

Objective

To make use of a high production but underused fruit in the wine industry with a focus on using by-products of creation within and in alternative products.

Market Analysis

The US produces about 156 million bottles of sparkling wine each year, while Champagne alone shipped 326 million bottles in 2022.

Competing Brands

Korbel	\$19.99/L
Mamamango	\$21.32/L
Our Wine	\$20/L

Ethics and Trends

Social: Increased Consumption of Mangoes

Ethics: Decreasing waste of mango over-production

Environmental: Use of excess CO₂

Design Considerations/Alternatives

Pulping

- Automated vs hand washing
- Peeled vs unpeeled
- Type of juice press

Sterilization

- Chemical vs. Heating
- HTST vs. LTLT
- Water Usage

Fermentation

- Type of Yeast Culture
- Temperature and pH
- Fermentation Time

Carbonation

- Amount of carbon dioxide.
- Carbonation method
- Temperature of wine

Primary Unit Operations

➤ Pulping

➤ 3 phases

- Mango washing
- Removing Mango Peel
- Mango Juice Extraction

➤ Fermentation

- Mix of Yeast Cultures
- Acidic pH and lower Temperature
- Ferment without mango peels or solids

➤ Sterilization

- Steam/pH-Based
- Focus on bottles
- High temperature, Short Time

➤ Carbonation

- Collection and compression
- Forced Carbonization

Experimentation



ABV

1 Week: 3%
2 Weeks: 5%

Mango Juicing

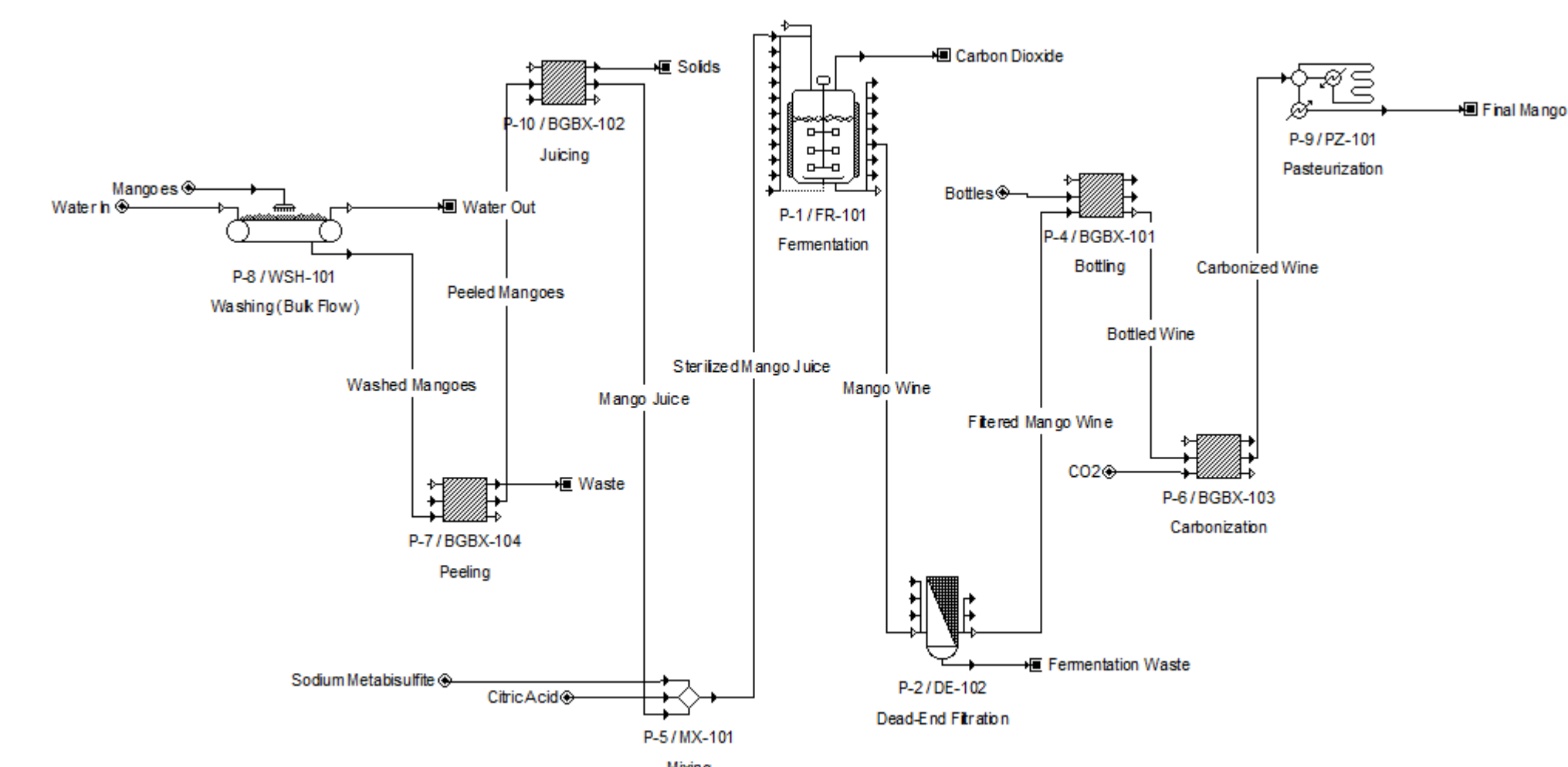
Base: 58%
Heating 37%

Considerations

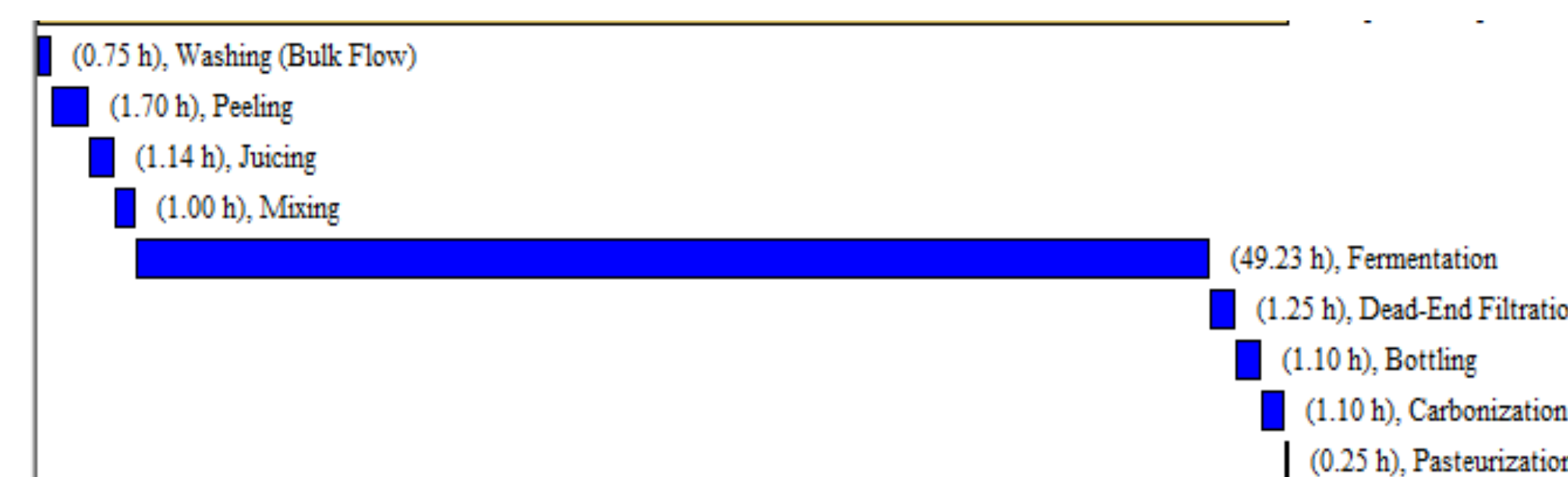
Ripeness of Fruit
By-Product Uses

Peeling Mangoes → Heating → Juicing → Fermentation → Bottling → Mango Wine

Process Overview



Process Scheduling and Optimization



Single Batch Optimized Schedule

For purposes of evaluating scheduling, the continuous process was mapped as a batch process:

Batch Time: 57.53 hours

Batch Size: 600 kg mangoes

Semi-Continuous Annual Batches: 1729 batches per year

Controls

Pulping

- PID controlled water heater/flowrate
- Photoelectric sensor for automated peeling
- Continuous Brix Sensors

Sterilization

- PID controlled flow rate
- IR Sensor for temperature
- Globe valve for flowrate

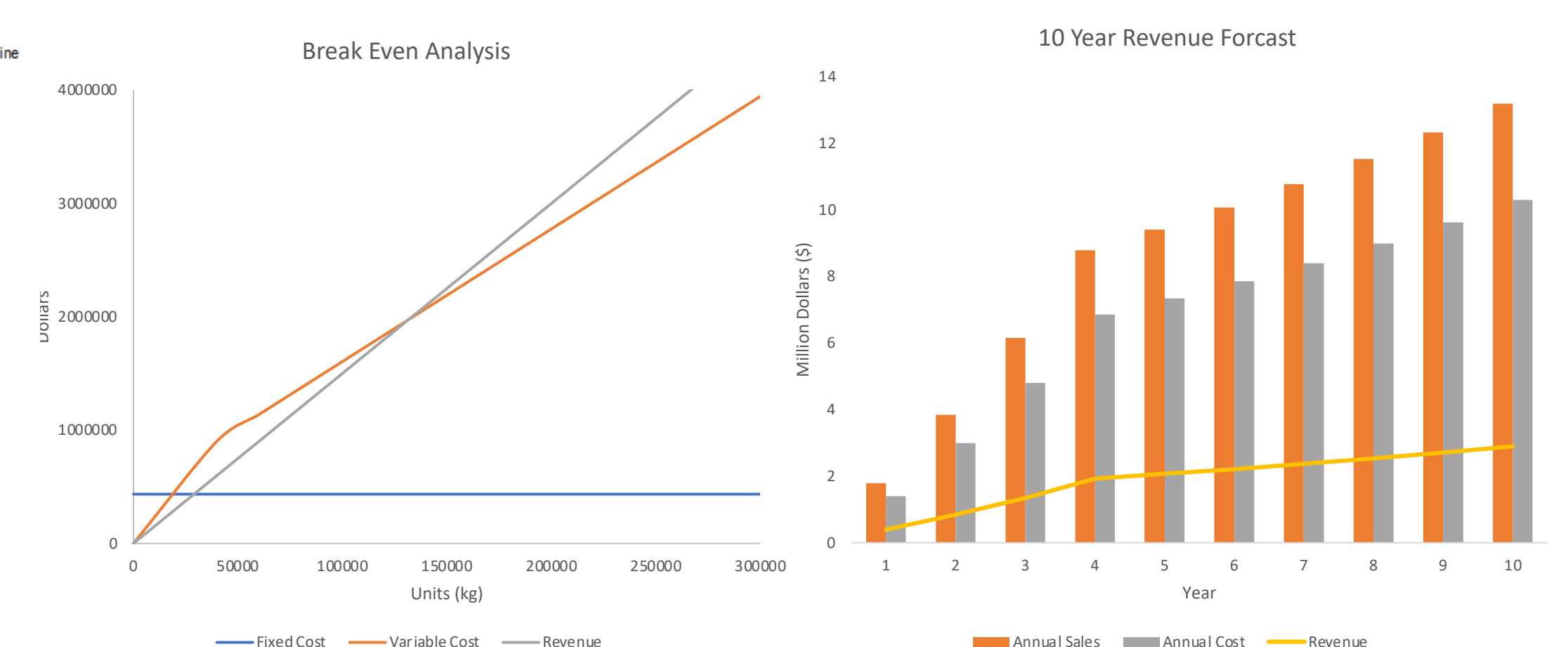
Fermentation

- PID controlled flow rate of inlet mango juice
- Thermistor for temperature of in-process batch
- ISFET sensor for pH

Carbonation

- PID controlled flow rate
- Digital temperature sensor
- Gauge pressure sensor

Economic Analysis



Optimization

Pulping

- Optimization Parameter: Feed Rate

- Optimum Feed Rate: 361 kg/hr

- Annualized Cost: -\$1,242,515

Fermentation

- Optimization Parameter: Temperature

- Optimum Temperature: 25 °C

- Annualized Cost: -\$6,791,467

Sterilization

- Optimization Parameter: Temperature

- Optimum Temperature : 120 °C

- Annualized Cost: -\$3,099,578

Carbonation

- Optimization Parameter: Amount

- Optimum Amount: 4 g/bottle

- Annualized Cost: -529.20\$

Future Recommendations

- Research and Development
 - Increasing juice yield
 - Optimization of ripeness
 - Alternative fruits

➤ Sustainability

- Utilizing carbon dioxide for factory farming of mangoes

➤ Increasing Profits

- Use of peels for new products
- Use of seeds in factory farm