



COOPERATIVE EXTENSION
College of Agriculture, Forestry and Life Sciences

CLEMSON EXTENSION FERMENTATION PROGRAM

Alex Thompson, Food Systems and Safety Agent, Clemson Cooperative Extension, Greenville, Spartanburg, Anderson, Pickens, and Oconee Counties

Speaker Background

- B.S. Food Science and Human Nutrition – Clemson University
- M.S. Food, Nutrition, and Culinary Science – Clemson University
- Former brewer at Brewery 85 in Greenville, SC
- US Army and OEF Veteran
- Current Position: Food Systems and Safety Agent, Clemson Cooperative Extension, Greenville, Spartanburg, Anderson, Pickens, and Oconee Counties
- Current President of Southeastern Section of Institute of Food Technologist (IFT)



Presentation Overview

- Clemson Cooperative Extension Brewing Program Overview and Background
 - Fermentation Lab Capabilities
 - Prior Research
 - Current Research
 - Future Research and Projects
 - Pathogens in Breweries

Clemson Cooperative Extension Fermentation Program

- Funded by Clemson Cooperative Extension Innovation Award – April 2022
 - Goal: To develop job training, product testing, and research capabilities within Clemson Cooperative Extension to assist the South Carolina brewing and fermented product industry
- Need: According to Brewers Association (2023 data)
 - 135 craft breweries (3.4/capita, 21+)
 - \$844 million economic impact
 - 137,969 barrels produced (1.1gal/capita, 21+)
 - North America fermented foods (Prebiotics, Probiotics, Vitamins, Industrial Enzymes, Organic Acid, Amino Acids, Others) revenue total USD 233 billion in 2024 and will grow at a compound annual growth rate (CAGR) of 4.4% from 2024 to 2031.



SOUTH CAROLINA

[FIND A BREWERY ▶](#)[STATE LAWS ▶](#)

3.4 Breweries per Capita*
(RANKS 32ND)

*per 100,000 21+ Adults

\$
ECONOMIC IMPACT
(2023)

844
Million Economic Impact
(RANKS 25TH)

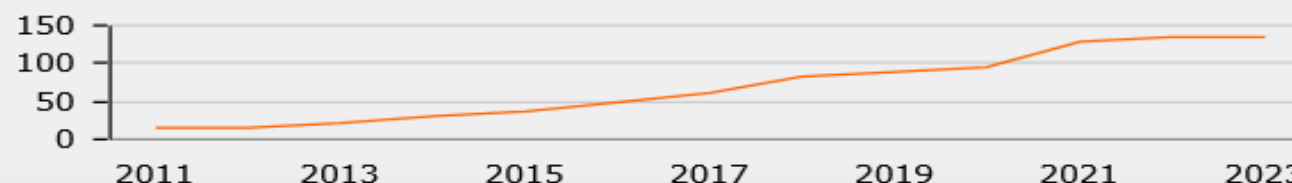
211.8
Impact per Capita
(RANKS 46TH)


PRODUCTION

137,969
Barrels of Craft Beer
Produced per Year
(RANKS 35TH)

1.1
Gallons per 21+ Adult
(RANKS 42ND)

NUMBER OF CRAFT BREWERIES OPERATING PER YEAR



Brewing Program Overview

- Self-paced online training
 - 7 modules over 14 weeks
 - Non-certificate and certificate option
 - Hands-on training in laboratory and at partner breweries (certificate option)

- Module Topics
 - Malt styles and biochemistry
 - Hop botany and utilization
 - Brewing water quality
 - Yeast biology and metabolism
 - Brewery processing and packaging
 - Brewery cleaning, sanitation, and safety

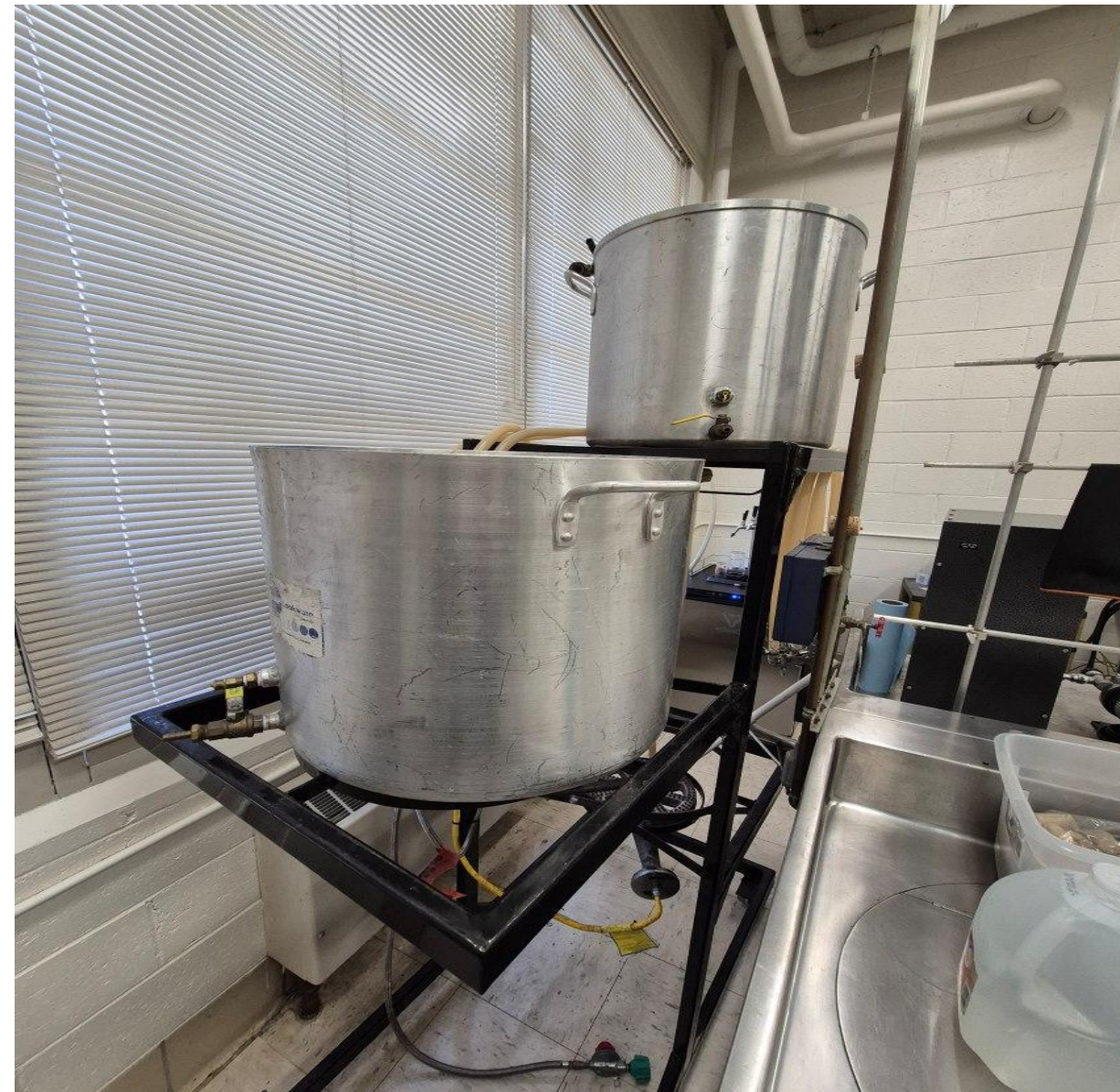


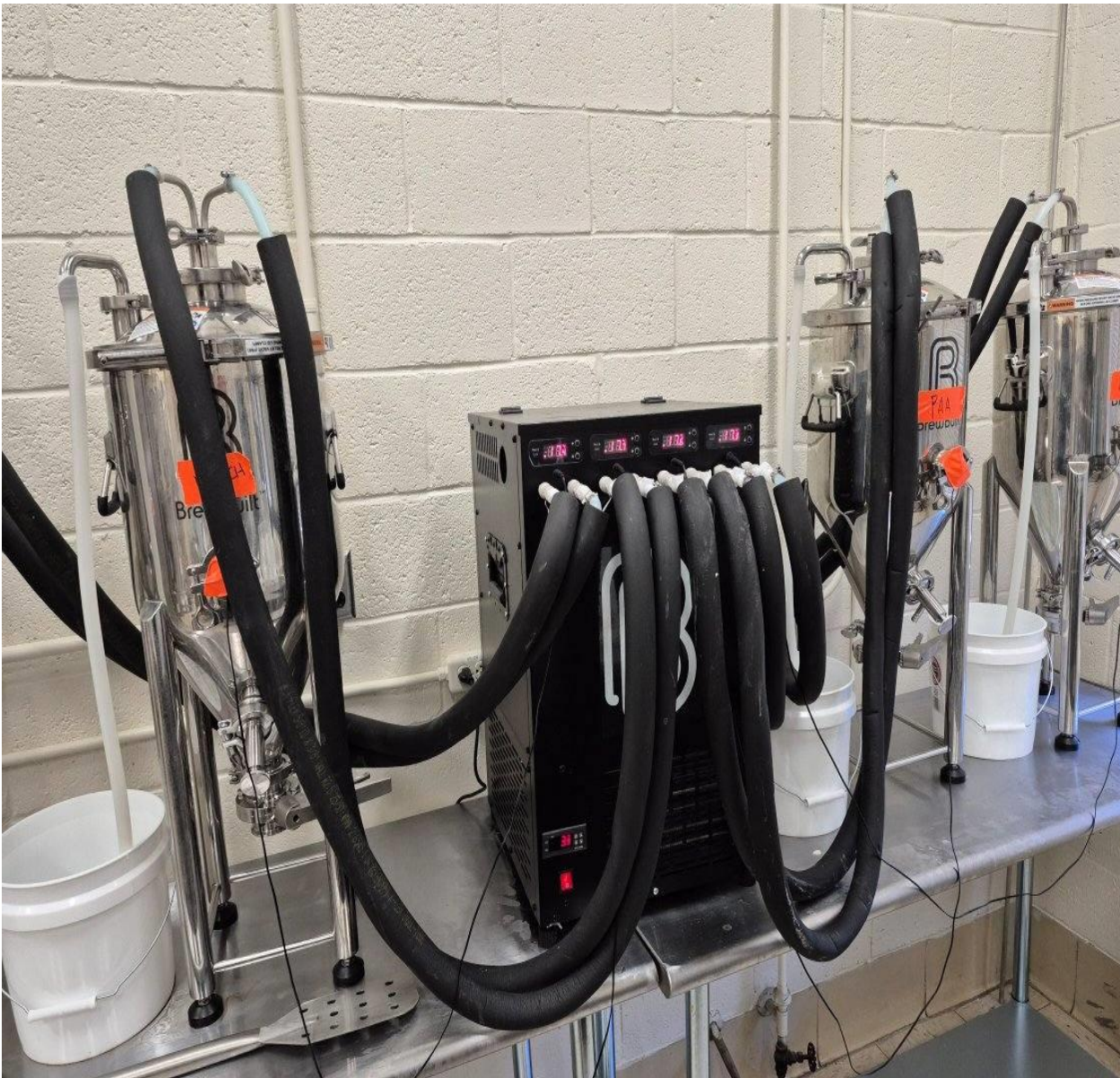
CLEMSON® EXTENSION

**BREWING
SCIENCES**

Fermentation Program Capabilities

- 20-gallon, 3-vessel electric brewing system
 - Provided at-cost by Grapes and Grains (Greenville, SC)
- 4x 7-gallon stainless steel cylindroconical fermenters
- 4-line glycol temperature control system
- Mobile, 20-gallon, 3-vessel propane brewing system
 - Donated by Keowee Brewing Company (Seneca, SC)
- 2-roller grain mill
- Can seamer (11-32oz)
- Keg and draft systems
- Counter-current plate heat exchanger





Prior Research

- Identification of locations of greatest bacterial contamination in microbreweries post-CIP
- Found survival of spoilage organisms in all finished beer
 - None presented negative quality
- Recommendations made to brewers about hygienic practices and sanitizer use
- Consumer awareness about unfiltered/unpasteurized beer

Vol. 13(1), pp. 1-10, January-June 2024

DOI: 10.5897/JBD2024.0060

Article Number: 705951B71856

ISSN 2141-2197

Copyright ©2024

Author(s) retain the copyright of this article

<http://www.academicjournals.org/JBD>



Journal of Brewing and Distilling

Full Length Research Paper

Bacterial contamination and surface hygiene in the microbrewery environment

Alex R. Thompson¹, Julie K. Northcutt² and Paul Dawson^{2*}

¹Clemson Cooperative Extension, Clemson University, Clemson, SC 29631, USA.

²Department of Food, Nutrition, and Packaging Sciences, Clemson University, Clemson, SC 29631, USA.

Received 6 January, 2023; Accepted 6 February, 2024

Bacterial spoilage has a negative impact on the quality, stability and consumer acceptance of beer. The present study was conducted to determine bacterial surface and product contamination in the microbrewery environment. HybriScan™ D Beer rapid molecular testing kits for bacterial cell counts were used to evaluate three microbreweries of similar size at eleven different locations within each

Current Research

- Creative Inquiry with 18 students at Clemson University
- Goal: Identifying viable methods for bacterial load reduction on fresh produce for craft brewers
- Method: One batch of beer split 4-ways and fermented. Muscadine grapes added to beer post-primary fermentation. Tested for spoilage organism presence.
- Treatments:
 - Control
 - Peracetic Acid
 - Bleach
 - Potassium Metabisulfite



Future Research and Projects

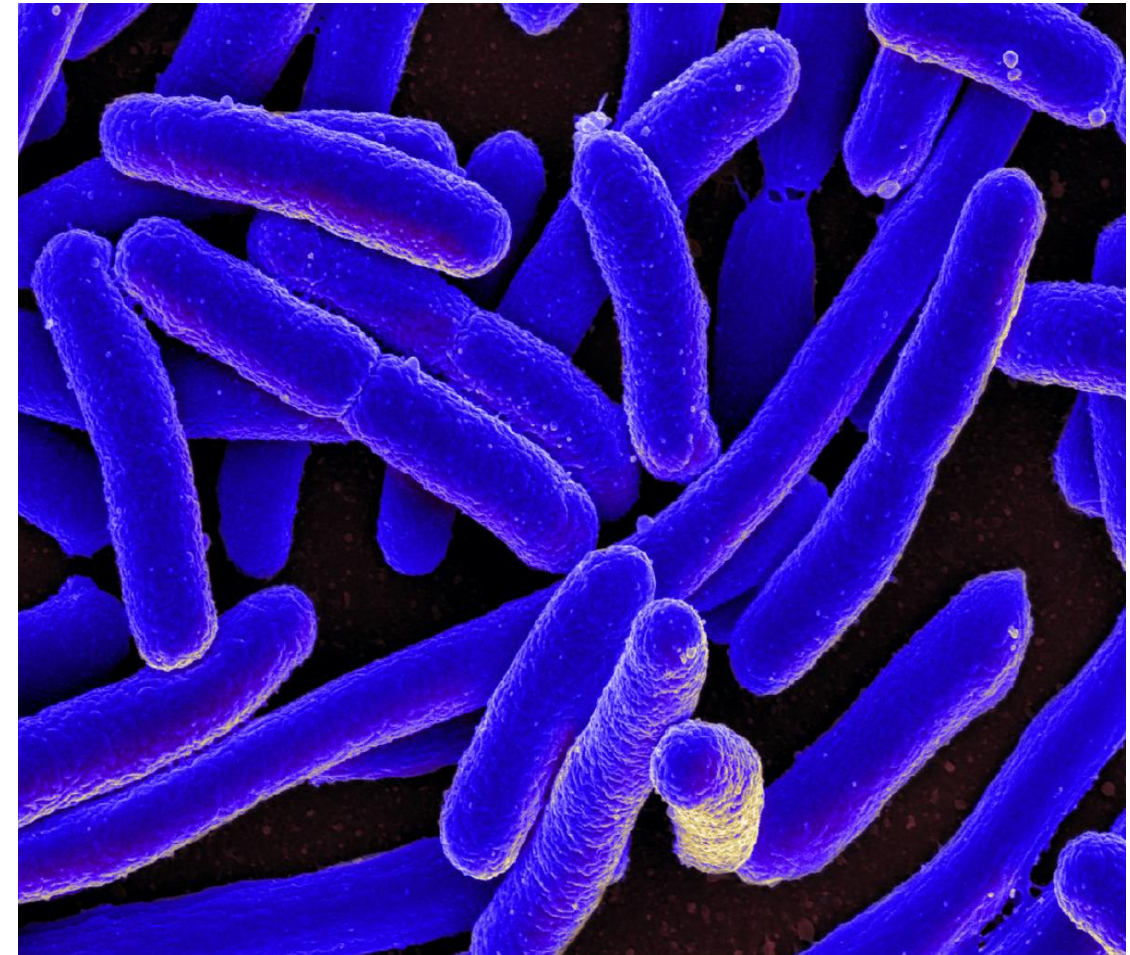
- Brewing Research: Identification of utilization impact on volatile aromatic compound production from *Humulus lupulus* in hazy/New England-style India pale ales
- Kombucha Research: current PhD student at CU will be using equipment for kombucha testing and production
- Home food fermentation training videos for SC Master Food Preserver program
- TTB lab certification for alcohol testing (beer, wine, cider, kombucha)
- Bacterial spoilage and dissolved gas testing for breweries



**SOUTH CAROLINA
MASTER FOOD
PRESERVER**
BY CLEMSON® EXTENSION

Pathogens in Breweries

- Standard beer is typically a low risk of pathogenic contamination due to factors such as:
 - pH (3.3 to 4.4)
 - ethanol concentration (3%-14% by volume)
 - CO₂ concentration (0.5% w/w)
 - Low O₂ levels (<0.1ppm)
 - Hop iso- α acids (17-55ppm)
- Low-alcohol (LA) and non-alcoholic (NA) beers are more susceptible to pathogens





Non-alcoholic beverage trends

- According to Nielsen IQ:
 - Sales at grocery, drug stores, mass merchants, convenience stores, and liquor stores, for 52-week period ending Jan. 4, 2025
 - 27% increase in sales of non-alcoholic beer, spirits, and other beverages (THC-beverages included)
 - \$829.2 million in total spending in 2024
 - NA beer accounts for \$699.2 million of sales
 - 25% growth in NA beer from 2023



Survival of Foodborne Pathogens in Low and Nonalcoholic Craft Beer

- Authors Maria Cobo (Cornell), Ann Charles-Vegdahl (Cornell), Kaylyn Kirkpatrick (BA), and Randy Worobo (Cornell)
 - Published in Journal of Food Protection, December 2023.
- Found survival of *E. coli* O157:H7 and *S. enterica* for up to 2 months at 4 and 14°C in low alcohol and NA beers.
- Average LA and NA beers had pH between 4.0 and 4.5, with some having pH of 5.0.
 - Potential of *C. botulinum* growth



Journal of Food Protection

Volume 86, Issue 12, December 2023, 100183






Research Paper

Survival of Foodborne Pathogens in Low and Nonalcoholic Craft Beer


Mario Cobo¹, Ann Charles-Vegdahl¹  , Kaylyn Kirkpatrick², Randy Worobo¹


[Show more](#) 

 Add to Mendeley  Share  Cite

<https://doi.org/10.1016/j.jfp.2023.100183> 

[Get rights and content](#) 

Under a Creative Commons [license](#) 

 [Open access](#)

Highlights



Hop Water

- Hop water is a water-based beverage with steeped hops added
 - Produced by many small breweries in-house and commercially available
- Capitalizes on popularity of IPA's and alcohol-free/health-conscious trends
- According to NIQ
 - Sales rose 142.5% from \$2.2 million in 2022 to \$5.3 million in 2023
 - Sales rose 48% to \$7.8 million in 2024



Acidification of Hop Water

- Hop water needs to be acidified to protect against pathogenic contamination
 - Typically acidified to 2.9 – 3.2 pH with citric or lactic acid
 - Acidified in the boil kettle during hop additions
- Hops raise pH by 0.03/g/hl (Cocuzza, S. 2019)
 - pH should be rechecked and adjusted post dry-hopping of hop water
 - Dry hopping is the addition of hops to hop water post-production to increase aromatics



Alex Thompson
Food Systems and Safety Agent
Clemson Cooperative Extension
Greenville, Spartanburg, Pickens, Anderson, and Oconee
Counties

Email: art6@clemson.edu

Phone: (864) 986-1286