Lab Protocols

Part A

In lab this week, you will prepare the wort and add the yeast to begin the fermentation process.

1. Boil 250 ml water in a 600mL beaker.
2. Add 71g malt extract and continue boiling for 45 minutes.
3. Add 1.5g hops and continue boiling for 15 minutes.
4. If using the Nottingham brand yeast, add 4ml sterile water to the glass vial roughly 15 minutes before addition to the wort.
5. Add water up to 500ml and cool in an ice water bath to room temperature.
6. Once extract is cooled, fill the bottle to right around the neck (roughly 200ml). Tighten lid (do not over tighten or you may break the lid) and invert the bottle roughly 20 times to aerate.
7. Open the bottle and sprinkle in the dry yeast.
8. Add lid, close almost completely (leave lid slightly open for CO₂ release).
9. Let sit in the designated container at room temperature.

To determine the alcohol and calorie content at the end of the fermentation process, you need to measure the specific gravity of the starting wort. The specific gravity is the density of the solution relative to the density of water and can be measured using a hydrometer. A hydrometer consists of a long glass bulb and stem (image below). The bulb is weighted and the stem has a scale to measure the specific gravity.

Because specific gravity is determined relative to water, if you float the hydrometer in water, the specific gravity will read as 1.000. If in the wort the hydrometer gives a specific gravity of 1.060, it means the solution is 6% heavier than water. As the sugar in the wort is fermented to alcohol, this will alter the density and thus the reading on the hydrometer.

10. Add much of the remaining wort to the hydrometer container (to the indicated line).
11. Add the hydrometer gently until it floats freely (see image to the right).
12. Spin the hydrometer (like a top) to eliminate air bubbles attached to the side.
13. Read the hydrometer when it stops moving and is not in contact with the sides of the container, as illustrated to the right. The upper measurement is your initial specific gravity.

   Initial specific gravity  
   

Finally, you want to measure the pH of your wort, as it can have an effect on yeast growth and metabolism, and thus the beer you produce.

14. Obtain a pH strip. Dip the strip into the hydrometer container.

15. Compare the color of the strip to the key on the pH paper container. Initial pH  

   

Part B

The fermentation process generally lasts from one to a few weeks. Due to the small volume that we are brewing (typically this occurs in 5 gallon containers for home brewers), the fermentation process can be completed in a shorter time frame. At this point, much of the sugar has been converted to ethanol and other by-products, which will impact the taste of the beer. Before serving though, the beer is carbonated by the addition of a small amount of sugar. This sugar will be converted to CO$_2$ (because the lid will be completely tightened) and a small amount of ethanol over the next week. In addition, by transferring the beer into a new container, you will be removing a number of the insoluble elements prior to drinking.

1. To a new glass bottle, add 5ml of a 33% sucrose solution.

2. Pour the contents of your beer into the new bottle by pouring down the side of the new bottle. This ensures minimal aeration of the solution and immediate fermentation by the yeast. Any yeast at the bottom of the bottle does not need to be transferred.

3. Tighten the cap (again do not over tighten or you will break the lid) and place in the designated container at room temperature.
Part C

Lab

Today you will assess your beer by a number of means including taste, alcohol content, pH, color (by Standard Reference Method – SRM) and calorie content.

Alcohol and Calorie content

1. As previously, pour the beer from the bottle into the hydrometer container (to the indicated line).

2. Add the hydrometer gently until it floats freely.

3. Spin the hydrometer (like a top) to eliminate air bubbles attached to the side.

4. Read the hydrometer when it stops moving and is not in contact with the sides of the container. The upper measurement is your final specific gravity.

   Final specific gravity

5. Once complete, pour the contents of the hydrometer container into a sterile glass bottle for tasting.

Using the chart to the right, calculate the alcohol content of your beer based on your initial and final specific gravities. If your initial specific gravity was 1.080, the potential alcohol content would be 10.5%. If your final specific gravity was 1.010, the potential alcohol content would be 1.3%. The alcohol content would then be 10.5% minus 1.3% or 9.2%.

Initial potential alcohol content

Final potential alcohol content

Alcohol content of beer

The following formula (American Society of Brewing Chemists, 1992, *Methods of Analysis of the ASBC*) allows you to determine your calorie count per 12 ounces of your beer from the initial and final gravity.
Calorie count = [(6.9 cal/g x ABW) + 4.0 cal/g x (RE – 0.1)] x Final Specific Gravity (g/ml) x 3.55 ml/ounce

ABW = alcohol by weight (g ethanol/100 g beer)

RE = real extract (in degrees Plato °P). This includes the impact that ethanol production has on the specific gravity since ethanol has a density of 0.79 g/ml. Our previous calculation does not take this into consideration when determining alcohol content.

The first bracket gives you the calories contributed by ethanol (6.9 calories/g). The second bracket gives you the calories contributed by carbohydrates (4.0 calories/g). These values give you the total calories per 100 g beer. We convert this to calories per 100ml beer with the final specific gravity (g beer/ml beer) and finally converted to calories per 12 ounces with the 3.55 factor (100ml/12 ounces = 3.55 ml/ounce).

As both RE and ABW are difficult to ascertain, we will utilize the following approximations:

Eqn 2 RE = (0.1808 x Initial Specific Gravity °P) + (0.8192 x Final Specific Gravity °P)

Eqn 3 ABW = \frac{(0.010665 \times Initial \ SG \ °P)}{2.0665} - RE
For the ABW and RE calculations, it is necessary to convert the specific gravity values from g/ml to °P as this is the scale commonly utilized by brewers.

Eqn 4 \[ °P = (-463.37) + (668.72 \times SG) - (205.35 \times SG^2) \]

Imagine our initial specific gravity is 1.060 and the final specific gravity is 1.010.

First, convert these to °P using equation 4. Initial SG is 14.8°P and Final SG is 2.6°P.

Now use these values to calculate the RE and ABW (equations 2 and 3). You should obtain values of 4.8°P for RE and 5.2 g ethanol/100g beer.

Finally, calculate calorie count with these values (equation 1). Remember to keep the Final SG in this case in terms of g/ml. From this, you should calculate 196 calories per 12 ounce beer.

Now do the same with your own beer. Be sure to include units for each

| Initial SG °P | Final SG°P | RE °P | ABW | Calorie content |
|---------------|------------|-------|-----|----------------|

As a frame of reference, these are percentage alcohol and calorie values from some commercial beers:

| Beer                        | Percent Alcohol | Calories per 12 ounces |
|-----------------------------|-----------------|------------------------|
| Coors Light                 | 4.2             | 102                    |
| Corona Extra                | 4.6             | 148                    |
| Sierra Nevada Pale Ale      | 5.7             | 171                    |
| Sam Adams Boston Lager      | 4.8             | 160                    |
| Guinness Extra Stout        | 7.5             | 176                    |
1. Obtain a strip of pH paper.
2. Dip the paper into the beer.
3. Compare the strip color with the key on the pH box.

**Final pH**

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**Standard Reference Method (SRM) – Beer color**

1. Set the spectrophotometer to 430nm.
2. Add 1ml distilled water to a cuvette and blank the spec.
3. Add 1ml of your beer from the 25ml tube into the cuvette. Make sure to avoid any debris in the beer if present.
4. Hit the Read Sample button on the spectrophotometer.

**OD value**

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5. SRM is calculated by multiplying the OD\textsubscript{430} value by 12.7.

**SRM**

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To the right is a chart that illustrates the SRM and the corresponding color and style of beer (Eppendorf, Short Protocol No 7, July 2014).
Taste

All students 21 and over who would like to taste the beer will be allowed to. To do so, you will need to show identification with your photo and birth date to your TA. If you are 21 years or older, your instructor will then tie a ribbon around your wrist that must be kept during this entire lab period. You will also want to bring a cup of some sort to sip from.

The tasting is through the sip and spit method only. **There is to be no drinking of the beer.** It is best to not do this immediately at the beginning of the class to allow it to warm slightly. Very cold beer can mask some of the flavors.

1. Pour some of the beer into your cup.
2. Swirl the beer gently to pull out any aromas.
3. Smell the beer and take note of any noticeable scents. All students (regardless of age) can participate in this step.
4. Take a sip (**but do not swallow**), noting the consistency of the liquid, and any sweet, salty, acidic or bitter flavors.
5. Spit the beer into the sink.
6. Feel free to repeat a few times if desired.
DIYeast: Capturing Yeast

Capturing Yeast
Method #1: Wild Yeast Starter Jars

Create A Yeast Bath: Day One

1. Create a starter as you typically would for a homebrew batch of beer. For ease, use a 1/10 ratio of filtered water to malt extract (1.040 gravity). A weaker gravity will work just as well, use whatever you’re comfortable with. Create enough volume to fill up three or more jars half way (the more jars, the more likelihood of success).

2. Boil the liquid mixture with a small amount of hops for at least 20 mins. You can boil longer with more hops, but you’re just trying to sterilize the wort and pick up the antibacterial properties from the hops (Hops will primarily slow the growth of Lactobacillus.).

3. Once the liquid has cooled enough so that you won’t burn yourself if it spills, pour into sanitized mason jars. If you have a pH meter, now’s a good time to check the pH level; this will be helpful later when verifying if the right kind of fermentation occurred.
Bring 'em Back Home: Day Two

1. The next day, bring in any cooled jars left outside.
2. Remove the cheese cloth. You can leave the liquid in the jars, but if you do so make sure to cover the surface of the liquid to prevent contact with the air. This will help reduce the chances of surface mold growth. You’ll probably still get mold, but this’ll probably make you feel more pro-active. Another option is to pour the liquid into a growler or jug and cover with an air lock.
3. Leave in a dark, room temperature place.

Monitor For Signs of Fermentation: Day One + Two Weeks

There’s A Fungus Among Us

1. Within a few days there should be the tell-tale signs of fermentation, with a small amount of CO2 bubbles coming to the surface of your jar or minor air lock activity. Don’t worry if you don’t see signs of activity quickly. Compared to a normal starter that has had billions of yeast cells accustomed to barley sugar, a comparatively small amount of wild microbes have started colonizing your wild yeast starters.
2. ABSOLUTELY DO NOT TASTE until fully fermented out. Never taste any starter unless active fermentation has been verified for a sustained period of days.
3. Roughly two weeks (assuming each jar or growler has fermented out) it should be safe to taste. Make sure you scrape off any mold, unless that’s your thing (please just do it). The presence of mold doesn’t mean your wild yeast starter is ruined, it’s just a common part of the process. If you have a pH meter, compare the current pH to the reading you took before putting the jars outside. If the pH dropped significantly you’re probably safe. *If the pH increased for any of your jars, discard the liquid and move on.*

4. Use the smell test first. If it smells good (honey, citrus, etc), you’ve probably got something fun. Creamed corn is a common aroma from certain wild yeast, and these strains often do not flocculate well. If it smells good, use a sanitized pipette to pull a sample from underneath the surface. If it tastes remotely palatable, and has dropped clear…you likely have something **INCREDIBLY AWESOME.**

5. You’re now ready to create agar plates so you can isolate your own yeast. You know you want to.

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**Uninvited Fungus**

**EDITOR’S NOTE:** Always practice common sense. If it smells horrible, and looks horrible just don’t taste it. Try one of your other test jars. If you look at the picture above, the jar in the middle has a reddish/orangeish hue. A good sign that this jar should not be tasted. Good thing, because it eventually grew a MUSHROOM. That is all.
Method #2: Collecting Samples from Fruit & Vegetables

The microbes that live on fruits are primarily yeasts and fungi, whereas vegetables typically have lactic-acid-producing “sour” bacteria like Lactobacillus and Pediococcus. Keep this in mind when attempting to capture microbes from your local vegetation.

This Fruit Could Make You Loopy

Collecting wild yeast samples from fruit and vegetables is significantly easier than creating a Wild Yeast Starter (Method #1). Look for fruits and vegetables that appear to have a fine dusting on their skin or have started to rot (but don’t use anything that’s already fallen on the ground!). Even if dust isn’t present, you’re pretty much guaranteed to collect some amount of wild yeast.

1. As pictured to the right, it’s as simple as putting several fruit in sanitized centrifuge tubes, or glass jam/mason jars.
2. Pour low gravity (1.010-1.020) unhopped starter wort into the container with fruit. Only pour enough to cover the fruit or vegetables, but leave enough room for fermentation activity at the top. It’s not necessary for fruit to be crushed for fermentation to take place.
3. Wrap the seal between the lid and container with plastic wrap. Shake vigorously to aerate, and then leave in a dark, room temperature place.
4. Within a few days you should see signs of fermentation taking place. A yeast sediment will eventually form at the bottom.
So you’ve acquired some wild yeast and bugs from your backyard, fruit or barrel room. Maybe you’ve brewed with it and now have your own unique house culture. That’s awesome. You are a rock star.

But what do you really have? Is it wild yeast? Is it something funky, like Brett? Is it all of the above? What’s causing that sour fermentation, if at all? Mixed wild cultures are wonderful, and are as close as we’ll ever get to replicating ancient fermentation practices.

It’s not until you isolate individual pure strains that you’ll be able to get some kind of control over your microbes and be able to accurately reproduce similar batches. You’ll also learn what makes each strain tick, and what beer styles and ingredients they meld with best. Plus, once you isolate your own yeast strain, everyone will think you’re a whiz kid.

Agar is a gelatinous-like substance made from seaweed that when boiled with wort causes the mixture to set quickly into a solid, jelly-like medium, that individual microbe colonies can grow and feed on.
Creating a Simple Agar Plate:

- **300 mL of 1.040 (or lower) wort** (If using extract, boil water and DME mixture before adding other recipe ingredients)
- **5 grams of agar agar powder** (Add more if liquid fails to set)
- **5 mg of yeast nutrient**

1. Heat wort in a small pot up to near boiling and stir in agar.
2. Bring to a boil. Agar and wort won’t successfully bind if not brought up to a boil.
3. Sterilize the media in an autoclave on a liquid cycle for at least 15 minutes.
4. Pour a small layer of liquid on to the petri dish and move to your draft-free storage area. It’s important to let the liquid cool before covering with petri dish lid to prevent condensation from forming on the lid, which helps reduce the likelihood of mold growth.
5. Wrap the edges of the plate lid with stretchable plastic wrap or stretched 1/2 inch strips of Parafilm. This will help reduce agar plate contaminants and prevent the plate from drying out if you don’t use the plate shortly afterward.
6. When you’re done, store upside down in a resealable plastic bag and refrigerate.

Now that you’ve made your own agar plate, the last thing to do is to isolate your yeast.
Part F - DIYeast: Isolating Yeast

Isolating Yeast

Isolating yeast at this point is as simple as taking a very small amount of your culture and rubbing (streaking) it on to an agar plate. Because of the stable, non-liquid agar medium, once streaked, single colonies of microbes are essentially stranded by themselves.

After a few days or weeks (depending on incubation temperature and microbe population), they’ll multiply and grow large enough to be seen with the naked eye. At that point, it’s a matter of selecting the colonies you like and growing them up to larger amounts.

It’s impossible to stress enough how important cleanliness and sanitation are at this point in the process. If you truly want a pure strain, you need to ensure you’re not contaminating what you’re trying to isolate with other cultures.
**Streaking Plates:**

If you already have a Saccharomyces culture from a yeast lab handy, it’s ideal to practice streaking on a plate with a pure culture. This will help you get an idea of what colonies of brewer’s yeast usually look like. That will be useful when deciding which colonies you want to select when isolating.

1. Turn on your burner. Try to do as much of your work as possible close to this source of heat. It will help keep your work area decontaminated by creating an updraft under which you’ll do your streaking.

2. Remove the plastic wrapping from your agar plate. If you kept it refrigerated upside down, you’ll have some condensation that’s formed on the lid. Keep the dish upside down, remove the lid from the bottom and just quickly tip the lid over and let the water fall out. Put your upside down plate back on the lid.

3. Sterilize your loop (or paper clip) by placing under burner flame until red hot. Make sure you let it cool down for roughly 30 seconds before going to the next step (or by dipping it into some sanitizer), otherwise you’ll caramelize your microbe friends.

4. If your culture was acquired from a Wild Yeast Starter Jar, use a sanitized pipette to pull a sample from the bottom. If your culture is in a centrifuge tube, shake it up to distribute the yeast. Dip the loop into your liquid culture. You only need a very small amount, just enough to get the tip wet (just the tip). While it seems like a small amount, once plated and incubated you’ll have more than enough microbes to work with.

5. Remove the lid from the agar plate. Gently streak a few lines across the outside edge of the agar plate at an angle. There are many techniques for streaking, but I find creating a diamond shape works best for me.

6. Sterilize loop under the flame again. This is important because you’ve just put a huge amount of microbes on your plate in that one streak. After this point, you just want to thin out what you already have streaked on the plate. Otherwise you’ll have big globs of microbes everywhere, making it nearly impossible to isolate a colony.

7. Sterilize loop again. Go back to previous streaks and drag across them, creating lines in another direction. Continue repeating this process until you’ve streaked in four different directions on the outside of the plate. If there’s room, do one last set of streaks but this time streaking to the inside of the plate. Be especially careful that you only streak into previously unused space.
8. Flip plate over (agar side up) and place on top of lid. Move to warm, dark area to incubate. This could take only a few days or as long as a couple of weeks depending on how many cells you initially started with and incubation temperature.

9. If you used a pure Saccharomyces strain to practice, you should now see a large amount of round, white to off-white colonies of yeast. The first lines that you streaked should be the heaviest in concentration, and the following lines should get progressively less dense until you see single colonies by themselves at the interior of the plate.

10. Wild Yeast culture: Repeat steps 1 through 8. Once the plate has been incubated, you’ll see far more diverse types of colonies growing and possibly mold. Since you want to isolate a wild yeast strain from among several different types of microbes, it’s important you start the next process soon after you see a healthy amount of colonies form on the plate. If you wait too long, some colonies will grow faster than others and will eventually take them over, making it impossible to isolate either of them.

Selecting Colonies:

To increase the odds of isolating a pure culture, select just one colony to propagate. It’s ideal to select at least a few colonies to increase the genetic diversity of your culture, but without the benefit of a microscope, you won’t know if the colonies you’ve selected are the same. If you want to go this route, you will need to streak another plate using the culture you’ve grown to guarantee a pure strain.

1. Snag a new plate from the fridge and remove ParaFilm.
2. Grab your previously streaked plate. It should be a cornucopia of microbes (including mold). This is ok!
3. Select Colonies By Color/Size/Shape

Sterilize the loop under your burner. Let it cool for roughly 30 seconds.

4. Look for medium-sized, white to off-white, nicely round, individual colonies.
5. Pick up a small amount from one colony. Restreak a new plate using steps #1-8 from Streaking A Plate section; incubate.
6. Continue picking a single colony, restreaking and incubating plates until you have one where all the colonies growing have the same shape, size and color.
7. Once you’re satisfied that you have a uniform plate of organisms, select one colony from the plate using a sterile loop.
8. Dunk into a vial with 10ml of boiled or sterilized low-gravity wort (1.010-1.020). Seal, and shake vigorously.
9. You now have the world’s smallest yeast starter. This starter can be “pitched” into 500 ml bottles of wort. Larger quantities can be grown and scaled up accordingly.
Protocol F: Colony PCR

This protocol can be used to isolate genomic DNA and amplify it to identify wild yeast samples. BLAST results from this protocol can identify the sample down to species and sometimes strain levels.

1. Lightly shake bottle of wort and yeast
2. Pipette 50 ul into a microcentrifuge tube
3. Spin down at 13000 rpm for 1 min. to pellet yeast cells
4. Use a toothpick to transfer cells into a PCR tube
5. Add other reagents and place in thermal cycler

Sample reagent mix:
1 ul forward primer
1 ul reverse primer
13 ul water
15 ul GoTaq Master Mix

Thermal cycler conditions:
Initial denaturation 95°C 15 min 1 cycle
Denaturation 95°C 30 s 40 cycles
Annealing 58°C 30 s
Extension 72°C 1 min
Final extension 72°C 5 min 1 cycle
## Assessment Rubrics

### 2019 First Brewing Poster

| Criteria                                                                 | Ratings                  | Pts  |
|-------------------------------------------------------------------------|--------------------------|------|
| Submitted on time                                                       | 1.0 pts                  | 1.0  pts |
| Full Marks                                                              | 0.0 pts                  |      |
| No Marks                                                                |                          |      |
| Abstract- appropriate length and contains all need information           | 2.0 pts                  | 2.0  pts |
| Full Marks                                                              | 0.0 pts                  |      |
| No Marks                                                                |                          |      |
| Intro/Methods- clear enough to understand project; emphasized why the recipe was chosen | 3.0 pts                  | 3.0  pts |
| Full Marks                                                              | 0.0 pts                  |      |
| No Marks                                                                | 0.0 pts                  |      |
| Results- 2/3 figures and/or charts with legends and body text; able to explain work and emphasize important points. What were your starting and ending measurements? Was your fermentation successful? | 6.0 pts                  | 6.0  pts |
| Full Marks                                                              | 0.0 pts                  |      |
| No Marks                                                                | 0.0 pts                  |      |
| Conclusions- Were you able to demonstrate a scientific reason why your beer tasted like it did? Are there any close comparisons to commercial beers? Imported images are fine here. | 3.0 pts                  | 3.0  pts |
| Full Marks                                                              | 0.0 pts                  |      |
| No Marks                                                                | 0.0 pts                  |      |

Total Points: 15.0
### Wild Yeast Poster

| Criteria                                      | Ratings | Pts |
|-----------------------------------------------|---------|-----|
| On time?                                      | 1.0 pts | 1.0 pts |
| Full Marks                                    | 0.0 pts |     |
| No Marks                                      |         |     |
| Abstract- appropriate length and contains all need information | 2.0 pts | 2.0 pts |
| Full Marks                                    | 0.0 pts |     |
| No Marks                                      |         |     |
| Intro/Methods- clear enough to understand project; emphasized unique elements of your beer | 3.0 pts | 3.0 pts |
| Full Marks                                    | 0.0 pts |     |
| No Marks                                      |         |     |
| Outcome Results- 2/3 figures with legends and body text; able to explain work and emphasize important points. Possible figures: location of wild yeast, picture of slant or plate, chart of recipe, analysis of brew (ABV/calories/color) DNA sequence if available | 6.0 pts | 6.0 pts |
| Full Marks                                    | 0.0 pts |     |
| No Marks                                      |         |     |
| Conclusion- What does your beer taste like? What's interesting and unique about it? | 3.0 pts | 3.0 pts |
| Full Marks                                    | 0.0 pts |     |
| No Marks                                      |         |     |

Total Points: 15.0
| Criteria                                                                 | Ratings              | Pts   |
|-------------------------------------------------------------------------|----------------------|-------|
| On time                                                                 | 10.0 pts Full Marks  | 10.0  |
|                                                                         | 0.0 pts No Marks     |       |
| Physical Format- contains all required elements. title, abstract, methods, results, conclusions | 15.0 pts Full Marks  | 15.0  |
|                                                                         | 0.0 pts No Marks     |       |
| Abstract- appropriate length and contains all need information           | 15.0 pts Full Marks  | 15.0  |
|                                                                         | 0.0 pts No Marks     |       |
| Outcome Intro/Methods- clear enough to understand project; emphasized unique elements of your beer | 20.0 pts Full Marks  | 20.0  |
|                                                                         | 0.0 pts No Marks     |       |
| Results- 2/3 figures with legends and body text; able to explain work and emphasize important points. Possible figures: location of wild yeast, picture of slant or plate, chart of recipe, analysis of brew (ABV/calories/color) DNA sequence if available | 30.0 pts Full Marks  | 30.0  |
|                                                                         | 0.0 pts No Marks     |       |
| Conclusions- What does your beer taste like? Why should it be the winner?| 10.0 pts Full Marks  | 10.0  |
|                                                                         | 0.0 pts No Marks     |       |
| **Total Points:** 100.0                                                  |                      |       |
Examples of student posters

Brewing poster

Lager than Life: A First Attempt at Brewing
La Salle Biology Department

Abstract

In this experiment, we attempted to brew a light beer from basic ingredients available to us. Different combinations and volumes of malt, hops, yeast, and water can change the chemical properties of a home brew. We measured the specific gravity, color, and alcohol content. Our resulting beer was one relatively low in calories and alcohol content.

Methods

- 7.5g of Muntons⅛ grain malt extract was added to boiling water and simmered for 45 minutes.
- 1.5g of Fuggles hops from Yakima Chief were added to the wort and boiled for an additional 10 minutes.
- Water was added to reach the 500 ml mark and the brew was cooled on ice to room temperature.
- Initial specific gravity and pH were measured before adding SafAleus yeast.
- Brew was placed in a bottle, capped, and inverted to aerate.
- Lid was loosened slightly before allowing the mixture to sit for a week at room temperature.
- To condition the beer, 3 ml of sucrose solution was added to the mixture.
- Alcohol and color content were calculated using a formula from the American Society of Brewing Chemists.

Results

Figure 4. (above) Example of a hydrometer, used to calculate specific gravity. The final specific gravity of our beer was 1.003.

Study Implications

- Our beer had a very low alcohol content, while being among the highest in calories (Fig. 1). This is due to leftover sugars that were not digested. This can be changed by adding more yeast, in order to turn more of the glucose into alcohol.
- Our beer was also not very carbonated. This is due to the conditioning of the beer. Better carbonation could be achieved with a tighter seal or more active yeast to digest the sucrose solution.

Acknowledgements

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Wild Yeast poster

Lemon Ginger Beer Brewed with Wild Yeast
La Salle University Biology Department

Abstract
In this experiment, wild yeast was collected from a bush outside of the Science building on the LaSalle campus (Fig. 1). Two batches of beer were brewed to test its effects. For both beers, properties like specific gravity, pH, and alcohol content were measured or calculated. The first batch of beer had a subtle citrus flavor that had a 4.3% alcohol content and was 1.47% calories. The wild yeast was also used to brew our second batch called ‘Lemon Ginger Beer’ that included lemon tea and ginger powder. The final product was a light beer with a more bitter flavor that had a 5.1% alcohol content and 158.22 calories.

Introduction
Brewing beer requires fermentation, a process where yeast breaks down sugars into alcohol under anaerobic conditions. Most beers are brewed with lab-strains, commercially available yeast that can produce specific flavors, aroma, and carbonation. Wild yeast is yeast derived from the environment and is associated with spontaneous fermentation. The wild yeasts most commonly used in brewing are strains of Saccharomyces, but they are highly unpredictable.2 The yeast can have a low alcohol tolerance, cause harshness, and produce unwanted byproducts that affect flavor.3 If successful, a brewer can produce a uniquely flavored beer. Lab strains have a specific flavor profile, whereas wild yeasts are naturally occurring and can produce unique flavors.

Methods

Starter: A slant was made to collect yeast from the environment. 200mL of water (40g of sugar) was boiled with hops for 20 mins, then poured into a jar. This jar was then placed in a batch on top of the science building (Fig. 2). Yeast was grown on a grapevitis medium plate. To make the media, 30g of malt, 1g of sugar, and 1g of yeast extract were added to boiling water. Once cooled, they were poured into tubes, capped with foil, and put into plates on a yeast date.

Fermentation: A pure culture of the wild yeast grown on the grapevitis medium plate was identified using a glucometer (Fig. 3). A 1% solution of yeast was inoculated into the medium and then transferred to an Erlenmeyer flask. The flask was then incubated at room temperature (Fig. 4). The fermentation process was followed by regularly monitoring the pH and specific gravity of the beer.

Discussion
The first batch of beer was cloudy and had a bitter taste with some notes of lemon. After measuring the final specific gravity, alcohol content was calculated to be 4.3% per liter (4% alcohol content). The second batch of beer was also cloudy and had a slightly bitter taste with no detectable notes of lemon or ginger. When we sampled the final batch, we detected an alcohol content of 5.1% per liter (5% alcohol content) of lemon and 3.8% per liter (3.8% alcohol content) of ginger (Table 1). The flavor of the beer was significantly different from the first batch, as we detected notes of aroma and flavor. The lower pH and specific gravity indicate that fermentation occurred (Table 1 and 2). The lower pH and specific gravity indicate that fermentation occurred (Table 1 and 2). The lower pH and specific gravity indicate that fermentation occurred (Table 1 and 2).

Results

Table 1: Wild Yeast Beer Ingredients

| Ingredient         | Quantity |
|--------------------|----------|
| Wild Yeast         | 14 mg    |
| Ginger Powder      | 14 mg    |
| Lemon Tea          | 14 mg    |
| Yeast              | 14 mg    |

Table 2: Characteristics of Lemon Ginger Beer before and after Fermentation

| Batch          | Specific Gravity | pH | Alcohol Content |
|----------------|------------------|----|-----------------|
| Before Ferment | 1.000            | 4.5 | 0.0%             |
| After Ferment  | 1.025            | 4.1 | 4.1%             |

Table 3: Characteristics of Lemon Ginger Beer before and after Fermentation

| Batch          | Specific Gravity | pH | Alcohol Content |
|----------------|------------------|----|-----------------|
| Before Ferment | 1.000            | 4.5 | 0.0%             |
| After Ferment  | 1.025            | 4.1 | 4.1%             |

Table 4: Characteristics of Lemon Ginger Beer before and after Fermentation

| Batch          | Specific Gravity | pH | Alcohol Content |
|----------------|------------------|----|-----------------|
| Before Ferment | 1.000            | 4.5 | 0.0%             |
| After Ferment  | 1.025            | 4.1 | 4.1%             |

Literature Cited

1. "Crouch, S., 2001. "Wild Yeast". Yeast, 17(11), pp. 1067-1079. https://doi.org/10.1002/1097-0061(200111)17:11<1067::AID-YEAST1067>3.0.CO;2-E
2. "Pepper, M., 2018. "Wild Yeast in Brewing." Advances in Yeast Technology, pp. 133-152. https://doi.org/10.1007/978-3-319-77858-0_8
3. "Li, J., 2016. "The Influence of Yeast on Beer Flavor." Journal of Food Science, 81(7), pp. 662-667. https://doi.org/10.1111/1750-3841.12840

Fig. 1: Wild yeast on grapevitis medium plate. Fig. 2: Wild yeast in the streets of LaSalle.

Fig. 3: Lemon Ginger Beer Ingredients: Lemon Tea, Ginger Powder, Yeast, Wild Yeast.

Fig. 4: First batch with wild yeast, "Lemon Ginger Beer."
Final poster

Kom-beer-cha!
La Salle University Biology Department, B1O 303-41

Abstract

In this experiment, beer was brewed to study the process of fermentation and the many factors that contribute to the flavor, color, and alcohol content of the final product. Other properties such as specific gravity, pH, and alcohol content were measured. A light and robust beer made with yeast, rice, and sweet rice was expected to be the final product. This experiment was done in an experiment's house using a wild yeast starter. Molasses was made from barley grains and is the integral source for yeast. A mix of seven yeast strains was used to give the beer a balanced flavor. Light strains were used to give a bitter flavor and act as a natural preservative. The bread hops were chosen because of their citrus scent. Kombucha was used as a special ingredient in the final beer to add sweetness and tartness.

Introduction

Brewing beer requires fermentation, a process by which yeasts break down sugars into alcohol under anaerobic conditions. Beer contains four major ingredients: water, malt, hops, and yeast. Kombucha is a fermented tea drink that is made by adding a symbiotic culture of bacteria and yeast (SCBY) to a mixture of black tea and sugar (Fig. 2). Bacteria ferments the sugar, and the resulting drink is slightly cloudy with a tangy, tangy flavor. Kombucha also contains probiotics, which are good bacteria that can prevent gut health.

Discussion & Conclusion

Table 1: Characteristics of beer before and after fermentation

| Table 1 | Characteristics of beer before and after fermentation |
|---------|-------------------------------------------------------|
| Specific Gravity (°PPL) | Protein | Ethanol | Calories | pH | Scum | Taste |
| Initial | 1.048 | - | - | 4 | Not Noted | Not noted |
| Final | 1.045 | 6.5% | 155 | 4 | Not Noted | Not noted |

Fig. 3 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 4 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 5 (left): Terpenes were analyzed using gas chromatography.

Fig. 6 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 7 (left): Terpenes were analyzed using gas chromatography.

Fig. 8 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 9 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 10 (left): Terpenes were analyzed using gas chromatography.

Fig. 11 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 12 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 13 (left): Terpenes were analyzed using gas chromatography.

Fig. 14 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 15 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 16 (left): Terpenes were analyzed using gas chromatography.

Fig. 17 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 18 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 19 (left): Terpenes were analyzed using gas chromatography.

Fig. 20 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 21 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 22 (left): Terpenes were analyzed using gas chromatography.

Fig. 23 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 24 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 25 (left): Terpenes were analyzed using gas chromatography.

Fig. 26 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 27 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 28 (left): Terpenes were analyzed using gas chromatography.

Fig. 29 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 30 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 31 (left): Terpenes were analyzed using gas chromatography.

Fig. 32 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 33 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 34 (left): Terpenes were analyzed using gas chromatography.

Fig. 35 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 36 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 37 (left): Terpenes were analyzed using gas chromatography.

Fig. 38 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 39 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 40 (left): Terpenes were analyzed using gas chromatography.

Fig. 41 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 42 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 43 (left): Terpenes were analyzed using gas chromatography.

Fig. 44 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 45 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 46 (left): Terpenes were analyzed using gas chromatography.

Fig. 47 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 48 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 49 (left): Terpenes were analyzed using gas chromatography.

Fig. 50 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 51 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 52 (left): Terpenes were analyzed using gas chromatography.

Fig. 53 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

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Fig. 65 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

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Fig. 68 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

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Fig. 71 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

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Fig. 73 (left): Terpenes were analyzed using gas chromatography.

Fig. 74 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 75 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 76 (left): Terpenes were analyzed using gas chromatography.

Fig. 77 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 78 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 79 (left): Terpenes were analyzed using gas chromatography.

Fig. 80 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 81 (left): Kombucha was made by fermenting tea with a wild yeast strain.

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Fig. 83 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 84 (left): Kombucha was made by fermenting tea with a wild yeast strain.

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Fig. 89 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 90 (left): Kombucha was made by fermenting tea with a wild yeast strain.

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Fig. 94 (left): Terpenes were analyzed using gas chromatography.

Fig. 95 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

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Fig. 97 (left): Terpenes were analyzed using gas chromatography.

Fig. 98 (left): Beer was made by brewing malt and yeast, which were then fermented with a wild beer yeast.

Fig. 99 (left): Kombucha was made by fermenting tea with a wild yeast strain.

Fig. 100 (left): Terpenes were analyzed using gas chromatography.
