The Eurofins Group

Solutions For The Lifecycle Of Your Product

- Pipeline Innovation
- Consumer Research
- Data Management
- Sensory Evaluation
- Product Design
- Process Development

Testing

- Shelf-Life & Stability
- Nutritional Chemistry
- Challenge Studies & Process Validation
- Food Safety & Microbiology
- Contaminants/ Pesticides/Residues

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About The NFL

Agile, Integrated Product Innovation Services

- Immersion / Qualitative
- Co-Creation / Stations
- Quantitative CLT / HUTs
- Culinary Protocepting
- Product Formulation & Prototyping
- Science/Technology Application & Discovery
- Specification Management
- Process Authority
- Pilot Plant Production
- Co-Man Search and Support
- Scale-Up Support
- Descriptive Analysis
- Product Landscape®
- Shelf Life Studies

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SYNOPSIS

1. Reducing Sugar – A Puzzle?

2. Defining The Puzzle
   a. Functionality
   b. Regulatory
   c. Consumer

3. The Tools
   a. Ingredients
   b. Technologies

4. The Approach
   a. Sugar Substitution – Overall Approach
   b. ... And An Example

5. To Summarize: Solving The Sugar Reduction Puzzle
WHY REDUCE SUGAR?

Consumers perceive sugar worse than fat and salt for health

A study published in the Journal of Human Nutrition and Dietetics shows that consumers consider sugar content as the most important factor when making healthy food choices.

February 28, 2020
REDUCING...

Dictionary

Search for a word

re·duc·tion
/reˈdəkshən/
noun

1. the action or fact of making a specified thing smaller or less in amount, degree, or size.
   "talks on arms reduction"

Similar: depletion, cut, cutting, cutback, scaling down, trimming

Source: Oxford/Lexico Dictionaries
REDUCED SUGAR STRATEGIES

WHAT’S YOUR SUGAR STRATEGY?

Future opportunities for reduced sugar intake are unlocked through mainstream strategies, more emerging strategies, or a combination of strategies.

**2 in 5 U.S. consumers use sweeteners “because they like sweet things but want to reduce the calories.”**

**3 in 5 U.S. consumers would rather cut back on sugar than consume alternative sweeteners.**

**Patent activity is thriving in natural sweeteners, 42% growth in allulose publications is just one indicator of this research trend. (Global, 2018 vs. 2017)**

**1 in 2 U.S. consumers prefer savory to sweet taste in an afternoon snack.**

Source: Innova Market Insights (2019)

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SUGAR REDUCTION / SUBSTITUTION PUZZLE

- Any food is a system
  - Components
  - Interactions
- Reducing/replacing sugar = filling the gap
- Reduction strategy must fit!
Defining The Puzzle Gap
SUGAR FUNCTIONALITY…

✓ Sweetness, flavor enhancement and palatability
✓ Color and flavor formation
✓ Texture:
  • Body/mouthfeel/viscosity
  • Tenderizer
  • Control crystallization
  • Gelling
  • Creaming
✓ Stability:
  • Aw reduction
  • Prevent browning discoloration
  • Prevent staleness
  • Foam stabilizer
✓ Fermentation Support

IN APPLICATIONS

IMPORTANCE OF EACH FUNCTIONAL characteristic in major sugar use cases

Source: Lux Research Inc., 2018
Standards of Identity

e.g. yogurt:

“...Not less than 3.25 percent milkfat and not less than 8.25 percent solids not fat, and has a titratable acidity of not less than 0.9 percent, expressed as lactic acid...”

(21CFR 131.200)
Understand The Consumer

80% of U.S. consumers are trying to limit or avoid sugar, up from 75% in 2017

3 in 10 consumers say they don’t sweeten foods or beverages

Source: IFIC Food & Health Survey (2019)

53% of consumers say the exclusion of undesirable ingredients is more important than the inclusion of beneficial ingredients

Source: Nielsen (2018)

6 in 10 consumers say they are extremely likely to check an ingredient list to avoid a certain ingredient

Source: Cargill (2017)
Understand The Consumer (cont.)

<table>
<thead>
<tr>
<th>Naturelles</th>
<th>Balancers</th>
<th>Sugar-frees</th>
<th>Sweet teeths</th>
<th>Carefrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey</td>
<td>Honey</td>
<td>Stevia</td>
<td>Honey</td>
<td>White table sugar</td>
</tr>
<tr>
<td>Raw sugar</td>
<td>Raw sugar</td>
<td>Honey</td>
<td>White table sugar</td>
<td>Honey</td>
</tr>
<tr>
<td>White table sugar</td>
<td>White table sugar</td>
<td>Sucralose</td>
<td>Raw sugar</td>
<td>Raw sugar</td>
</tr>
<tr>
<td>Agave</td>
<td>Stevia</td>
<td>Agave</td>
<td>Stevia</td>
<td>Molasses</td>
</tr>
<tr>
<td>Stevia</td>
<td>Agave</td>
<td>Aspartame</td>
<td>Agave</td>
<td>Agave</td>
</tr>
</tbody>
</table>

Source: Ingredion (2019)
The Tools
# Sweeteners

<table>
<thead>
<tr>
<th>Nutritive</th>
<th>kCal/g</th>
<th>SEV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sugar</strong> – in all its forms</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Simple mono &amp; disaccharides:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fructose</td>
<td>4</td>
<td>1.7</td>
</tr>
<tr>
<td>• Dextrose</td>
<td>4</td>
<td>0.7</td>
</tr>
<tr>
<td>• Maltose</td>
<td>4</td>
<td>0.3</td>
</tr>
<tr>
<td>• Isomaltulose</td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>• Tagatose</td>
<td>1.5</td>
<td>0.92</td>
</tr>
<tr>
<td>Polyols:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Maltitol</td>
<td>2.4</td>
<td>0.9</td>
</tr>
<tr>
<td>• Sorbitol</td>
<td>2.6</td>
<td>0.55</td>
</tr>
<tr>
<td>• Xylitol</td>
<td>2.4</td>
<td>1</td>
</tr>
<tr>
<td>• Isomalt</td>
<td>2.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Other purified compounds:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Maltodextrin</td>
<td>4</td>
<td>0.1 – 0.2</td>
</tr>
<tr>
<td>• scFOS</td>
<td>1.4</td>
<td>0.5</td>
</tr>
<tr>
<td>• Inulin</td>
<td>1.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Natural extracts/combinations:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Honey</td>
<td>4</td>
<td>~1.1</td>
</tr>
<tr>
<td>• Syrups: agave, maple, rice, date etc.</td>
<td>4</td>
<td>0.5 – 1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non - Nutritive</th>
<th>SEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple carbohydrates:</td>
<td></td>
</tr>
<tr>
<td>• Allulose*</td>
<td>0.7</td>
</tr>
<tr>
<td>Polyols:</td>
<td></td>
</tr>
<tr>
<td>• Erythritol*</td>
<td>0.65</td>
</tr>
<tr>
<td>Artificial High-Intensity Sweeteners:</td>
<td></td>
</tr>
<tr>
<td>• Sucralose</td>
<td>~600</td>
</tr>
<tr>
<td>• Acesulfame – K</td>
<td>~200</td>
</tr>
<tr>
<td>• Aspartame</td>
<td>~300</td>
</tr>
<tr>
<td>• Saccharin</td>
<td>7,000 – 13,000</td>
</tr>
<tr>
<td>• Neotame</td>
<td></td>
</tr>
<tr>
<td>Natural High Intensity Extracts:</td>
<td></td>
</tr>
<tr>
<td>• Stevia extracts: Reb A, Reb D, Reb M of various purities</td>
<td>100 – 400</td>
</tr>
<tr>
<td>• Monk Fruit extracts of various purities</td>
<td>100 – 250</td>
</tr>
</tbody>
</table>

Source: Compiled from literature
Sweeteners (cont.)

Source: Ingredion
Sweeteners (cont.)

Technical Data: Time-Intensity Profile

Source: Morita Kogaku Kogyo

Source: Tan et al., Food Res. Intl., 2019
Sweetness Modulators

• Address flavor and/or temporal profile challenges

# Technologies

## I. Reduce Intrinsic Sugar

<table>
<thead>
<tr>
<th>BRAND</th>
<th>FAT CONTENT</th>
<th>FLAVOR</th>
<th>SUGAR PER 5.3 OZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chobani</td>
<td>whole milk</td>
<td>plain</td>
<td>5.0</td>
</tr>
<tr>
<td>Chobani</td>
<td>nonfat</td>
<td>strawberry</td>
<td>5.3</td>
</tr>
<tr>
<td>Organic Valley</td>
<td>whole milk</td>
<td>plain</td>
<td>7.1</td>
</tr>
<tr>
<td>Stonyfield</td>
<td>whole milk</td>
<td>plain</td>
<td>7.3</td>
</tr>
<tr>
<td>Dannon</td>
<td>whole milk</td>
<td>plain</td>
<td>7.3</td>
</tr>
<tr>
<td>Stonyfield</td>
<td>nonfat</td>
<td>blueberry on the bottom</td>
<td>8.0</td>
</tr>
<tr>
<td>Stonyfield</td>
<td>nonfat</td>
<td>plain</td>
<td>8.0</td>
</tr>
<tr>
<td>Brown Cow</td>
<td>whole milk</td>
<td>plain</td>
<td>8.0</td>
</tr>
<tr>
<td>Yoplait</td>
<td>nonfat</td>
<td>strawberry</td>
<td>8.8</td>
</tr>
<tr>
<td>Chobani</td>
<td>lowfat</td>
<td>&quot;is hint of strawberry&quot;</td>
<td>9.0</td>
</tr>
<tr>
<td>Dannon</td>
<td>nonfat</td>
<td>plain</td>
<td>9.9</td>
</tr>
<tr>
<td>Chobani</td>
<td>nonfat</td>
<td>vanilla</td>
<td>13.0</td>
</tr>
<tr>
<td>Stonyfield</td>
<td>lowfat</td>
<td>strawberry</td>
<td>14.0</td>
</tr>
<tr>
<td>Stonyfield</td>
<td>whole milk</td>
<td>strawberry</td>
<td>14.6</td>
</tr>
<tr>
<td>Stonyfield</td>
<td>whole milk</td>
<td>strawberry on the bottom</td>
<td>14.8</td>
</tr>
<tr>
<td>Chobani</td>
<td>nonfat</td>
<td>strawberry on the bottom</td>
<td>15.0</td>
</tr>
<tr>
<td>Dannon</td>
<td>whole milk</td>
<td>vanilla</td>
<td>15.9</td>
</tr>
<tr>
<td>Organic Valley</td>
<td>whole milk</td>
<td>vanilla</td>
<td>15.9</td>
</tr>
<tr>
<td>Brown Cow</td>
<td>whole milk</td>
<td>vanilla</td>
<td>16.0</td>
</tr>
<tr>
<td>Dannon</td>
<td>whole milk</td>
<td>strawberry</td>
<td>16.0</td>
</tr>
<tr>
<td>Yoplait</td>
<td>lowfat</td>
<td>strawberry</td>
<td>16.8</td>
</tr>
<tr>
<td>Yoplait</td>
<td>lowfat</td>
<td>strawberry (whips)</td>
<td>18.3</td>
</tr>
<tr>
<td>Stonyfield</td>
<td>whole milk</td>
<td>chocolate on the bottom</td>
<td>19.1</td>
</tr>
<tr>
<td>Dannon</td>
<td>lowfat</td>
<td>vanilla</td>
<td>19.4</td>
</tr>
<tr>
<td>Brown Cow</td>
<td>whole milk</td>
<td>strawberry</td>
<td>22.0</td>
</tr>
<tr>
<td>Dannon</td>
<td>lowfat</td>
<td>strawberry on the bottom</td>
<td>22.0</td>
</tr>
</tbody>
</table>

Source: Popular Science (2018)

![Yogurt Nutrition Facts](source: The Good Brand™)
II. Reduce Sweetness Needed

- Sweetness – potentiating molecules
- Aromas providing cross-modal effects
- Stealth reduction approaches
III. Ingredients

Lux Take: Sugar Reduction Technology Ranking

Source: Lux Research Inc., 2018
III. Ingredients: A Better Sugar?

DouxMatok Sugar

Source: DouxMatok

Nestlé Structured Sugar

Source: Nestlé
The Approach
SUGAR REDUCTION – OVERALL APPROACH

1. Define application
2. Define objective & scope
3. Criteria & guardrails
4. Select tools
5. Design solution
6. Evaluate performance
7. Refine, as needed

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CASE STUDY: PROTOTYPING

Define application

- Plain yogurt add-on
- Stretch goal: add to pancakes, waffles, oatmeal

Define objective & scope

- Provide sweetness, fruit and flavor
- Calories, sugar content ≤ yogurt with fruit
- Portable stick/sachet
# CASE STUDY: PROTOTYPING (cont.)

## Criteria & guardrails

### Consumer Research & Market Trends
- Natural
- Taste is King
- Real fruit
- Shelf stable and convenient

### Health & Nutrition
- ≤ 10 Calories

### Functionality
- Sweetness = 2 tsp sugar
- Flavor
- Color
- Mouthfeel
- Portability
- Quick distribution via stirring

### Regulatory
- n/a

### Labeling
- ≤ 5g
- Fruit claims?

### Stability
- Aw < 0.4
CASE STUDY: PROTOTYPING (cont.)

Select Tools

✓ Zero Sugar
✓ Target Greek yogurt with blueberry
✓ Ingredients of interest:
  • Natural sweeteners: erythritol, stevia extracts
  • Fruit pieces
  • Fruit flavors
  • Hydrocolloids TBD
CASE STUDY: PROTOTYPING (cont.)

Design Solution

- Erythritol
- Freeze-dried blueberry pieces
- Cranberry and blueberry powders
- Blueberry flavor
- Stevia extract: Reb D + Reb A
- Texturizer system

Sweetness Intensity

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Evaluate performance

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Blueberry GY</th>
<th>Plain GY + Add-On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving size, g</td>
<td>150</td>
<td>150 + 5</td>
</tr>
<tr>
<td>Calories</td>
<td>130</td>
<td>80 + 10</td>
</tr>
<tr>
<td>Carbohydrates, g</td>
<td>19</td>
<td>6 + 4</td>
</tr>
<tr>
<td>Sugars, g</td>
<td>15</td>
<td>4 + 1</td>
</tr>
</tbody>
</table>

 ✓ Sensory performance
To Summarize...
SUGAR REDUCTION / SUBSTITUTION

Define application
Define objective & scope
Criteria & guardrails
Select tools
Design solution
Evaluate performance
Refine, as needed

Reduction Approach

Sensory
Stability
Regulatory
Cost
Sweetness
Health
Functionality
Safety
Thank You!