SENIOR CAPSTONE/ SENIOR DESIGN EXPERIENCE 2025

DESIGN AND OPTIMIZATION OF SCOBET PRODUCTION

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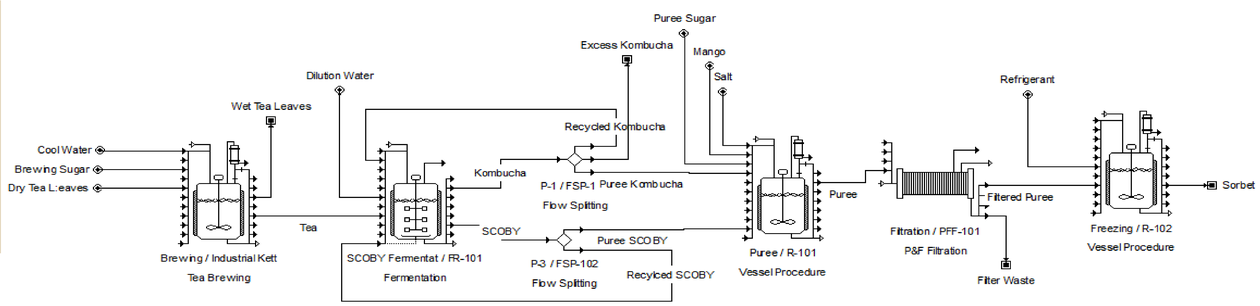
Project Objective

Develop an experimental design and business plan that optimizes the process production of a SCOBY sorbet (Scobet) by adopting circular methods to minimize discharge and energy consumption

Background

- Scobet converts kombucha waste byproduct into a novel dessert
- Kombucha is a fermented beverage from tea and SCOBY (symbiotic culture of bacteria and yeast)
- Fermented food products are trending in the U. S. given their health benefits
- Current digestive health market evaluated at about $13.53 billion
- CAGR is currently 8.3%
- International foods are growing in popularity, particularly in heavily populated regions
- Production and sales of both kombucha and Scobet maximizes profit
- Based on alternative analysis, the heuristic approach was deemed most appropriate for product manufacturing within each unit operation



Experimentation

Brewing
- 3 tea samples with 3 different brewing parameters were tested for polyphenol content
- Optimal extraction (167 mg/ml) at 85°C and 15 min

Fermentation
- Assessed mixed culture growth rate as a function of surface area
- Growth rate is directly proportional to the surface area of the fermentation

Pureeing & Freezing
- Assess probiotic viability changes
- Inoculated MRS with Scobet sample
- 930 MPN/mL pre-puree, 750 MPN/mL post-freeze

Design of Process Operations

Determination of equipment design
- Industrial kettle: V ~ 30 L, t ~ 30 min, P ~ 60 kW
- Fermenter: V ~ 1 bbl, fermentation time: 1 week
- Puree agitator: V ~ 134 L, impeller diameter ~0.811 m, P ~ 32.6 kW/batch
- Scraped heat exchanger: A ~ 5m^2, dynamic freezing time: 5 min, static freezing time: 2.8 hr

Optimization and Controls

Brewing
- Optimization of brew temperature to minimize heat exchange area and steam usage cost
- Optimal brewing conditions: 85°C & 15 minutes

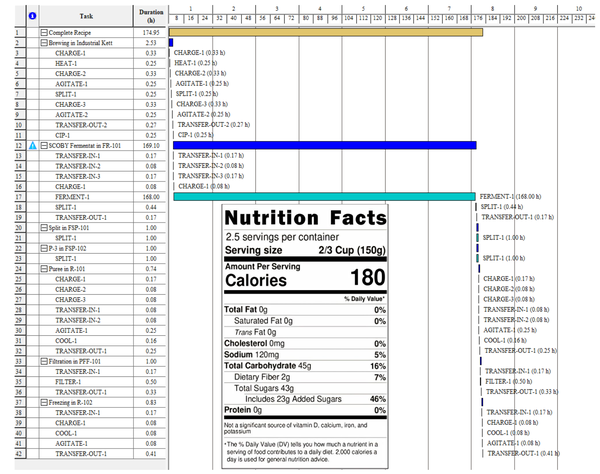
Fermentation
- Optimization of cost of fermentation as a function of fermentation time
  - Optimal fermentation time: 25 hours

Pureeing
- Optimization of rotational speed to reach desired consistency and reduce power consumption
  - Optimal RPM: 400 RPM

Freezing
- Optimization of rotational speed to minimize heat exchanger area
  - Optimal rotational speed: 300 RPM

Final Design

- Direct costs: **$29.68/kg product**
- Sale price: **$33.26/kg product** (for breakeven production)
- Annual yield: **155,818 kg/year**
- Annual revenue: **$5.18 million**
- Annual cost of production: **$4.53 million**
- Total capital investment: **$453,212**
- Plant systems: The sole byproducts from the process are tea leaf waste and fruit filtrate which can be converted and reused as:
  - Biofuel for powering the manufacturing plant
  - Compost for tea leaf production



Nutrition Facts

2.5 servings per container

Serving size 2/3 Cup (150g)

Amount Per Serving

Calories 180

	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 120mg	5%
Total Carbohydrate 45g	16%
Dietary Fiber 2g	7%
Total Sugars 43g	
Includes 23g Added Sugars	46%
Protein 0g	0%

Not a significant source of vitamin D, calcium, iron, and potassium

*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.

Future Works

- Improving the sample size for spectroscopy data of tea extraction
- Specific research into stages of kombucha fermentation for a more robust model
- Rheological analysis of different fruit purees
- More data collection required for change in viable cell counts throughout the processing