Fungi and Beverages

Fungal Beverages
- Will cover three categories of beverages.
  - Kombucha: A specific beverage and not a category.
  - Beer
  - Wine
- The last two are familiar, alcoholic beverages while the Kombucha is a tea.

Kombucha
- What is it?
  - A "composite organism" that has the appearance and consistency of "fish cake".

Kombucha
- What is it?
  - Composite organism is a symbiont relationship composed of several species of yeast and bacteria:
    - Acetobacter xylinum
    - Acetobacter xylinoides
    - Saccharomyces ludwigii
    - Schizosaccharomyces pombe
    - Saccharomyces cerevisiae

Kombucha
- Currently a very popular beverage and said to be a remedy for many ailments.
  - Arthritis
  - Kidney Stones
  - Early Stages of Cancer
  - High Cholesterol
  - Many, many more.

Kombucha
- Is known by a variety of other names:
  - The Tea Fungus
  - Fungus Japonicus
  - Manchurian Mushroom Tea
- First recorded use was in 221 B.C., during the Tsing Dynasty, in China. Thus, it is also an old beverage.
So, how do you make Kombucha tea?

To make approximately 40 fluid ounces of tea:
- Boil 40 fluid ounces of water in container, with lid.
- After boiling, remove lid and add one third to one half cup of white sugar.

Kombucha

To make approximately 40 fluid ounces of tea:
- Add two regular size tea bags or equivalent amount to water.

Kombucha

To make approximately 40 fluid ounces of tea:
- Allow the tea to steep for 10-15 minutes, remove tea bags and cool.
- Pour into a large glass container (volume = 64 fl. oz.).

Kombucha

To make approximately 40 fluid ounces of tea (Continued):
- Pour 8-12 fluid ounces of fermented tea or place a small piece of the Kombucha into the newly brewed tea.

Kombucha

To make approximately 40 fluid ounces of tea (Continued):
- Cover tea and allow to cool to room temperature.
- Cover glass container with unbleached filter paper held in place with a rubber band.
- After a while, the “kombucha” will grow as a layer on top of tea.
Alcoholic Beverages

In the broad sense, there are only two categories of alcoholic beverages:
- Beer
- Wine

Both are fermentation products, requiring the presence of yeast that produce ethanol as its final metabolic product.

The reaction can be generally written as:

\[ \text{Yeast} + \text{Glucose} \rightarrow \text{Ethanol} + \text{CO}_2 \]

Yeast involved is generally Saccharomyces carlsburgiensis or S. cerevisiae, or strains referable to these species, but other species are also used.
- All Yeast cells eventually die.
- Ethanol toxic to yeast between 14-18% 
- Same reaction also important in baking.

What is beer? What is wine?
- Beer is usually fermentation of malt, from digestion of germinated barley grains.
- Beer can also be fermentation of other grains as well, e.g., rice and corn.
- Wine is usually fermentation of grape juice, but may also be other fruit juices as well, e.g., elderberry, peach, etc.

What is perception of beer and wine?
- Beer making is very complex and precise. Reason for doing everything.
- Much scientific research has gone into beer making.
- Wine making is relatively simple and results difficult to control.
- Wine making can occur naturally without human intervention.

Beer
Useful to know process of making beer to appreciate evolution of beer making.

With some equipment, beer can readily be made at home. Here’s how:

- **Mashing**
  - Heat water with germinated barley in stainless steel pot with spigot at 130°F for 45 minutes.

- **Mashing (Continued)**
  - Rest: After 45 minutes, barley has consistency of mush.
  - Activate enzymes in barley to digest starch and protein to simple sugars and amino acids, respectively, at 155°F.
  - When conversion is complete, the water-barley is now referred to as the wort.
  - Heat wort to 168°F to deactivate the enzymes.
  - It is the simple sugars in the wort that is fermented to ethanol.

- **Sparging** - Separation of the barley from the liquid:
  - If the pot has a spigot, separation is a simple process.
  - False Bottom filters out barley and liquid is drained from kettle into another kettle.
Beer

- With some equipment, beer can readily be made at home. Here's how:
  - **Sparging** - Separation of the barley from the liquid:
    - Another method is to place the grain in a nylon or cotton straining bag.
  - Sparging is then carried out by pouring water directly into the bag and the sugars will filter out into the pot.

- After sparging, the dark brown liquid that has been separated is the malt.
- Boil wort for 90 minutes and hops is added at this time. The boiling will rid the wort of unwanted microorganisms.
  - However, if you are too lazy to make the malt, you can buy pre-made malt extract.

- Malt extract can be purchased in packaged containers, so that the mashing and sparging steps can be eliminated.

- Placing grain in nylon or cotton bag.
- Placing bag of grain in pot with heated water.
- Pour malt extract from bag and add water and hops.
Hops pellets added to malt gives beer its bitter taste. Hops serves as a preservative for the beer.

With some equipment, beer can readily be made at home. Here’s how:

- After boiling for 90 minutes, a wort chiller is placed into the wort.

Glass carboy, and plastic fermenters, with spigots, left.

- With some equipment, beer can readily be made at home. Here’s how:
  - After cooling, the wort is drained into the primary fermenter and the yeast added.

- Liquid is allowed to ferment in primary fermenter for several weeks, at 45°F.

- Liquid is then transferred to the secondary fermenter for several more weeks to complete fermentation.

- Drain beer into bottle and add a little sugar and cap. The sugar ferments in the bottle, creating CO₂ that carbonates the beer.

- Pour chilled wort into primary fermenter.

- Yeast added into wort in primary fermenter.

- Siphoning beer into bottle.

- A small amount of sugar is placed in the bottle before siphoning.

- Beer is siphoned in and refermented to carbonate the beer.

- Beer is stored at 60-70 °F for the first few days and then cooled at 50-60 °F for a week or two. You can now drink beer!
**Beer**
- Next to wine, beer is the oldest alcoholic beverage.
- Beer is made from fermentation of various types of grains.
- In western cultures, beer is usually made from barley.

**History of Beer**
- Earliest documented beer was brewed in Babylonia, 6000 years ago.
- Underbaked bread, made from germinated barley was cut into pieces and placed into jug of water.
- Yeast is already in bread and germinated barley provided malt, which is fermented by yeast.
- After yeast ferments malt, a crude beer made that was “drinkable”. Hops is not included here.

**History of Beer**
- Early beer was flat and not very palatable.
- Spoiled quickly.
- In 8th. Century, in Central Europe hops flower added:
  - Preserved beer.
  - Made it palatable.
  - Gave beer bitter taste.
- During Medieval times, beer made in homes by women.

**History of Beer**
- The Story of American Beer
  - Beer was brewed in New World, by Native Americans, using corn.
  - Puritan landing on Plymouth Rock was not by choice, in 1620, but because they ran out of beer.
  - Early English settlers did not begin breweries until 1629.
  - Dutch settlers began breweries immediately.
  - Many early settlers had their own breweries, e.g., Washington, Penn, etc.

**History of Beer**
- By 14th and 15th Century beer making moved from homes to pubs and monasteries.
- Brewing beer now made for mass consumption.
- Beer up to this time were ales.
- Lagers discovered by accident when stored in cool cellars for long periods.
- By mid 1800s, beer was very efficiently made, but role of yeast still unknown until Pasteur in 1857.

**History of Beer**
- If beer tasted so bad, why did it continue to be fermented and consumed?
  - In many cultures water was often contaminated with waste.
  - Thus, beer was the beverage for all ages, including children.
By 1840, German immigrants brought bottom fermenting lager to America. Frederick Pabst, Bernard Stroh, Joseph Schlitz, Adolph Coors, Henry Weinhard, Theodore Hamm are among some of German brewers.

Soon replaced ales.

In the United States, in 1876, there were 4,137 breweries.

After Prohibition, fewer than 700 breweries reopened.

Beer making was automated and bland.

After World War II, some beers were made lighter to appeal to women. Thus, origin of light beer.

Light beer, however, had little appeal and only sold moderately well, until 1972.

Philip Morris acquired Meister Brau and its lite label that year and renamed it Miller Lite.

Using a sophisticated advertising campaign, Miller moved from 7th. To 2nd place, in sales among U.S. brewers.

Their slogan: "all you want in a beer and less".

Business realized that promotion and not necessarily quality determined success of a product.

Two major categories of beer.

Lagers:
- Bottom fermenting yeast.
- High in carbonation.
- Fermented at low temperature.
- Clearer beer.
- Alcohol content low.

Ales:
- Top fermenting yeast.
- Lower carbonation than lagers.
- Fermented at higher temperatures.
- Murky beer.
- Alcohol content higher than lagers.
Categories of Beer

- Many varieties under categories:
  - Ale:
    - Stout
    - Porter
    - Brown ale
    - Bitter
    - Mild

Beers in Different Cultures

- Why is the alcohol content of beer (and wine) no more than 18%?
  - Alcohol is toxic to yeast, at 18%.
- Beers of other cultures:
  - **Corn Beer**: Made by Native American Indian. Corn is first chewed. Amylase of saliva digest starch to simple sugars, which is fermented to alcohol.
  - **Saki (rice wine)**: Actually a beer. Rice is first digested by *Aspergillus* into simple sugars to be fermented to alcohol.

Beers in Different Cultures

- Beers of other cultures (continued):
  - **Kvas**: Russian beer. Made by adding stale black bread, to malt, flour, sugar and water and allowing to ferment. Alcohol content is 1-2%.

Beer and Religion

- In many cultures, beer was associated with women:
  - In Babylonia, beer was attributed to Goddesses Siris and Ninkasi.
  - In Rome, beer was attributed to Ceres, the Goddess of the corn and their name for beer was *cerevisia*.
  - Women were also made priestesses of these goddesses, and brewers in many culture.

- In many cultures, beer was also believed to be a heavenly gift:
  - Norse believed beer was the drink of Vahalla, the heaven for warriors who died in battle.
  - In China, beer was a gift from heaven.

Wine
Wine

• Wine is the world's oldest beverage.
• Wine is a beverage that is fermented from grapes and other fruits. However, some "purist" = wine snobs restrict wine to fermentation of grapes.
• Unlike beer, wine not associated with women.

Wine

• Greece, Dionysus gave wine to man
• Roman, Bacchus was the god of wine.
• In Hebrew folklore, Adam was said to have planted the first grapevine.
• Unlike beer, the process of wine making has changed little since its discovery.

Making Wine

• Wine making
  ■ Separate grapes from stem
  ■ Crush grapes.
  ■ Place crushed grapes (=must) into fermentation tank with sulfur dioxide and add yeast.
  ■ Ferment:
    ○ After 8-10 days, remove grape skin.
    ○ After 20-30 days, dead yeast and other particulate matter.

Making Wine

• Wine making
  ■ Racking: Separating the wine off the sediment (=lees) by siphoning it into another container.
  ■ Machinery has in some cases replaced manual process, but method of making wine has remained essentially the same.

Wine

• For example, crushing grape by stomping on them with your feet was a method used by early wine makers.
• In some parts of the world, this has been replaced by a wine press.

Grapes are loaded in press and crushed by press. Grape juice is squeezed through large pores on side of press.

Wine

• Regardless of what mechanical device has been added. Wine made essentially the same as it was thousands of years ago.
• A much simpler process than beer making, BUT quality wine takes a lot more effort.
  ■ Although yeast occurs naturally on grapes, adding an inoculum of a desirable yeast gives you some measure of control of wine quality.
Wine

- **Red wine**: Skin of grape and stem placed in fermentation tank with juice.
- **White wine**: Skin of grapes and stems separated from juice in fermentation tank.
- **"Racking"** is another source of uncertainty. Refers to placing wine in wooden casks. Since wood cannot be clean, provides a distinct, unique flavor to wine.
- **Aging** wine for different periods of time also changes quality of wine.

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Wine

- **Sweet Wine**: If fermentation is ceased before all sugar is utilized by yeast.
- **Dry Wine**: If all sugar is metabolized during fermentation.
- **Alcohol content**: Grape wine has between 14-18% alcohol content, but other fruit wine has lower sugar content and yields only 5-7% alcohol content.
- **Champaign and other sparkling wines**: Like beer, carbonation is obtained by adding sugar and then capping bottle.

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*Botrytis: “Noble Rot”*