Introduction

- It is all about the bubbles: Sourdough is fermented with a live culture of yeast and lactobacillus bacterium that must be fed water and flour daily.
- Simple Ingredients: Flour (54%), water (42%), active sourdough culture (2.6%), and salt (1.4%). That’s it!
- Partial Baking and Freezing: A long shelf-life means fresh bread with a crisp crust straight out of the oven every time
- Objective: To design and optimize the production line for artisan, par-baked, and frozen sourdough loaves in order to generate profit

Market Size

- Consumer preferences for bakery products have been shifting from basic to artisan
- Demand is high for all natural products

Global and Societal Impact

Health Benefits

- Fermentation reduces starch availability and gluten formation giving sourdough a low glycemic index
- Improves bioavailability of nutrients compared to white bread

Economic Benefits

- Fermentation reduces pH to allow for longer shelf-life and reduced food waste

Historical Impact

- First historical records are 6000 years old
- Nourished western US settlers

Project Timeline

- Literature Review and Patent Search
- Experimental Design
- Process Optimization and Plant Design
- Business Plan

Annual Material Cost

- 300 day per year continuous process with production rate of 670 loaves/hour (100 kg/hour)
- 720,000 kg/year production or 6,259,680 packs
- 4 rolls/pack at $12.00
- Income Tax: 35%
- Equipment Lifespan: 10 years
- Return on Investment: 20%

Alternative Solutions Evaluation

Steam Injection:

- Common baking practice used to decrease pore size in the crust
- However, experimentally reduced the bread quality

Culture Type:

- Can be natural (Type I), liquid (Type II), or spray-dried (Type III)
- Natural cultures are cheap and self-sustaining.
- However, the concentration of lactobacilli in the region is low
- Batches came out dense and tough, thus a spray-dried sample was used to start the culture.

Continuous vs. Batch:

- Typically a batch production because of starter culture kinetics
- Emerging technologies allow continuous processes.

Recommended Solutions

- Determine better simulation for steam injection
- Attempt proofing at higher temperatures to decrease proofing time to improve processing time
- Design experiment on re-baking time and temperature
- Evaluate possibility of CO₂ recovery from fermentation tanks
- Use of natural additives to improve crumb/crust sensory quality

Industrial Sourdough Processing

- Starter Culture
- Mixing & Proofing
- Partial Baking
- Freezing

Bread Chemistry

- Maillard Browning
- Starch Gelatinization
- Moisture Migration
- Microbial Conversions
  - Yeast CO₂ production
  - Lactic Acid Fermentation

Preliminary Energy and Mass Balance

- Process Optimization
- Processing Efficiency
- Utility Consumption

Plants Design

- Process Optimization
- Process Efficiency
- Equipment Selection

Acknowledgements:

- Thank you to Dr. Okos for the use of laboratory equipment used in testing
- Use of natural additives to improve crumb/crust sensory quality

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Technical Advisor:

- Dr. Martin Okos

Instructors:

- Dr. Martin Okos
- Troy Tonner
- Allysa Christoffer


Nourished western US settlers

- Four factor, full factorial design
- Tested proofing humidity and time, and baking temperature and steam injection
- Color analysis using scale to the right and sensory preference test
- Conclusions: Quality decreased with steam injection and increased with increased proofing time and humidity

 DOE Experimental Results

Crumb Texture - Crust Texture - Taste - Top Color - Bottom Color

Difference of Means

- Proofing Humidity - Proofing Time - Baking Temperature - Steam Injection

Annual Cash Flow

- $491,848

Annual Sale Revenue

- $75,116,160

Material Costs

- $385,196

Total Annual Utilities

- $506,752

Fixed Capital Percent of TCI

- 85%

Total Capital Investment

- $73,880,690

Business Plan

- Initial Cash Flow
- Return on Investment
- Total Annual Utilities
- Annual Sale Revenue
- Material Costs
- Fixed Capital Percent of TCI
- Total Capital Investment
- Annual Cash Flow

Equipment Lifespan: 10 years

Return on Investment: 20%

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