2.122 Other Alternative Sweeteners

Other alternative sweeteners have been developed to provide zero-calorie or low calorie sweetening for foods and drinks. The sweeteners that have been approved by the FDA are saccharin, aspartame, neotame, acesulfame potassium (K), sucralose, and tagatose. In late 2008 the FDA first decided that it would allow the use of "highly purified stevia preparations in food products," essentially allowing the natural sweetener to begin to be used.

Because many of these provide little to no calories, these sweeteners are also referred to as non-nutritive sweeteners. Aside from tagatose, all of the sweeteners on the list below meet this criteria. Aspartame does provide calories, but because it is far sweeter than sugar, the small amount used does not contribute meaningful calories to a person's diet. Until the FDA allowed the use of stevia, this collection of sweeteners were known as artificial sweeteners because they were synthetically or artificially produced. However, with stevia, the descriptor artificial can no longer be used to describe these sweeteners. The table below summarizes the characteristics of some common alternative sweeteners.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Trade Name</th>
<th>kcal/g</th>
<th>Relative Sweetness&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Heat-Stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharin</td>
<td>Sweet &amp; Low, Sweet Twin, Sweet 'N Low Brown, Necta Sweet</td>
<td>0</td>
<td>200-700</td>
<td></td>
</tr>
<tr>
<td>Aspartame</td>
<td>Nutrasweet, Equal, Sugar Twin</td>
<td>4</td>
<td>160-220</td>
<td></td>
</tr>
<tr>
<td>Neotame</td>
<td></td>
<td>0</td>
<td>8000</td>
<td>X</td>
</tr>
<tr>
<td>Acesulfame-K</td>
<td>Sunett, Sweet &amp; Safe, Sweet One Splenda</td>
<td>0</td>
<td>200</td>
<td>X</td>
</tr>
<tr>
<td>Sucralose</td>
<td>Splenda</td>
<td>0</td>
<td>600</td>
<td>X</td>
</tr>
<tr>
<td>Tagatose</td>
<td>Nutralose</td>
<td>1.5</td>
<td>0.75-0.92</td>
<td>X</td>
</tr>
<tr>
<td>Stevia</td>
<td>Truvia, PureVia, SweetLeaf</td>
<td>0</td>
<td>150-300</td>
<td>X</td>
</tr>
</tbody>
</table>

<sup>a</sup> Relative to Sucrose =1

Saccharin is the oldest of the artificial sweeteners. You do not want to use it in cooking or baking because it develops a bitter taste.
Aspartame is made up of 2 amino acids (phenylalanine and aspartate) and a methyl (CH$_3$) group. The compound is broken down during digestion into the individual amino acids. This is why it provides 4 kcal/g, just like protein. Because it can be broken down to phenylalanine, products that contain aspartame contain the following message: "Phenylketonurics: Contains phenylalanine." Phenylketonuria (PKU) will be covered in greater detail in section 2.25. When heated, aspartame breaks down and thus loses its sweet flavor.

Neotame is like aspartame version 2.0. Neotame is structurally identical to aspartame except that it contains an additional side group (bottom of figure below, which is flipped backwards to make it easier to compare their structures). While this looks like a minor difference, it has profound effects on the properties of neotame. Neotame is much sweeter than aspartame, is heat-stable, and isn't broken down into the individual amino acids during digestion. As a result it is not a worry for those with PKU. 
Figure 2.1223 Structure of neotame

Acesulfame-potassium (K) is not digested or absorbed, therefore it provides no energy or potassium to the body. Acesulfame-potassium (K) is not digested or absorbed, therefore it provides no energy or potassium to the body.

Sucralose, is structurally identical to sucrose except that 3 of the alcohol groups (OH) are replaced by chlorine molecules (Cl). This small change causes sucralose to not be digested and as such is excreted in feces.
Tagatose is an isomer of fructose, that provides a small amount of energy 1.5 kcal/g. 80% of tagatose reaches the large intestine, where it is fermented by bacteria, meaning it has a prebiotic-type effect. Notice the similarity in structure of tagatose to sugar alcohols, the only difference being a ketone (\(=\text{O}\)) instead of an alcohol (\(\text{OH}\)) group.

![Figure 2.126 Structure of tagatose](image1)

The new kid on the alternative sweetener block is stevia. Stevia is derived from a South American shrub, with the leaves being the sweet part. The components responsible for this sweet taste are a group of compounds known as steviol glycosides. The structure of steviol is shown below.

![Figure 2.127 Structure of steviol](image2)

The term glycoside means that there are sugar molecules bonded to steviol. The two predominant steviol glycosides are stevioside and rebaudioside A. The structure of these two steviol glycosides are very similar. The structure of stevioside is shown below as an example.
The common name for a sweetener containing primarily rebaudioside A is rebiana. Some are predicting rebiana will quickly make it into soft drink products because it is a "natural" alternative sweetener, as you can see in the video below.

Video: Stevia "The Holy Grail of Sweeteners" (2:08)

Check Yourself
1. The ingredients for a stick of Wrigley's Extra® gum are as follows:
SORBITOL, GUM BASE, GLYCEROL, MANNITOL, NATURAL AND ARTIFICIAL FLAVORS; LESS THAN 2% OF: HYDROGENATED STARCH HYDROLYSATE, ASPARTAME, SOY LECITHIN, GELATIN
ACESULFAME K, COLORS (TITANIUM DIOXIDE, BLUE 1 LAKE), BHT (TO MAINTAIN FRESHNESS).
PHENYLKETONURICS: CONTAINS PHENYLALANINE.

Which of these ingredient(s) is a sugar alcohol? Which are alternative sweeteners?

2. The ingredients for a common diet drink are as follows:
CARBONATED WATER, CARAMEL COLOR, ASPARTAME, PHOSPHORIC ACID, POTASSIUM
BENZOATE (PRESERVES FRESHNESS), CAFFEINE, CITRIC ACID, NATURAL FLAVORS.
PHENYLKETONURICS: CONTAINS PHENYLALANINE.
Can you identify the alternative sweetener(s)?

**References & Links**

**Video**
Stevia "The Holy Grail of Sweeteners" http://www.youtube.com/watch?v=_hFpformeZEE