Freeze Dried Yogurt Bears

Introduction/Market

- Yogurt is a semisolid fermented product made from a standardized milk mixed by the activity of Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgarcus cultures.
- Yogurt has become more and more popular in recent years due to its nutritional value and benefits of probiotics.
- Compared with milk, yogurt is easier to digest and can be consumed by groups with low lactose tolerance.
- The consumption of probiotics has been shown to have health benefits such as prevention and treatment of diarrhea and enterococciis, and maintenance of general gut health.
- The consumption of yogurt has reached record levels globally: 13 million metric tons were consumed in 2016 alone.
- The problem for commercial yogurt products is the high content of sugar and artificial sweeteners.
- Drying yogurt can save storage and transportation resources and produce a more shelf-stable product.
- Dried yogurt has been commercialized, and many yogurt drinks add heat treated dry yogurt powder.
- Many drying processes which utilize heat input result in low probiotic levels in the dried product.
- Freeze dried dairy is a premium product, commanding a premium price: “The growing consumer interest toward such high-value dairy is also expected to be a future trend for freeze-drying technique in the dairy industry” [1]

Objectives

- This project endeavors to design an optimal method to capitalize on a substantial commercial opportunity.
- Plant design, ingredient chemistry, social and environmental implications, and processing effects on product quality were considered.
- Alternative processing techniques and formulations were investigated.
- These criteria were used to select an optimized set of process conditions.

Experimental Design

A Plackett-Burman experimental design was chosen to efficiently screen variables with the largest effects on quality and process efficiency in the manufacture of freeze dried yogurt. Yogurt batches were prepared, freeze-dried, and analyzed for variable effects on quality.

Plant Design

Economics

Retail price equivalent for yogurt products

<table>
<thead>
<tr>
<th>Traditional Yogurt</th>
<th>Freeze Dried Yogurt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>100 oz</td>
</tr>
<tr>
<td>Price</td>
<td>$3.49/oz</td>
</tr>
<tr>
<td>Total Value</td>
<td>$64.50</td>
</tr>
</tbody>
</table>

Summary of capital investment

- Direct Costs: $1,406,300.00
- Indirect Costs: $1,547,000.00
- FG: $12,156,000.00
- Working Capital: $2,107,500.00
- Total Capital Investment: $14,155,000.00

Summary of expenses and income

- Direct Production Costs: $1,920,796.70
- Fixed Charges: $1,133,800.00
- Plant Overhead Costs: $213,579.38
- General Expenses: $477,868.87
- Total Product Cost: $4,894,364.15

Income

- Yearly Production: 100,000 kg
- Value of Final Product: $51,52 per kg
- Yearly Income: $6,634,652.00
- Gross Earnings: $1,956,696.37

Results

<table>
<thead>
<tr>
<th>Variables Low High</th>
<th>Freeze Dryer Yield (%/w/w)</th>
<th>Water Activity</th>
<th>Moisture (%/w/w)</th>
<th>Probiotic Count (CFU/g)</th>
<th>Reconstitutibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Milk Fat %</td>
<td>+0.58% (p = 0.028)</td>
<td>-0.075</td>
<td>-0.19% (p = 0.146)</td>
<td>+2.6874 (p = 0.419)</td>
<td>-0.156 (p = 0.0003)</td>
</tr>
<tr>
<td>Straining</td>
<td>+0.54% (p = 0.029)</td>
<td>-0.0158</td>
<td>-0.20% (p = 0.140)</td>
<td>+2.6854 (p = 0.463)</td>
<td>+0.344 (p = 0.00004)</td>
</tr>
<tr>
<td>Pasteurization</td>
<td>+0.35% (p = 0.001)</td>
<td>-0.0136</td>
<td>-0.18% (p = 0.158)</td>
<td>+0.2633 (p = 0.463)</td>
<td>-0.259 (p = 0.00012)</td>
</tr>
<tr>
<td>Incubation Temp.</td>
<td>+0.08% (p = 0.030)</td>
<td>0.4695</td>
<td>0.13% (p = 0.219)</td>
<td>+4.4864 (p = 0.442)</td>
<td>-0.219 (p = 0.0016)</td>
</tr>
<tr>
<td>MPC Addition</td>
<td>-0.06% (p = 0.049)</td>
<td>0.0303</td>
<td>0.17% (p = 0.414)</td>
<td>+5.6754 (p = 0.408)</td>
<td>-0.0038 (p = 0.00085)</td>
</tr>
</tbody>
</table>

Significant effects on quality:

- Whole Milk, Strained, and Pasteurized at 95°C for 10 minutes.
- Any
- Highest Quality Conditions: Whole Milk, Strained, Pasteurized at 95°C for 10 minutes, MPC added

Source:


Acknowledgements:

We would like to thank Professor Okos for his guidance throughout this project. We would also like to thank Mirjana Curic-Bawden at Chtr. Hansen for supplying the culture used to make our product. Finally we would like to thank Erik Kurbskalek for allowing the use of the Skidmore Product Development Lab and Pilot Plant.

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