Flavor Challenges in Non-dairy Frozen Dessert

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• Monica Kapoor is a Principal Scientist at Edlong Corporation in their Applications Team. In this role, she solves customer challenges in flavor by working side-by-side with customer R&D and Edlong flavorists to deliver flavor solutions.

• Monica has over 20 years of experience in the food industry working for leading food ingredient and flavor companies where she continues to lead food ingredient focused R&D in a variety of food ingredients and products such as dairy, fats and oils, beverages, seasonings, and plant-based systems.

• Monica received her M.S. in Food Science from Kansas State University and her B.S. in Biology from Beloit College.
Agenda

1. Who is Edlong?

2. Where do flavor challenges in non-dairy frozen desserts come from?

EDLONG THEN

1914

1960s

1980s

1990s
THE WORLD’S MOST COMPLETE LINE OF DAIRY FLAVORS

MILK

BUTTER

CHEESE

CREAM

CULTURED

SWEET DAIRY

MASKING / MOUTHFEEL
Where Do Flavor Challenges in Non-Dairy Frozen Desserts Come From?
Non-Dairy Frozen Dessert Manufacture

Source: dairyprocessing.com
Factors influencing the flavor of non-dairy frozen desserts

- **Ingredients**
  - Protein Ingredients
  - Fats and Oils
  - Ingredient-Ingredient and Ingredient-Flavor Interactions

- **Processing**
  - Thermal Processing
  - Proper cooling

- **Packaging, Storage and Shelf life**

- **Final flavor impact and Eating Experience**
1. Ingredients

OAT MILK (WATER, OATS), LIQUID SUGAR (SUGAR, WATER), CORN SYRUP, COCONUT OIL, WHEAT FLOUR, WATER, SUGAR, BROWN SUGAR, COCOA (PROCESSED WITH ALKALI), SOYBEAN OIL, CHOCOLATE LIQUOR, PEA PROTEIN, FAVA BEAN PROTEIN, TAPIOCA FLOUR, NATURAL FLAVOR, VANILLA EXTRACT, GUAR GUM, MOLASSES, SALT, LOCUST BEAN GUM, COCOA BUTTER, SUNFLOWER LECITHIN, SOY LECITHIN, INVERT SUGAR.
Impact of Ingredients

117 participants evaluated the sensory attributes using CATA technique.

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>Cream, modified milk Ingredients, sugars (sugar, glucose), concentrated skim milk and/or skim milk powder, vanilla bean seeds, vanilla extract, tara gum, mono &amp; diglycerides, natural flavour, carob bean gum, guar gum</td>
</tr>
<tr>
<td>Frozen Dairy</td>
<td>Modified milk ingredients, water, sugars (sugar, glucose), coconut Oil, vanilla extract, mono and diglycerides, tara gum, guar gum, natural vanilla flavour, carob bean gum, annato, turmeric extract</td>
</tr>
<tr>
<td>Dessert (FDD)</td>
<td></td>
</tr>
<tr>
<td>Coconut</td>
<td>Coconut base (filtered water, coconut), sugars (cane sugar, tapioca syrup), coconut oil, pea protein, locust bean gum, guar gum, natural flavour, vanilla bean</td>
</tr>
<tr>
<td>Cashew</td>
<td>Cashew base (filtered Water, Cashews), sugars (cane sugar, tapioca syrup), coconut oil, pea protein, sea salt, locust bean gum, vanilla extract, guar gum, natural flavour</td>
</tr>
<tr>
<td>Soy</td>
<td>Soymilk (filtered water, soybeans), tapioca syrup, cane sugar, soybean oil, inulin, locust bean gum, gellan gum, guar gum, natural flavour</td>
</tr>
</tbody>
</table>
Impact of Ingredients

Sensory Perception Mapping

Gorman, M. et al. 2023
Impact of Protein Ingredients

Protein Ingredients

Inherent (off) flavors

Protein-Flavor Interactions
Plant Protein Characterization

- 30 different commercial protein ingredients
- Trained descriptive panel
- 10% solutions at 21 C

USDEC, DMI (2018)
Characterization Grouping

**Plant Proteins**
- Cereal
- Sulfurous
- Beany
- Pyrazine/bell pepper
- Earthy/potting soil
- Fruity
- Sour aromatic
- Sour
- Umami

**Dairy Proteins**
- Cardboard
- Brothy
- Herbal/grassy
- Salty
- Bitter
- Astringent
- Sweet aromatic
- Milky/cooked
- Soapy
- Animal
- Tortilla

USDEC, DMI (2018)
Flavor Variability in Pea Protein from Various Suppliers

PCA Biplot of sensory properties and volatile compounds of 24 rehydrated commercialized Pea Protein (Liu Y, Cadwallader DC, Drake MA, 2022)
Protein - Flavor Interactions

<table>
<thead>
<tr>
<th>Type of interactions</th>
<th>Secondary molecular interactions</th>
<th>Regions or groups of proteins involved</th>
<th>Reversibility</th>
<th>Example of flavours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicochemical interactions</td>
<td>Hydrophobic interactions</td>
<td>Interior hydrophobic area of proteins</td>
<td>Reversible</td>
<td>Ketones, aldehydes, alcohols, ester</td>
</tr>
<tr>
<td></td>
<td>Hydrogen bonds</td>
<td>-OH, -COOH, -SH</td>
<td>Reversible</td>
<td>Aliphatic alcohols, lactone, volatile acids</td>
</tr>
<tr>
<td></td>
<td>Ionic bonds/electrostatic linkages</td>
<td>-NH₂, -OH</td>
<td>Reversible</td>
<td>Volatile acid</td>
</tr>
<tr>
<td>Chemical bondings</td>
<td>Covalent linkages</td>
<td>-S-S, -SH, -NH₂</td>
<td>Reversible</td>
<td>Hydrocarbons, Aldehydes, vanillin, sulphur containing flavours</td>
</tr>
</tbody>
</table>

Protein – Flavor Interaction: Hydrophobic Binding

- Flavor muting
- Loss of flavor over-time

Figure 4. Opportunities for flavour to interact with protein molecules (Schematic model adapted and modified from Reineccius (2006))

Kun and Arntfield, 2016
Impact of Fats and Oils

✓ Mouthfeel
  ✓ Due to difference in SFC vs. butterfat
  ✓ Blend fats to get similar SFC (e.g. coconut + soy oil)

✓ Oxidation
  ✓ Factor in oxidative stability when formulating (e.g. High Oleic oils)

Fig. 3.1 Variation of liquid fat content with temperature for fats suitable for use in ice cream

Goff and Hartel, 2013
Strategies To Mitigate Flavor Challenges In Non-Dairy Frozen Desserts
Strategies To Mitigate Flavor Challenges In Non-Dairy Frozen Desserts

1. Off-flavor masking

2. Using highly aromatic flavors

3. Congruent Flavor Technique

4. Off-note reduction (process-driven)
   1. Fermentation (e.g. Fermented pea protein)
   2. Volatilization of off-flavors (e.g. Direct-steam inject)
1. Masking

Masking vs. blocking

- **Masking**: using compounds to neutralize off-notes without imparting characteristic flavor

- **Blocking**: happens at the taste receptor site, using compounds to bind specific off-note molecule → changing the molecular format → incompatible to attach at the receptor site.
  
  More common in pharma/ drug industry.
Masking Techniques

✓ Mixture suppression
  • Using a strong taste to mask other (e.g. sugar, NaCl – beware FPD)

✓ Using masking flavors
  • Different technologies from different flavor houses

“A spoonful of sugar helps the medicine go down.”
2. Using Highly Aromatic Flavors

- High aromatic flavors or extractives to dominate off-notes
- E.g. blueberry flavor, banana flavor, vanilla, etc.
- Odor-induced Taste Enhancement (OITE)

Cross modal sensory interaction of taste and smell
3. Congruent Flavor Technique

• Select flavor profile that work with the note in your base mix.

Mix undertone
Brown caramelic
Brown, bitter
Cereal

Congruent Flavor
Caramel, Toffee
Chocolate
Sugar Cookies

• Some masking work might still be needed to clean up other undesirable off-note (beany, grassy, etc.)
Strategies to mitigate lack of mouthfeel

✓ Select appropriate Fats and oils, or combination thereof, to create SFC like SFC in milkfat

✓ Using mouthfeel flavors
  ✓ Enhances perception of creaminess and fatty mouthfeel.
  ✓ Proprietary technology
Key Take Aways

• Ingredients are one of the major factors contributing to flavor challenges in non-dairy frozen desserts
  • Alternative proteins and fats
  • Ingredient selection matters

• Major flavor challenges include:
  • Inherent (off) flavors from ingredients
  • Protein-flavor interactions that leads to loss of flavor

• There are various techniques and strategies that are available to reduce off-flavors in non-dairy frozen desserts and other plant based dairy products

• Flavor Masking is the most common technique and can be combined with other strategies to achieve a “winning” product for your consumers.
We can help mask...

- CHIA SEEDS: 6-9 grams protein per 3 tbsp
- POTATO: 8 grams protein per 1 large
- PEAS: 4 grams protein per 64 grams
- ALMONDS: 15 grams protein per 64 grams
- ALMOND BUTTER: 7 grams protein per 2 tbsp
- HAZELNUTS: 10 grams protein per 64 grams
- WHEAT BERRIES: 4 grams protein per 64 grams
- BLACK BEANS: 4 grams protein per 64 grams
- BLACK EYED PEAS: 13.5 grams protein per 64 grams
- OATMEAL: 3.5 grams protein per 64 grams
- CHICKPEAS: 7.5 grams protein per 64 grams
- FLAXSEED: 6-8 grams protein per 3 tbsp
- SPIRULINA: 12 grams protein per 3 tbsp
- HEMP SEEDS: 10 grams protein per 3 tbsp
- QUINOA: 4 grams protein per 64 grams
- EDAMAME: 13 grams protein per 64 grams
- ...and more!

Thank You!

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