SENIOR CAPSTONE/
SENIOR DESIGN EXPERIENCE
2024

ACV SODA

Vaishnavi Elango[1], Hanna Inoue Goes[2], Athulya Nair[3], Maya Bjerke[4]

[1]Biological Engineering; [2]Biological Engineering; [3]Biological Engineering; [4]Biological Engineering;

PURDUE UNIVERSITY
Agricultural and Biological Engineering

OBJECTIVE

The objective of this project was to create a gut healthy apple cider vinegar soda to provide a healthier alternative to the current beverages on the market.

BACKGROUND

Market Size

The nonalcoholic beverage market is expected to show an annual growth rate of 5.3% resulting in a market volume of $1.7 trillion by 2027 (Statista Market Insights, 2023)

Target Consumer

Adults who are interested in health and wellness

Competitors

Trader Joe's Organic Sparkling Apple Cider Vinegar Beverage and Poppi Prebiotic Soda

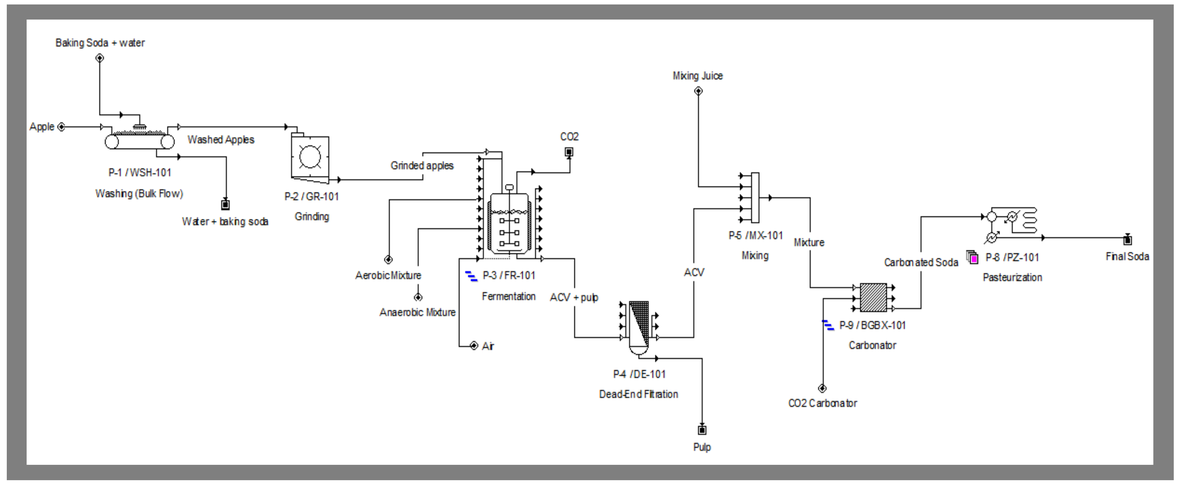
Ethical and Societal Considerations

- Locally sourced ingredients and packaging materials
  - Sourcing apples from local farms, recyclable materials for packaging
- Health and safety regulations
  - Following FDA regulations
- Waste management and environmental practices
  - Composting apple solids, renewable energy
- Consumer awareness with health claims
  - Supported health claims with scientific evidence

FUTURE WORK

- Adding more juices and flavor profiles to the ACV Soda to reach a larger market
- The addition of more probiotics into ACV Soda to add more benefits

PROCESS FLOW DIAGRAM



Anaerobic Fermentation

Chosen: Bioreactor
Alternatives: Closed cylindroconical tank, open square fermenter

Aerobic Fermentation

Chosen: Stirred tank reactor
Alternatives: Bubble column bioreactor

Filtration

Chosen: Gravity filter
Alternatives: Centrifugal filter, vacuum filter, cyclone separator

Pasteurization

Chosen: Flash pasteurizer
Alternatives: Tunnel pasteurizer, aseptic pasteurizer

EXPERIMENTAL DESIGN

- **Anaerobic Fermentation:** Altering the amount of *Saccharomyces cerevisiae* used to turn apple juice mixture into ethanol
- **Aerobic Fermentation:** Addition of *Acetobacter* and exposure to air to turn ethanol to ACV. Acidity measured until reaching a pH of 2.8
- **Filtration:** Excess foam and pulp removed from fermentation processes before use in final product
- **Pasteurization:** sterilization at 75°C
- **Final Product:** The ratio of ACV to juice mixture was varied to get the best-tasting product with the most health benefits possible. This product was carbonated and bottled
- **Ingredients:** Water, juice concentrate, apple cider vinegar, sugar, lemon juice.

Nutrition Facts

1 servings per container
Serving size 1 Can (355ml)

Amount Per Serving
Calories 80

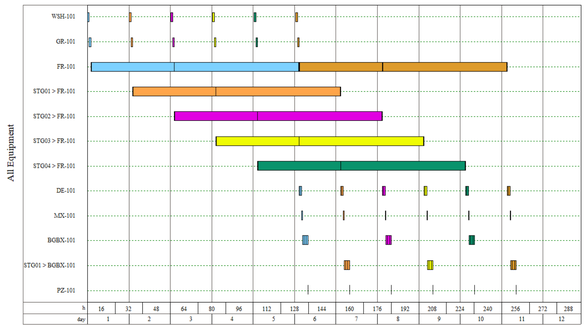
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Polyunsaturated Fat 0g	
Monounsaturated Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 12g	4%
Dietary Fiber 0g	0%
Total Sugars 11g	
Includes 5g Added Sugars	10%
Sugar Alcohol 0g	
Protein 0g	0%
Vitamin D 0mcg	0%
Calcium 0mg	0%
Iron 0mg	0%
Potassium 0mg	0%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

PROCESS OPTIMIZATION

Unit of Operation	Optimized Variable	Optimum Value
Anaerobic Fermentation	Number of Fermenters	6 fermenters
Aerobic Fermentation	Vessel Diameter	0.13 m
Filtration	Area	2.96 m²
Pasteurization	Outlet Steam Temperature	25.4°C

PLANT DESIGN

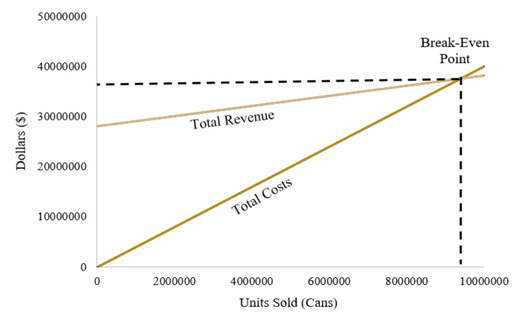


MANUFACTURING

Economic Results

Financial Component	Value
Total Capital Investment	$868,237.66
Total Production Cost / yr	$29,990,426.42
Cost / Can (12 oz)	$2.44

Financial Plan



Instructor: Dr. Martin Okos
Advisor: Daniel Hauersperger

Acknowledgments to the Agricultural and Biological Engineering Department, Purdue Engineering, and Purdue University