An Introduction to Brewing Experiments

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Society of Barley Engineers
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There are things known and there are things unknown, and in between are the doors of perception. ~ Aldous Huxley ~
Lets Begin With a Beer!

Village Park Pale Ale
Practice 2 oz pour size please!

Volunteers to help set up Experiments?
Tonight Goals

- Define Experiments and Variables
- Describe Controlled Experiments
- Perform a few simple experiments
- Discuss experimental design
- Discuss data collection options
- Get more club members to conduct better experiments and publish their findings
Village Park Pale Ale

- **Grist (For 12 gallons)**
  - 21# Briess 2 Row (80.8%)
  - 2# Bonlander Munich (7.7%)
  - 2# Victory (7.7%)
  - 1# White Wheat (3.8 %)

- **Water 1:1 RO:filtered tap +**
  - 10g gypsum, 6mL lactic acid
  - 5g calcium chloride

- **Mash**
  - 8.5 g Strike Water @ 168°F
  - 152°F Rest 45m, recirculate 15m
  - Batch Sparge w/ 8.5 g @ 182°F

- **Yeast**
  - Vermont Ale, 1st generation

- **Hops for 40 IBU**
  - 5 mL Hop Extract
  - 1oz ea @ 10 min &
    Whirlpool @ 180°F for 15 mins
    - Citra, Delta, Amarillo, Cascade, Centennial, Chinook

- **Gravity**
  - OG 1.056
  - FG 1.008

- **Ferment**
  - Pitch @ 66°F floor catch to 70°F

- **Brewed 12/13/15**
What is Experimenting?

• testing
• collecting data
• analyzing data
• forming evidence
• drawing conclusions

• Are brewers always experimenting?
WHAT IF I TOLD YOU IT DEPENDS
Controlled Experimenting is key to successful experimenting and better brewing.
Controlled Experimenting

• The goal of a controlled experiment is to gain evidence that independent variable affects the dependent variable.
• controls attempt to remove or reduce bias or subjectivity
• nearly endless, strong conclusions lead to more experimenting
• weights and measures standardized
• controlling variables
Define Variables

- **Independent** Variable – the ONE factor that you are testing and/or
- **Dependent** Variable – the ONE factor you are measuring or evaluating
- **Controlled** Variables – everything else should be exactly the same
- Remove or reduce the effect of all variables except the one you intended to change
Goal of a Good Experiment

- **Independent** Variable – the ONE factor that you are changing or testing
- **Dependent** Variable – the ONE factor you are measuring or evaluating
- **Controlled** Variable
- Remove or reduce the effect of all variables except the one you intended to change
Let's do an Experiment

- Triangle test Green Light
- Goo.gl link to survey
- Which one is different?
- A, B or C
- Results
Experiment 1

• Receive 3 samples (A,B,C)
• Browse to... goo.gl/QcHYsr
• Enter tasting notes (optional)
• Look for one that is different

• If no changes are perceived by a significant number of your sample population.
Green Light

• Grist (FOR 12 gallons)
  – 13.5# Pilsner (~77%)
  – 2# Carapils (~11.5%)
  – 2# Rye 20 (11.5%)

• Water 100% RO +
  – 6mL lactic acid
  – 2t calcium chloride

• Mash
  – 6.25 g Strike Water @ 165°F
  – 154°F Rest 45m, recirculate 15m
  – Batch Sparge w/ 9.5 g @ 182°F

• Yeast
  – WLP001 Vermont Ale, 2rd generation

• Hops for 15 IBU
  – 60mins ¼ oz. Mosaic
  – 20mins ¾ oz. Mosaic
  – Whirpool 2 oz. Mosaic

• Gravity
  – OG 1.047
  – FG 1.007

• Ferment
  – Pitch @ 66°F floor catch to 70°F

• Brewed 1/17/16
Experiment 1 Results
What is more useful?

• Qualitative or Descriptive data is highly subjective and varies significantly based on panel palates and preferences.

• Quantitative Data is much more analyzable.

• What was the difference in the samples?
Clarity Ferm

APPLICATIONS:
1) increase the colloidal stability of beer by reducing chill haze.
2) Producing gluten reduced beers in beers made from barley and wheat.

From: https://www.whitelabs.com/other-products/wln4000-clarity-ferm-brewers-clarex
Clarity Ferm

Prevents the precipitation of complexed polyphenols and proteins by hydrolyzing the sensitive (haze-active) polypeptides in the region where such hydrogen bonding occurs. The specificity of the enzyme ensures that no other beer parameters are affected.

Clarity Ferm is a product containing a highly specific endo-protease which only cleaves polypeptides at the carboxyl end of the amino acid proline. Protease is derived from *Aspergillus niger*.

From: https://www.whitelabs.com/other-products/wln4000-clarity-ferm-brewers-clarex
ClarityFerm 1.007

Final Gravity

Regular 1.0065
Clarity Ferm
Without
Characteristics of Good Experiments

- Good experiments are designed with the end in mind
- What characteristics of your beer are you trying to improve?
- What are you going to change to improve that characteristic?
- Use metrics to focus evaluation on specific aspects:
  - Give tasters specific choices (yes/no, ratings)
  - Use anchors that are opposites (not hoppy – very hoppy)
  - Use quantitative questions and add qualitative data
- All or most brewing processes have written protocols to ensure consistent results
- Gain evidence that the independent variable affected the dependent variable(s)
Consistently Measure Accurately

• Do you calibrate your digital scales?
• Is the 5 mark in your cooler really 5 gallons?
• How about that 5.37g you got from your software? How do you measure that?
• How do you take your gravity samples (60F?)
• Do you calibrate your refractometer?
• Do you measure the same way every time?
Consistently Measure Accurately

- Accurate measurement is crucial to repeatability.
- Consider using pre-graduated pitchers AND/OR cylinders, STILL cross verify
Bel-Art Scienceware 289910000 Polypropylene Graduated Pitcher, 1000mL Capacity, 6.6" Height, 50mL Graduation Interval

by Bel-Art Products

List Price: $22.24
Price: $9.70 | FREE One-Day
Delivered tomorrow for FREE with qualifying orders over $35. Details
You Save: $12.54 (56%)

In Stock

Want it tomorrow, Feb. 4? Order within 1 hr 51 mins and choose One-Day Shipping at checkout. Details

Ships from and sold by Amazon.com. Gift-wrap available.

- Balanced handle for controlled pouring
- Perfect for either wet or dry ingredients
- Gracefully proportioned, these pitchers are ideal for general laboratory use
- Translucent and heat resistant to 121 degree C
- 4.1" top inside diameter x 6.6" height
SEOH Graduated Cylinder Borosilicate Glass Hex Base - Capacity (ml) 500

Price: $8.26 + $5.05 shipping

Note: Not eligible for Amazon Prime.

In Stock.
Estimated Delivery Date: Feb. 5 - 10 when you choose Expedited at checkout.
Ships from and sold by Scientific Equipment of Houston.

2 new from $8.26

Specifications for this item

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Click to open expanded view
Consistently Measure Accurately

• Accurate measurement is crucial to repeatability.
• Consider using pre-graduated cylinders & pitchers
  – Measure in smaller volumes first then scale up
• Calibrate your equipment
  – digital scales, hydrometers & refractometers
• Design and write protocols for measuring
Evaluation

• Begin your experiment with evaluation in mind
• What are you going to ask your tasters?
• Ask better questions!
• Favor questions with choices rather than:
  – which one is best?
  – which scores best by BJCP judges
• Rating Scales AND/OR yes/no questions easier to analyze and draw conclusions
• Use technology, statistics and p-values
Types of Evaluation

• Descriptive
  – provide information on selected characteristics

• Difference
  – Determine whether there are detectable differences between products

• Affective
  – Subjective attitude to a flavor or attribute. Acceptability or preference.

• Attribute
  – break down product to specific attributes
BIG QC DAY

SPRING 2016 EDITION: Big QC Day includes test for such parameters as Diacetyl and IBUs, as well as alcohol, calories, color, real and apparent attenuation, microbiological contaminants, and more, all for one low price ($139) for two samples. Gluten is available for an additional charge (Big QC Day + gluten is $199).

** The deadline for signup is Feb. 26 **

To order, visit yeastman.com, click the Laboratory Supplies and Services tab, and the item is located in the top section called Laboratory Services. Or call 1-888-5-YEAST-5. Write info@whitelabs.com for more information.

BACKGROUND: Big QC Day began in 2007 as a way to provide a low cost option for breweries to get a variety of tests conducted. The goal was to promote QC testing among craft breweries. Each year, at least 10 percent of the country’s craft breweries have participated. Each gets at least two of their beers tested for more than dozen factors including alcohol, IBUs and calories. The results can be compared to the study group as a whole or by region. Starting in 2011, a second testing round of testing was started in the fall.
Common Experiments

- Yeast 1 vs. Yeast 2
- Use of x vs. no use of x
- Mash Temps
- Boil lengths
- Fermentation temps
- Pitch Rates
- Spice/Adjunct/Flavoring amounts (vanilla, coffee, etc.)
Unusual Experiments

• Enzymes –
  – Amylase (found in spit)
  – Beano (commercially available)
  – Papayas (extract Bromelain)
  – Proteases (meat tenderizer)

• Unusual Ingredients
# Model Experimenters

### Professional
- White Labs
- Society of Brewing Chemists
- Institute of Brewing & Distilling
- UC Davis
- Oregon State

### Homebrewers
- Zymurgy
- Brew Your Own Magazine
- Brulosophy.com
- ExperimentalBrew.com
- ScienceBrewer.com

Too many...
BRÜLosophy

- started by Marshall Schott of Fresno in 2014, now includes Ray Found, Greg Foster, and Matt Waldron of CA and Malcom Frazer of PA
- exBEERiments or xBmts over 70 completed!
Experiment 2

• Ratings
• Let’s try one with my Barleywines
• Use your experimental design goals or BJCP or BA guidelines to design a survey
• Ratings Scale 1-6 to 1-10

• Survey Link... goo.gl/7hWGWl
22C. American Barleywine

**Overall Impression:** A well-hopped American interpretation of the richest and strongest of the English ales. The hop character should be evident throughout, but does not have to be unbalanced. The alcohol strength and hop bitterness often combine to leave a very long finish.

**Aroma:** Hop character moderate to assertive and often showcases citrusy, fruity, or resinly New World varieties (although other varieties, such as floral, earthy or spicy English varieties or a blend of varieties, may be used). Rich maltiness, with a character that may be sweet, caramelly, bready, or fairly neutral. Low to moderately-strong fruity esters and alcohol aromatics. However, the intensity of aromatics often subsides with age. Hops tend to be nearly equal to malt in the aroma, with alcohol and esters far behind.

**Appearance:** Color may range from light amber to medium copper; may rarely be as dark as light brown. Often has ruby highlights. Moderately-low to large off-white to light tan head; may have low head retention. May be cloudy with chill haze at
Kimo’s Klaws Barleywine

• Grist (FOR 12 gallons)
  – 15# Maris Otter (~43%)
  – 15# 2 Row (~43%)
  – 2# Crystal 20 (6%)
  – 2# English Dark Crystal (~6%)
  – ½# Special B (~1.5%)
  – ½# Pale Chocolate (~1.5%)

• Water filtered tap +
  – 6mL lactic acid
  – 2t calcium chloride

• Mash
  – 11 g Strike Water @ 168°F
  – 150°F Rest 45m, recirculate 15m
  – Batch Sparge w/ 8.5 g @ 182°F

• Yeast
  – WLP001 Cal Ale, 2nd generation

• Hops for 85 IBU
  – 4 oz. Magnum
  – 3oz ea @ Whirlpool @ 180°F for 15 mins Amarillo, Centennial,

• Gravity
  – OG 1.107
  – FG 1.024
  – 11.1% ABV

• Ferment
  – Pitch @ 66°F floor catch to 70°F

• Brewed 10/15/15
Experiment 2 Results
Homebrewers Association
Research and Education Fund
Homebrewers Association
Research and Education Fund

Members can submit proposals to apply for funding to help support their research endeavor. Members will be asked to identify their concept in detail, including a proposed budget request. Proposals are reviewed quarterly where a selection of projects will be approved for funding.

Upon approval, research projects are refunded for the agreed value once a satisfactory write-up summarizing quality research has been submitted and accepted.

Completed projects are featured on HomebrewersAssociation.org and have the potential to be showcased in Zymurgy magazine. Completed projects can also be the source of content for future National Homebrewers Conference Seminars.
Homebrewers Association
Research and Education Fund

9 Completed Projects

- Cider Yeast Comparison (Stan Stisson)
- Cask Conditioned Ale Experiment
- Measurement of Protease Secreted into Beer During Fermentation
- The Brewing Potential of New “Wild” Yeast Strains
- To Decoct or Not to Decoct: That is the Question
- Mead Experiment: Same Must, 12 Different Yeasts
- The Effects of Live-Culture Beer on One Man’s Microbiome
- Influence of Water Chemistry on the Fermentation and Flavor Profiles of Traditional Mead
- Brewing Beer Without Hops in the Boil
Sample Collection and Analysis: Distal Microbiome kits were ordered from UBiome (Figure 1). Samples were collected at the conclusion of each week on Monday morning. In brief, distal gut samples were collected from toilet paper with a sterile swab which was swirled in a collection tube for 1 minute. The tube was tightly capped and shaken by hand for an additional minute. The samples were then sent in the enclosed envelope to UBiome where they were further processed and sequenced. DNA sequences corresponding to specific microbial populations were analyzed by UBiome, the results of which were displayed via their Beta software (Figure 2). UBiome enables users to see the relative abundance of the bacterial Phyla in the sample as it compares to the Average for all samples received (Figure 2A). The microbiome data can also arranged as a tree, organized by scientific taxa. While some species level information can be obtained in the Raw Data, only genus level information was displayed on the tree.

Figure 1: UBiome Distal Gut Microbiome Kit

A.

B.

C.

Figure 2: Measurement of protease activity in homebrew.
(A.) The beers of two different homebrews were tested for PrA activity. Beer1 shows activation of the sensor, indicating the presence of PrA. Beer2 has no detectable PrA. Error bars represent the standard deviation of three experiments. (B.) PrA activity increases with long-term cold storage of beer.

Figure 2: UBiome Microbiome Analysis Examples
Experimentation and Future Publication Opportunities

• Big Brew Day
  – In March we will have a big brew on the big system here!
  – Penny Blonde base
  – Bring vessels to take home wort
  – Sign up and state your preference @ goo.gl/D8Rwsa

• Club Lambic
  – Various fruiting methods
  – Aging
  – ???
Suggested Publication Format

- Introduction
- Purpose
- Methods
  - Recipe, techniques, protocols
- Results
- Conclusion
- Discussion
Experiment 3

• What level of Gypsum?

• What would you do?

• How would you measure?

• The base solution is 2g/L
• Hombrewers Association
Research and Education Fund
Have the AHA pay for a batch!
Engineer your way to better beer. Be scientific...

- Control your Variables
- Consistently Measure Accurately
- Use Solid Evaluation Criteria
- Draw conclusions wisely
• Find reliable information, learn as much as you can, and brew as much as you can. Take copious notes. Then, never stop trying to brew better beer with science

Have Fun!

THE END
THANK YOU!