The Craft Beverage Laboratory
Craft Beverage Regional Exchange Group
Richard Gualandi
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The Craft Beverage Laboratory

- Laboratory Safety
- Determining your Needs
- Planning your Laboratory
- Laboratory Equipment
- Laboratory Services
- Questions
Laboratory Safety

• Should always be the primary consideration

• Understand the legal requirements for safe laboratory operation (OSHA)

• Understand the hazards present and minimize exposures
Designing a Safe Laboratory

• Many aspects to consider:
  – Infrastructure
  – Layout
  – Equipment
  – Processes
  – Materials storage/disposal
  – General hazards
  – Specific hazards
  – Culture of safety
  – Housekeeping
  – Etc.
OSHA and the Laboratory

• Occupational Safety and Health Administration (OSHA)
  – Regulates safe working conditions for employees

  – Requires employers to:
    • Communicate hazards associated with job duties
    • Provide training and protective equipment

• CFR 29 1910.1450 - Laboratory Standard
  – Requires employers who operate a “Laboratory” to:
    • Provide safety training and equipment
    • Monitor and minimize chemical exposure
    • Provide medical attention when necessary
    • *Develop an written Chemical Hygiene Plan (CHP)*
Hazards in the Laboratory

• CHP - Assess all hazards and required protective measures

• Hazard assessment
  – Safety Data Sheets (SDS/MSDS)
  – Chemical Labels
  – Process hazards

• Hazard Mitigation
  – Training
  – Safety equipment
  – Standard Operating Procedures (SOP)
Laboratory Safety Equipment

• Engineering Controls
  – Chemical Fume Hood
  – Safety showers and eyewash stations
  – Fire suppression

• Personal Protective Equipment (PPE)
  – Eye protection
    • Chemical splash goggles and/or face shields
    • Respirators – Note: it is illegal to have a respirator in the lab unless personnel have been trained in it’s use
  – Skin protection
    • Lab coats and/or chemical aprons
    • Chemical resistant gloves

http://ehis.fullerton.edu
http://www.longolabs.com
Laboratory Safety Equipment

- Chemical storage and disposal
  - Flammables, acids, caustics, dry, wet cabinets
  - Waste accumulation and legal disposal
- First Aid Kit
- Spill Containment kit
- Fire extinguishers
  - “ABC” rated
  - Note: It is illegal to use a fire extinguisher in the workplace without training

http://www.chemicalcabinets.com
http://www.uvm.edu
Pricing Laboratory Safety Needs

- Cost may vary widely based on size and processes
  - Chemical Hygiene Plan (CHP) ~ 40 hours
  - Chemical fume Hood ~ $3–10K
  - Safety shower/eyewash ~ $500–1,000
  - Chemical Storage cabinets ~ $300-1,000 ea.
  - PPE ~ $100.00 / person
  - First aid kit ~ $50-100
  - Chemical Spill Kit ~ $100-500
  - Fire extinguisher ~ $30-100 ea.
  - Waste disposal
    - Organic solvents ~ $5 – 8 / gal.
    - Acids ~ $20 / gal.
Understanding your laboratory needs

• Are you an employer?
• What are your goals?
  – What testing?
  – For what purpose?
• What do you have to invest?
• How much space do you have?
• How much throughput?
• Staff expertise
Planning the Laboratory

- Clearly identify your needs
- Identify your budget
- Understand your legal safety obligations
- Identify the laboratory space
- Prioritize equipment purchases – shop around
- Design layout for safe, efficient use
- Plan for potential future expansion
Basic Laboratory Equipment
(Home and small-scale commercial producers)

- Basic glass ware ~ $100-1000
  - Beakers
  - Graduated cylinders
  - Volumetric flasks
  - Test tubes
  - Petry dishes (glass or plastic)

- Distillation set up ~ $200-400
  (stirring hot plate ~ $100-500)
  - Alcohol content
  - Diacetyl (VDK)

- Titration set up ~ $100-300
  - Total acidity
  - Buffering capacity
Basic Laboratory Equipment

• Laboratory Pipettes ~$50-500 ea.
  (With volumetric or precision tips)
  – Precision volume measurements
  – May want 100uL, 1mL, 10mL

• 60cc Laboratory syringe, barometer, thermometer ~ $50
  – Volumetric measurements
  – CO₂
Basic Laboratory Equipment

- **Hydrometer ~ $10-20**
  - Specific gravity
  - Extract values

- **Dissolved oxygen sensor ~$150-5000**
  - DO
  - Several designs – pros and cons (Hach, Anton-Paar, many others)

- **Refractometer ~$50- 5000**
  - Brix
  - Specific Gravity
  - Alcohol

[Links for equipment images and related websites]
Basic Laboratory Equipment

- **Microscope ~$100-10K**
  - Yeast and bacteria counts

- **Hemocytometer ~$20-500**
  - Yeast and bacteria counts

- **ATP luminometer ~ $1K-10K**
  - Hygiene monitoring
Basic Laboratory Equipment

• pH meter ~$25-10K
  – Multi-meters
  – Litmus paper test strips may work for home use ~ $5-10

• Water bath ~ $100-1000
  – Sample attemperation
  – Sample prep

• Refrigerator/freezers ~ $100-15K
  – Materials storage
  – Yeast storage

http://ecx.images-amazon.com
https://static.fishersci.com
http://ecx.images-amazon.com
https://static.fishersci.com
Standard Laboratory Equipment
(Small to moderate commercial producers)

• Analytical balance ~$500-5K
  – Media Prep
  – Reagent Prep
  – Etc.

• Centrifuge ~ $5K-10K
  – Various methods

• Shaker table ~ $500-5K
  – Degassing
  – Media Prep

• Digital Multi-meters ~$1K-5K
  – Exchangeable probes
  – Various parameters
  – Many Brand names

https://static.fishersci.com
Standard Laboratory Equipment

- Autoclave ~$500-10K
  - Media Prep
  - Materials sterilization
  (pressure cooker may work for small operations)

- Incubator ~$2K-5K
  - Yeast and bacterial analysis

- Anaerobic inserts ~$100-800
  - Yeast and bacterial analysis

- Sterile hood ~3K-10K
  - Microbiological applications
  - HEPA filtration
Standard Laboratory Equipment

• Digital Density meter ~$3K-30K
  – Specific gravity
  – Extract values
    (Anton-Parr, Mettler Toledo, others)

• Turbidity/Haze meter ~ $500-3K
  – Turbidity
    (Hach, Anton-Paar, others)

• Spectrophotometer ~$2K-10K
  – Many methods – VDK, color, turbidity, proteins, IBU, hops acids and H.S.I., diacetyl, polyphenols, carbohydrates, DO, FAN, sulfites, metal pro-oxidants, more ...
    (Hach, Thermo, many others)
Advanced Laboratory Equipment
(Industry Specific)

• Anton-Paar – PBA ~65-120K
  – Broad capabilities – modular system
  – Single run multi data potential
  – Density/specific gravity, alcohol, dissolved gasses (O₂/CO₂), color, turbidity, pH, extract values, degree fermentation, carbohydrates, calories, more calculated values...

• Haffmans beverage analyzers ~10K-30K ea.
  – Dissolved gasses – O₂, CO₂, O₂/CO₂,
  – Turbidity
  – Foam properties
  – More

• Other Brands...ex. Hach, Zahm-Hartung, etc.

http://www.haffmans.nl
http://anton-paar.com
Advanced Laboratory Equipment
(Large commercial producers/researchers)

• Gas Chromatography ~$20K- >100K
  – GC, GC-MS, GC-FID, GC-ECD, etc.
  – Some used systems available
  – Detector options
  – Aroma profiling (hops, esters, etc.)
  – Alcohol, Diacetyl (VDK), Sugars
    (Agilent, Shimadzu, Thermo, more)

• Liquid Chromatography ~ $20K- >150K
  – LC, HPLC, UPLC, LC-MS, etc.
  – Some used systems available
  – Detector options
  – Broad capability
  – Hops Bittering acids, Organic acids,
    Sugars/carbohydrates, Other flavoring
    components
    (Agilent, Waters, Thermo, others)
Advanced Laboratory Equipment

- **Atomic Absorption spectroscopy ~$20K- >250K**
  - AA
  - Some used systems available
  - Elemental analysis (metals, minerals)
  - Water, raw materials

- **Ion Chromatography ~$20K- >250K**
  - IC
  - Some used systems available
  - Detector options
  - Elemental analysis (metals, minerals)
  - Water, raw materials

- **Inductively Coupled Plasma ~$20K- >250K**
  - ICP, ICP-MS, etc.
  - Some used systems available
  - Elemental analysis (metals, minerals)
  - Water, raw materials
Laboratory Testing Services

• Laboratory testing services can offer a viable option for small companies who are not ready to invest in a lab in-house
• Limited commercial options for Craft Beverage specific testing
• Prices variable

• Potential Advantages
  – No start up and maintenance cost
  – No cost to maintain trained staff
  – Specialized expertise
  – Package testing
  – May offer consultations

• Potential Disadvantages
  – Samples typically must be sent in
  – Lag time results = no in process adjustments
  – More expensive over time
  – Loss of control over testing processes
Commercial Laboratory Testing Services

• White Labs/Siebel Institute. – San Diego, CA
  – Beer, wine, spirits, raw materials – Comprehensive services
  – Developing testing kits
  – Yeast bank
  – Consultations
• Brewing and Distilling Analytical Services – Lexington, KY
  – Beer, wine, spirits, some raw materials – Comprehensive services
  – Consultations
• Hop Union/Alpha Analytics – Yakima, WA
  – Beer, Hops (chemical and micro analysis)
• Keystone Home Brewing Supply – Bethlehem, PA
  – Beer, wine (basic chemical analysis)
  – Consultation
• Other International Resources
Other Laboratory Testing Services

• Appalachian State University – Boone, NC
  – Fermentation Sciences Program
  – Comprehensive laboratory testing services for craft beverages

• BioNetwork at Asheville Buncombe Technical Community College – Asheville, NC
  – In collaboration with Craft Beverage Institute of the Southeast Program
  – Future development of finished beer testing services
Thank you for your time

Cheers!