1. **How do we classify sweeteners?**

   - Natural sweeteners (honey, maple syrup, molasses, date sugar, fruit juice)
   - Artificial sweeteners
   - Natural sweeteners
   - Extensive sweeteners (polyol, not as sweet as sugar)
   - Intensive sweeteners

2. **Non-calorie sweeteners**
   - Low-calorie sweeteners
   - Reduced-calorie sweeteners

3. **Nutritive sweeteners** (naturally occurring sugar, added sugars)
   - Non-nutritive sweeteners (saccharin, etc)

4. **Which one do you choose?**

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<table>
<thead>
<tr>
<th>INS No</th>
<th>Additive</th>
<th>Functional Class</th>
<th>Year Adopted</th>
<th>Dietary Energy (Kcal/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>968</td>
<td>Erythritol</td>
<td>Flavour enhancer, Humectant, Sweetener</td>
<td>2001</td>
<td>0.2</td>
</tr>
<tr>
<td>966</td>
<td>Lactitol</td>
<td>Emulsifier, Sweetener, Thicken</td>
<td>1999</td>
<td>2.0</td>
</tr>
<tr>
<td>965(i)</td>
<td>Maltitol</td>
<td>Bulking agent, Emulsifier, Humectant, Stabilizer, Sweetener, Thicken</td>
<td>1999</td>
<td>2.1</td>
</tr>
<tr>
<td>421</td>
<td>Mannitol</td>
<td>Anticaking agent, Bulking agent, Humectant, Stabilizer, Sweetener, Thicken</td>
<td>1999</td>
<td>1.6</td>
</tr>
<tr>
<td>964</td>
<td>Polyglycitol syrup</td>
<td>Sweetener</td>
<td>2001</td>
<td>3.0</td>
</tr>
<tr>
<td>420(i)</td>
<td>Sorbitol</td>
<td>Bulking agent, Humectant, Sequestrant, Stabilizer, Sweetener, Thicken</td>
<td>1999</td>
<td>2.6</td>
</tr>
<tr>
<td>967</td>
<td>Xylitol</td>
<td>Emulsifier, Humectant, Stabilizer, Sweetener, Thicken</td>
<td>1999</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Source: GSFA, Table 3 (www.codexalimentarius.org)
When added to foods, polyols add sweetness, bulk and texture. They also help food stay moist, prevent browning when heated and add a cooling sensation to products. Polyols are often combined with artificial sweeteners to enhance sweetness. Polyols can be used in the food with the same volume as sugar but with about half of the calories.

Examples of products with polyols:
- Chewing gum
- Baked goods
- Candy
- Chocolate
- Ice cream
- Cough drops
- Frozen desserts
- Cough syrup

### Non-Caloric Sweeteners (NCS)

<table>
<thead>
<tr>
<th>Intense Sweeteners</th>
<th>INS</th>
<th>Year of Discovery</th>
<th>Sweetness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acesulphame potassium</td>
<td>950</td>
<td>1967</td>
<td>200</td>
</tr>
<tr>
<td>Alitame</td>
<td>956</td>
<td>1979</td>
<td>2000</td>
</tr>
<tr>
<td>Aspartame</td>
<td>951</td>
<td>1965</td>
<td>200</td>
</tr>
<tr>
<td>Aspartame-acesulphame salt</td>
<td>962</td>
<td>1937</td>
<td>350</td>
</tr>
<tr>
<td>Cyclamate or Calcium cyclamate or Sodium cyclamate</td>
<td>952</td>
<td>1937</td>
<td>30-50</td>
</tr>
<tr>
<td>Neotame</td>
<td>961</td>
<td>1992</td>
<td>7000 – 13,000</td>
</tr>
<tr>
<td>Saccharin</td>
<td>954</td>
<td>1878</td>
<td>300</td>
</tr>
<tr>
<td>Stevia (Steviol glycosides)</td>
<td>960</td>
<td>1887</td>
<td>250 - 300</td>
</tr>
<tr>
<td>Sucralose</td>
<td>955</td>
<td>1976</td>
<td>600</td>
</tr>
<tr>
<td>Thaumatin</td>
<td>957</td>
<td>1972</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Example of Synergy in Intense Sweeteners


What will happen when you chew your food or drink your beverage?

www.elperfecto.com

A sweetener tastes sweet

Why?

Schallenberger’s “saporous unit” theory
Shallenberger and Acree (1967)

“Sweet” molecule contains H-bonding forming groups such as hydroxyls, amines etc. Sweetness: “AH – B” Hypothesis

A dan B electron negative atom, typically O and N
H hydrogen

How sweetness receptor site interact with sweeteners (saccharin)

Geometrical saporous group is important to interact with the sweetness receptor site

Acesulfame-K (potassium salt)

Receptor Site with Saccharin

Receptor Site with Acesulfame

http://chemistry.elmhurst.edu/vchembook/549receptor.html
How do we measure the sweetness of sweeteners?

- **By comparing them to sugar (sucrose)**
- **Standard:** a sugar solution of **36 mg/mL**
- **Example:** a sweetener solution (4 mg/ml) tastes as sweet as sugar solution (36 mg/ml), then the sweetness is \( \frac{36}{4} = 9 \) (nine times as sweet as the sugar solution)
Saccharin often gives a **bitter metallic aftertaste** at high levels. **Blend or add certain compounds** such as tartaric acid, dipeptides or gluconates to **reduce this aftertaste**.

**Compound Sweetener:**
A product made from various natural or synthetic sweeteners together to produce compound taste and function.

**Criteria of good quality compound sweetener:**
- Good taste (very similar to cane sugar)
- Enhances flavors, particularly those of fruit, chocolate, coffee and vanilla
- Masks the bitter after-tastes of intense sweeteners such as cyclamate and saccharin
- Easy to handle
- High solubility
- High freezing point depression
- High osmotic pressure in solution (low water activity)
- Acts as a good humectant
- Low viscosity in solution
- Browns readily (Maillard reaction)

**Application:** Used in beverage, fruit juice, cold drink, dairy products, preserved foods, bakery foods, confectionery, etc.

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**Challenges in Formulation with High Intensity Sweeteners**

Various high intensity sweeteners to a varying degree have inherent flavor properties:

- a delay in the onset of the perceived sweetness;
- a lingering sweetness;
- bitter aftertaste;
- metallic aftertaste;
- a non-linear sweetener concentration to sweetness equivalency ratio;
- adaptation or desensitizing; and
- a lack of mouthfeel or body.

High intensity sweeteners extracted from plants may have an herbal or licorice type flavor.

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Significant differences exist in the **bitter taste** between **sucrose** and the **erythritol/stevia** combination. This combination indicates higher intensities in this attribute.

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**QDA data**

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**QDA data**

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Erythritol: the lowest intensities in sweet taste (half as strong as sucrose), the highest intensities in the bitter taste. Higher intensities than maltitol in the cooling effect.
Maltitol: sweeter than erythritol, less sweeter than sucrose. Together with sucrose it shows significant lower intensities in the bitter taste and the cooling effect.
Sucrose: the sweetest sample and the sweetener which has the significant highest intensities in the long-lasting sweetness.

QDA data

Consideration in formulating sweety products

- We talk about the total flavor acceptability, not only the sweetness
- Several factors may influence the perception of flavor:
  - appearance
  - mouthfeel or texture
- Viscosity influences the perception of sweetness. Example:
  - Sorbitol is more viscous than other polyol (same T and C)
  - Replacing sucrose or corn syrup with intense sweeteners will significantly affect the viscosity, body, and mouthfeel
  - Adding solids or ingredients that increase viscosity will likely change the flavor perception
- Because intense sweeteners are used at low level they have no influence on the surface tension or viscosity of the finished product
- The temperature at which the product is consumed influences the perception of sweetness and flavor (volatility of certain compounds)

In producing acceptable products we need CREATIVITY

Dedi Fardiaz
ILSI, Singapore, 27/10/2015

Improving the Taste of Stevia with Taste Modifiers
(http://www.foodprocessing.com/assets/knowledge_centers/WILD_Flavors/assets/sweeteners_and_taste_modification.pdf)

What is it important? Sensory characteristics of a food product will greatly influence the consumer preference

Dedi Fardiaz
ILSI, Singapore, 27/10/2015
Thank You Very Much