

Lab 10 Fermentation

Alcoholic beverages occur throughout the world in many different forms and tastes. The types of beverages produced in any particular region or culture are usually based on the crops grown locally. For example, the colder regions of Europe, Scandinavia, Poland, and Russia will produce beers and lagers from grains. While in the warmer climates of Spain, Greece, Italy, and France, grapes are grown which are used to produce wines.

When starting with sugary products (fruit juices, plant sap, or honey), the only preprocessing required is a grinding. When starting with starchy materials (cereal crops such as grains or roots), the starch needs to first be hydrolysed to simple sugars (monosaccharides). When allowed (or controlled) to ferment by microorganisms, the end-product is a liquid containing anything from a few percent up to 16% alcohol. With an acidic pH, depleted in nutrients for most contaminating microorganisms, and other anti-septics (CO₂) the alcoholic beverages become a 'safe' drink. The alcohol beverages can be drunk fresh, but often a period of storage (aging) is practiced. The aging can improve organoleptic properties making the product unique and more desirable. Further concentration of the alcohol (distillation) will increase the alcohol concentration and produce spirits such as whisky, brandy, vodka, gin, and rum. Cordials and liqueurs are sweetened alcohol distillates derived from fruits, flowers, leaves, etc.

The earliest record of brewing was inscribed in cuneiform characters on clay tablets in Sumeria (present day Iraq) from the 3rd millennium BC. Beer can be basically defined as a drink obtained by the fermentation of an aqueous extract of germinated cereal with the addition of hops.

Beer making takes advantage of yeast metabolism, starting with a mixture of malted grain (the sugar source) and hops (for flavor and aroma) in water. Commercial beer is most often fermented "single culture" style, with one of two kinds of yeast: *Saccharomyces cerevisiae*, favored in ales or *Saccharomyces pastorianus*, favored in lagers. However it is possible to brew alcoholic beverages with wild microbes. In fact, some (few) breweries and vineyards run "open fermentations" that encourage the growth of wild yeasts to create beverages with novel flavors. Volatile aroma compounds produced during spontaneous

fermentation can impart interesting fruity and floral flavors to the product, with the presence of multiple yeast, other fungi, and bacterial species contributing to a unique final flavor profile.

There are five major steps in the brewing of beer from grains:

Malting Dried barley (or other grain) is soaked or steeped in water and then spread out on the malt house floor or in revolving drums. Here the seeds germinate and produce starch-degrading (amylase) and protein-degrading (protease) enzymes. The germinated seeds are then killed by kilning (slow heating to 80°C) but the enzymes are not denatured thus still active.

Mashing In this stage the malt is mixed with hot water (55-65°C), where the starches and proteins are broken down to produce dextrans, maltose, and other sugars along with protein breakdown products, minerals, and other growth factors. This produces the *wort*. Hops are now added to give characteristic flavor and some antiseptic properties.

Fermentation The wort is transferred to a bioreactor system and inoculated with pure strains of yeast. In Britain, a top-fermenting yeast *S. cerevisiae* is used and incubated at 20-28°C to produce beers, stouts, or ales. In continental Europe, a bottom-fermenting yeast *S. uvarum* ferments the wort at a lower temperature (10-15°C) to produce lager.

Maturation and finishing Beer can be matured in casks at 0°C for several weeks to improve flavor, settle out the yeast and remove haze. Bottled or canned beers are usually either pasteurized (60°C for 20 min) or 'cold' filtered. Many home brewers will practice a two-stage fermentation. When the fermentation slows down, but before complete, the beer is transferred to a new container to finish the 'secondary' fermentation then it is bottled.

Procedure

Wort Preparation

- Pour 2.5 gallons of clean water into your brew pot and begin to heat.
- Pour crushed grains into the grain bag (sock) and tie a loose know at the top of the bag. (The grains should not be compacted inside the bag.)
- When the water temperature is 150° - 165°F place the bag into the brew pot.
- Steep grains for about 20 min.
- Remove the grain bag and without squeezing, allow the liquid to drain back into your brew pot.

Mashing

- Bring the wort to a gentle boil
- Add one can of the Liquid Malt Extract (warm in hot water first)
- Continually stir
- Add the hops (1 oz) to the wort
- Boil the wort for 45 min.
- Add the other can of Liquid Malt Extract
- Continue to boil for 15 more minutes
- Cool the Pot down to 70°F by placing in a sink filled with ice water
- Add water to bring your wort up to about 5 gallons
- Thoroughly stir the water into the wort (be careful that the extract does not accumulate and caramelize on the bottom of the brew pot)
- Measure the Original Gravity and record
- Transfer \cong 700 ml of wort into a Mason Bell jar
- Add \cong 50 ml of your liquid yeast culture to the Mason Bell jar
- Seal the jar with lid and airlock (be sure to put some water in the airlock to prevent air from entering the wort)

Fermentation

- Let the jars ferment for a couple of weeks in the dark at room temperature