SENIOR CAPSTONE/
SENIOR DESIGN EXPERIENCE
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# YoBi: Freeze-Dried Yogurt Bites

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## Objective

- Develop a shelf-stable, nutritious yogurt bite product using freeze-drying technology
- Design, optimize, and scale up an environmentally sustainable, high quality manufacturing process
- Conduct economic analysis to ensure market feasibility and profitability

## Market Analysis

- The freeze-dried food market is rapidly expanding due to demand for convenient, shelf-stable, and nutrient-dense snacks
- Global market projected to grow at a 7.6% CAGR from 2022 to 2023 (Grand View Research, 2023)
- Growth driven by advancements in preservation and a shift towards natural, minimally processed foods
- Freeze-dried yogurt bites offer a high-protein, probiotic rich snack that requires no refrigeration
- U.S. market valued at $5.4 billion in 2023, with growth in health-conscious and active lifestyle segments
- Few competitors offer yogurt-based freeze-dried snacks, presenting a clear opportunity for product differentiation

## Design Considerations

| Cultural/Social | Environmental |
|---|---|
| • Clean ingredients<br>• Ethical sourcing<br>• Adhere to fair trade practices | • Extended shelf-life → less food waste<br>• Reduce energy and carbon emissions<br>• Environmentally conscious packaging |

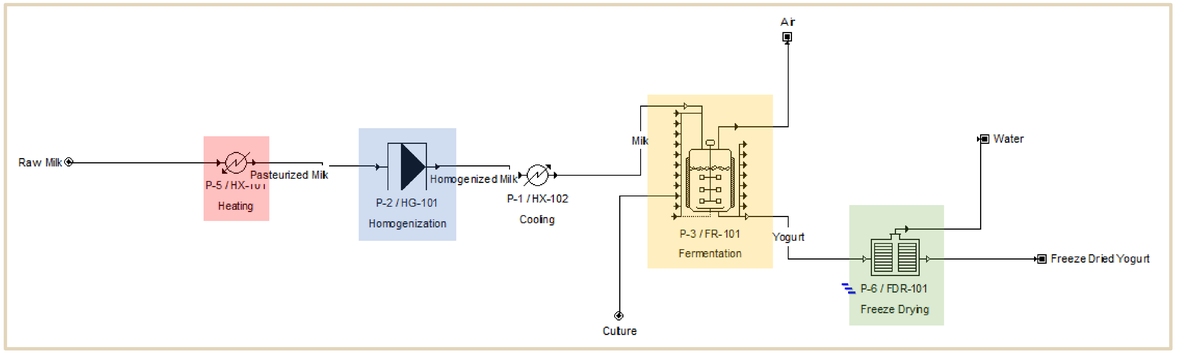


**Figure 1**: *Process Flow Diagram for freeze dried yogurt bites*

| Pasteurization | Homogenization | Fermentation | Freeze Drying |
|---|---|---|---|
| Chosen:<br>• High-Temperature, Short Time (HTST) Pasteurization –> 72°C for 30 seconds | Chosen:<br>• High Pressure Homogenization (HPH) | Chosen:<br>• Anaerobic Fermentation in a CSTR | Chosen:<br>• Conventional tray freeze drying |
| Alternatives:<br>• Low-Temperature, Long Time (LTLT) Pasteurization –> 63°C for 30 minutes | Alternatives:<br>• Ultrasound<br>• Microfluidization | Alternatives:<br>• Fed-batch reactor | Alternatives:<br>• Spray Drying<br>• Vacuum Drying |

## Experimental Design and Optimization

### Pasteurization

**Design:** Milk was batch-pasteurized at 73°C for 15 secs using a controlled hot water bath, and Colisure testing was used to measure microbial reduction.

**Results: E**ffective microbial reduction with no detectable coliforms (<1 MPM per 100 mL) present after treatment.

### Homogenization

**Design:** Different temperatures (65°C and 80°C) and different speeds (50% and 85%) were tested to determine the most efficient method. The Babcock method was used to determine fat content.

**Results:** A temperature of 65°C at 85% speed was most effective

### Fermentation

**Design:** Milk was inoculated with yogurt starter culture and fermented at 43°C for 6 hours. PH readings were taken every hour until a pH of 4.6 was reached

**Results:** Set yogurt with whey and "curd" separation

### Freeze Drying

**Design:** Developed and tested different drying temperature profiles to assess their impact on final moisture content

**Results:** Based on theoretical performance curves and literature, increasing shelf temperature improves heat flux and reduces drying time

## Plant Design and Scheduling

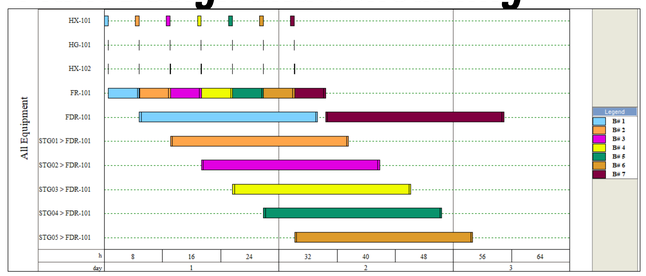


**Figure 2**: *A model of the most efficient scheduling for the plant, which maximizes time and resources*

## Economic Analysis

| | |
|---|---|
| **Total Capital Investment** | $7,851,320 |
| **Total Production Cost** | $2,496,923.11/year |
| **Price/40g package** | $4.99 |
| **Cumulative Net Profit (Year 1)** | $1,053,906.89 |

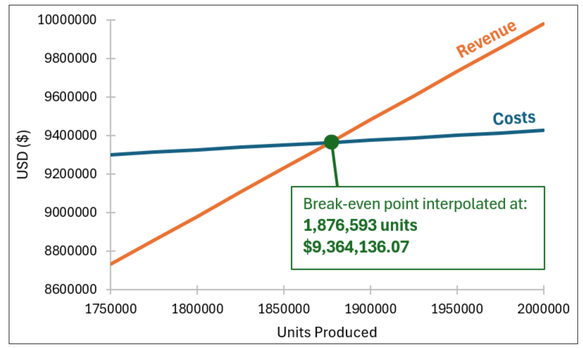


**Figure 3**: *The break-even chart for the product. The break-even point is about 1,876,593 single serve YoBi packages.*

## Future Work and Considerations

- Explore whey recycle stream from fermenter
- Determine optimal stabilizers to improve texture and shelf life
- Investigate ways to optimize nutritional content, such as developing Greek yogurt bites for higher protein content

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