBIER</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PALE ALE</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SAISON</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>ESB</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>DOUBLE IPA</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>DARK LAGER, AMBER ALE</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>BROWN ALE, DUNKELS</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>DOPPELBOCK, PORTER</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>STOUT</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>BALTIC PORTER</td>
<td></td>
</tr>
<tr>
<td>40+</td>
<td>IMPERIAL STOUT</td>
<td></td>
</tr>
</tbody>
</table>
barley → water → steeping → germination → kilning → milling

cooling → plate heat exchanger → whirlpool separator → brewing

mashing → grist → water → mash mixer → lautar tun → wort → kettle

fermentation → yeast → maturation → filtration → flash pasteurization

packaging
Mashing

- In the brewery malted grain milled to fine particles
- Mixed with hot water right mix of salts
- Fine ales need high levels of calcium
- Famous pilsners are low levels of calcium
- 3:1 water : malt 65°C
- Granules of starch more susceptible to enzymatic digestion
Mashing

- Amylase digestion of starch (about 1 hr)
- Some brewers add starch from other sources: corn or rice (adjuncts)
- Liquid portion of the mash becomes: **wort**
- Recovered, either by straining through residual spent grains or by filtering through plates
- **Wort:** about 10% sugar (mainly maltose and maltotriose), amino acids, salts, vitamins, carbohydrates, and small amounts of protein
Lautering

- “Lautering” Old German word for Purifying
- Mashout ↑ temperature to 77 °C
- Stops amylase activity
- Makes mash and wort more fluid
- Recirculation of wort from bottom adding to the top
- Lauter tuns typically with slotted bottoms to assist filtration process
- Mash functions as a filter to capture mash debris and proteins
- Step monitored via turbidimeter
Brewing

- Wort run to kettle ("copper")
- Boiled for 1 hour
  - Sterilisation of wort
  - Precipitation of proteins (can cause cloudiness)
  - Removing unpleasant grainy characters of barley
  - Some adjunct sugars & some hops can be added here
Hops

- Varieties hop (Humulus lupulus) selected and bred for the bitter and aromatic qualities
- Female flowers, or cones glands containing flavoring compounds
- Traditionally dried hop cones added
- Powdered compressed hops often used - more efficiently extracted
- Hop extracted made with liquid CO₂ extraction
- Member of the Cannabaceae family (😊)
Hopping

- Two components:
  - **Resins (α-acids)** 'isomerised' during boiling to **iso-α-acids**
    - bitterness
    - process inefficient, today extracted hop oils may be used
    - Hop is expensive!
  - **Oils** 'hoppy nose' of beer
    - Very volatile (hops added before boil, loss of aroma)
    - Added towards the end of boiling
- Traditional ale production some hops added at end of the process (complex mixture of oils distinctive character)
- Dry hopping

[Structural formulas for Myrcene and Humulene]
Plant world full of terpenes

- Geraniol (Geranium)
- Limonene (Lemons)
- Menthol (peppermint)
- Thymol (Thyme)
- Taxol (Pacific Yew)
- Retinol (carrots)
- Lycopene (tomatoes)
- Natural rubbers
- Camphor (camphor laurel)
- Borneol (Artemisia absinthium, etc.)
- Eucalyptol (Eucalyptus tree)
- Zingiberene (Ginger)
- Caryophyllene (Clove)
- Cholesterol (animals) C-30
International Bitterness Units

- American Lager: 5
- Blonde ale: 15–30
- Kölsch: 18–25
- Märzen/Oktoberfest: 18–25
- Ordinary English bitter: 20–35
- Porter: 20–40
- Brown ale: 15–25, North American styles 25–45
- Bohemian-style Pilsner: 30–45, range up to 100 (e.g., German Bitterpils)
- India Pale Ale: 40 or higher
- An Irish stout like Guinness: 25–60
The process of brewing beer involves several steps:

1. **Mash and Laughter:**
   - mash mixer
   - mash (contains water, grains, and yeast)
   - lauter tun
   - wort

2. **Fermentation:**
   - fermentation vessel
   - yeast
   - green beer
   - excess yeast

3. **Maturation:**
   - maturation tank

4. **Filtration:**
   - filtration unit
   - plate heat exchanger

5. **Pasteurization:**
   - flash pasteurization

6. **Packaging:**
   - keg

7. **Final Steps:**
   - filling and crowning
   - tunnel pasteurization
   - labeled bottles
   - cans
Fermentation

- Hopped wort cooled and pitched with yeast
- Many strains of brewing yeast (Saccharomyces cerevisiae)
Yeast strains

- Saccharomyces
- **Ale strains** - surface fermenting *S. cerevisiae*
  - few days at temperatures up to 20°C
- **Lager strains** - bottom fermenting *S. carlsbergensis*
  - lager fermentations as low as 6°C can take several weeks
- Both types need some oxygen
- **Traditional ale** brewing beer mixed with hops, some priming sugars and with isinglass finings (from the swim bladders of fish to settle out the solids in the cask (mainly collagen - gelatine)
- **Traditional lager** brewing the 'green beer' matured by several weeks of cold storage, prior to filtering
- Modern yeast systematics, brewing strains “*S. cerevisiae*”
Fermentation

- Pitching temperature of wort: **15 to 18 °C for ale & 7 to 12 °C for lager**
- During fermentation specific gravity ↓ – sugars → alcohol
- Yeast multiplies five- to eightfold and generates heat
- Temperature allowed to reaches 20 to 23 °C for ale & 12 to 17 °C for lager
- Cooling follows to 15 °C for ale & 4 °C (39 °F) for lager
- Near end of fermentation green beer most yeast removed
- Still containing about 500,000 yeast cells/ml
- Secondary fermentation
Secondary fermentation

- Slow secondary fermentation of residual or added sugar
- Generates CO$_2$-vented purging green beer of undesirable volatiles
- Yeast activity removes strong flavouring compounds such as diacetyl
  - At moderate conc. Buttery flavor - high level butterscotch flavor - undesired in beer
- Sealed vessels then increases carbonation giving the beer its “condition”
Conditioning - Carbonation

- Relatively short conditioning period after fermentation and before filtration
- At -1°C for a minimum of three days
- More proteins precipitate, beer less likely to turn cloudy
- Filtered beer adjusted to the required carbonation
- FYI J.J. Schweppe (1740–1821) developed manufacture of carbonated mineral water Schweppes Company in Geneva 1783
- 1767, Joseph Priestley discovered a method of infusing water with CO₂
Preservation

- Beer kept oxygen free (which ultimately spoils beer)
- Filtered through cellulose or diatomaceous earth to remove all yeast
- Packaged at 0 °C under pressure of carbon dioxide
- Most beers packaged in bottles or metal cans pasteurized 60 °C for 5 - 20 min
The final product at last!

- Several hundred of simple organic compounds characterized in beer
- Majority of these are produced by yeast
- Bitter substances of hops, ethanol, and CO$_2$ have the greatest effects
- Other compounds: **esters**: isonamyl acetate (banana), ethyl hexanoate (apple), and ethyl acetate (solvent)
- **Higher alcohols**: isonamyl alcohol and 2-phenyl ethanol
- **Acids**: octanoic, acetic, isovaleric, butyric, malic, and citric
- Dialkyl sulfides: dimethyl sulfide
- Diketones: diacetyl
- **Ethyl isovalerate (ester) & nonenal (aldehyde) contribute to stale and oxidized flavours**
A six pack of nutrition (2 l volume)

- 540 mg K  RDI: 3,500 mg
- 80 mg Ca  RDI: 1,000 mg
- 280 Mg  P RDI: 1,000 mg
- 10 g protein* RDI: 50g
- 70 g carbohydrate RDI: 300 g
- 820 Cal “RDI” 2,000 Cal

*responsible for head (foam)
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First evidence Greek alchemists working in Alexandria the 1st century AD

First dated and certain evidence of distillation of alcohol School of Salemo in the 12th century

Fractional distillation developed by Taddeo Alderotti in the 13th century

1500 German alchemist Hieronymus Braunschweig published: Liber de arte destillandi (The Book of the Art of Distillation)
Principle of distillation
Bp: H₂O 100° C ethanol 78° C
Distilled Spirits

- Fractional distillation used to increase ethanol concentration to any level up to 95% (“190 proof”)
- Most are kept at 40%
- Storing – aging
- All distillates of alcoholic fermentations are clear/colorless
- Storing in wooden barrels
  - Leaching of compounds from wood into products
  - Color, added flavour
Classic distillation equipment
Apple Jack - Freeze distillation

- Fermented apple juice (10% ethanol)
- Simply left in barrels outside to freeze
- Periodically removal of ice forming on surface
- Up to 30-40% ethanol
- Illegal as is hot distillation (moonshining)
  - Potential of methanol poisoning
  - Distillation may lead to concentration of toxic methanol
  - In mere homemade beer & wine - low level methanol contamination possible but not enriched as in distillation
Home distillation

- **Moonshine, white lightning, mountain dew, hooch, homebrew, and white whiskey** terms used to describe high-proof distilled spirits that are generally produced illicitly.

- During the Prohibition many intoxications via methanol and other chemicals from home made stills (lead, glycol from radiators used as condensers etc.)
Names like "life water" have continued to be the inspiration for the names of several types of beverages.

Gaelic whisky, French eaux-de-vie and possibly vodka.

- 1715, from Gaelic uisge beatha "whisky," literally "water of life."

Scandinavian akvavit spirit named from the Latin phrase aqua vitae.
Whiskey

- Grain spirit, whisky specific origins are unknown
- Production in Ireland and Scotland for centuries
- First confirmed written record of whisky: 1405 in Ireland
  - from malted barley mentioned in Scotland in 1494
Gin

- Distilled spirit flavored with juniper berries added during distillation
- Known as Jenever (the Dutch for "juniper")
- Originally used for medicinal purposes
Brandy

- Distillation of wine (Brantwein – German burned Wine)
- Originated in 15th century in wine growing regions of Eurasia
- Distillate aged in oak barrels to mature
Vodka

- The word "vodka" first recorded 1405 in Poland
- Distilled from any starch- or sugar-rich plant matter
- Most from sorghum, corn, rye or wheat
- From potatoes, molasses, soybeans, grapes, rice, sugar bees etc.
Tequila

- From blue agave plant area surrounding the city of Tequila
- After harvesting, slowly baked in ovens to break down complex fructans into simple fructose
- Shredded or mashed
- Some pulp fiber, added to fermentation tanks for a stronger agave flavor
- Agave juice fermented, distilled twice
- Clear "silver" tequila
- Aged in wooden barrels developing a mellower flavor and amber color
“Obstler”
German/Austrian Liquor from distilled fruits

Three categories of type/quality

- **Edelbrand** – 100% fruit fermented and distilled
  - Plums, cherries, etc.: 100 kg - 6-12 product
  - Grappa (grapes): 100 kg – 2-6 L product
- **Schnapps** – 33% fruit fermented – distilled - ethanol added
- **Geist(spirit)** – fruits macerated in ethanol and distilled
- **Spirit** – 5 kg fruit in 20 L ethanol - distilled
Problem of alcohol abuse

- Acute intoxication problems:
  - Euphoria, risk taking behavior, confusion, emesis, falls, trauma, etc.
  - Sedation, unconsciousness, respiratory arrest (death)
- Chronic problems:
  - Social, financial issues
  - Fatty liver disease, liver cirrhosis, acute pancreatitis
  - Alcoholic neuropathy, Wernicke and Korsakoff Encephalopathy
  - Erectile dysfunction: Shakespeare: "it provokes the desire, but it takes away the performance"
Pharmacokinetics of alcohol

- **Metabolism**
  - Hepatic alcohol dehydrogenase (ADH) oxidation to acetaldehyde oxidized by acetaldehyde dehydrogenase (ALDH) into acetic acid - Acetyl-CoA - Krebs cycle or lipogenesis (7kcal/g!) “beer belly”
    - ALDH2 gene mutation G→A (Glu→Lys substitution) in many Asian people (50% of Japanese origin!)
    - 500-fold decrease in effectiveness of acetaldehyde dehydrogenase activity - increased toxicity due to acetaldehyde accumulation
Disulfiram aversion therapy
“Abhorrierende Alkohol Entzugs Therapie” (😊)
ADH 1B Polymorphism

- Alcohol dehydrogenase single aa mutation: Arg → His
- Enzyme 40-100 fold increased oxidation of ethanol
- Accumulation of acetaldehyde – avoidance of alcohol
- Variant appeared in **Southern China** about 7-10 k years ago
- Positive selection since cultivation of rice and fermented alcoholic foods and drinks
- Strong east - west cline of frequency
Distribution of the ADH1B*47His allele and the sites of early rice relics
North America’s history of alcoholic beverages

- Prior to contact with colonists, alcohol use and production very limited to Southwestern US
- Weak beers, wine and other fermented beverages with low alcohol concentrations (8%-14%)
- Used only for ceremonial purposes
North America’s history of alcoholic beverages

- In Colonial America, Europeans introduced widespread consumption of alcohol.
- Mayflower brought more beer than water as it departed for the New World.
- Drinking wine and beer at that time was safer than water.
- Alcohol used as an analgesic, provided energy necessary for hard work, and generally enhanced the quality of life.
- Early traders caused a large demand for alcohol used to trade for animal skins and other materials.
- Traders giving free alcohol to the Native Americans during trading sessions.
Ethnic (Genetic) links to alcoholism?

- Like nearly all complex medical conditions, drug & alcohol addiction displays a “genetic predisposition”
  - Hypertension, obesity, depression, schizophrenia, etc.

- **2013 review of academic literature on the issue,**

  - “there is a "substantial genetic component in Native Americans" but that these factors are "similar in kind and in magnitude to the genetic influences contributing to the liability for these phenotypes in other ethnic groups." American Journal of Psychiatry 2013

- Genetic variants in dopamine receptors most likely one of the culprits