SENIOR CAPSTONE/
SENIOR DESIGN EXPERIENCE
2024

Non-Alcoholic Blackcurrant Wine

Hannah Slabach[1], Jenna Hans[1], Nathan Greenland[1]
Dr. Martin Okos[1], Daniel Hauersperger[1]
[1]Biological Engineering, Purdue University, West Lafayette, IN

PURDUE UNIVERSITY
Agricultural and Biological Engineering

Objective

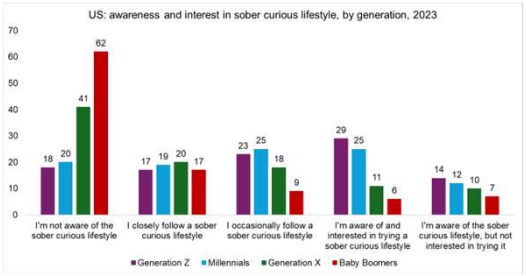
To create a unique and fun alcohol alternative to create inclusivity in social settings

Design Considerations

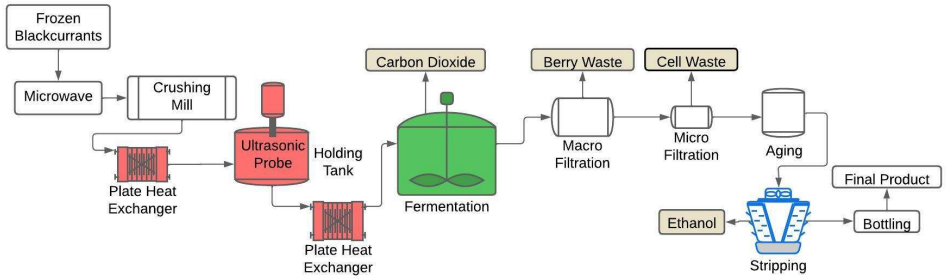
- Environmental Impact
- Consumer Opinion
- Flavor Profile

Market Analysis

- 28% of consumers purchase a new beverage if it has a unique flavor
- 60% of Consumers in 2023 believe that the quickest way to improve health is to decrease alcohol consumption
- 57% of Women choose wine as their primary alcoholic beverage
- 20% of women participate in a sober curious lifestyle

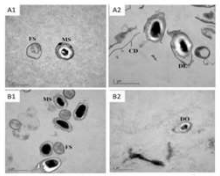


Process Design

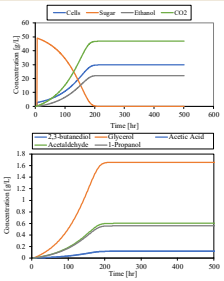


	Pasteurization	Fermentation	Stripping
Controls	Monitor outlet temperature to correct incoming heating/cooling fluid rate	Temperature and level sensors to counteract generated heat and CO_2	Temperature and Differential Pressure Sensors to alert operators of values outside allowable range
Alternatives	Sulfites Thermal Pasteurization	Semi-Batch Perfusion	Reverse Osmosis (RO) Evaporative Pertraction (EP)
Optimization	HX Plate Optimal Gap 4.59 mm Cost: $27,500	Reactor Volume 1,474 L Cost: $54,160	Vapor-Liquid Flow Mass Ratio 5.60 Cost: $12,700

Experimental Results



Thermal-sonication at 55°C with a frequency of 20 Hz & power density of 16.2 W/mL has a log reduction of 3.3 of *saccharomyces cerevisiae*[5]



Based on blackcurrant sugar content, a fermentation time of 8 days is needed[2]

SCC reduced the ethanol content of wine to the lowest ABV of all commercially-viable techniques at 0.3%[3]

Dealcoholized wine by SCC was found to have better sensory characteristics than raw wine by tasting panel[4]

Economic Analysis

Total Capital Investment	$7,858,018.92
Raw Material Cost/kg Product	$5.66/kg
Total Product Cost	$4,105,346.34
Break Even Production Rate	269,000 kg/yr

After 10 years of production

Sales/kg	$38.33/kg
Sales/750 mL bottle	$24.44/bottle
Annual Sales	$5,766,286.98
ROI	31.2%
DCFR	4.33%

Plant Design

Wastewater Management
- Recycling water used in HEX

Reactor Waste Management
- Recycling yeast (with careful monitoring)
- Selling blackcurrant pomace as compost
- Engineering yeast to utilize CO_2

Ethanol Waste Management
- Stripped ethanol used for energy valorization

Future Work

- Improve product taste while minimizing added sugar
- Collect experimental data with updated recipe and physical distillation equipment
- Maximize flavor compounds post-fermentation and stripping
- Determine optimal yeast nutrition

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4 - Bellsario-Sánchez, Y. Y., Taboada-Rodríguez, A., Marín-Iniesta, F., Iguaz-Gainza, A. & López-Gómez, A. (2012). Aroma recovery in wine dealcoholization by SCC distillation. Food and Bioprocess Technology, 5, 2525-2535.
5 - Silva, F. V. (2020). Ultrasound assisted thermal inactivation of spores in foods: Pathogenic and spoilage bacteria, molds and yeasts. Trends in Food Science & Technology, 105, 402-415. https://doi.org/10.1016/j.tifs.2020.09.020