






**Artificial Sweeteners**  
The History and Facts of Sugar Substitutes

### History of Sugar

- Sugar cane plant first discovered in New Guinea around 500BC
- Spread to SE Asia & India around 1000BC, then west to Mediterranean
- Sugar cane was desired for its sweetness and use in cooking
- In 1444, Prince Henry of Portugal imported African slaves to his colony of Madeira to help expand his sugar trade—established the "Trade Triangle"
- Brazil developed their own sugar industry, further expanding the trade of sugar



### Effects of the Napoleonic War

- In the early 1800's, Britain blockaded France's trade routes with the Caribbean, limiting their supply of sugar
- In response, Napoleon developed the sugar beet industry in order to provide France with a source of sugar without the need for the cane plant
- Following the war, sugar had become affordable to the general public
- With sugar consumption greatly increasing, adverse side effects began to become apparent

### Saccharin: the 1<sup>st</sup> Sugar Substitute

- In 1878, Russian chemist Constantin Fahlberg inadvertently contaminated his own dinner roll with a sweet residue from his laboratory
- This sweet substance, now called Saccharin, was in fact benzoic sulfimide—formed by a reaction between o-sulfobenzoic acid, phosphorus chloride, and ammonia
- In 1882, Fahlberg tested the safety of Saccharin—after 24 hours of no adverse side effects, he also found that the entire dose had been excreted into his urine.
- Doctors began prescribing Saccharin for headaches and nausea
- In 1912, with consumption skyrocketing, Saccharin was prohibited in processed foods.

### Industry Development


- (1914) WWI saw a shortage of sugar and a subsequent push by the scientific community for saccharin usage
- (1939-45) WWII saw a similar sugar shortage and increased use of saccharin, resulting in a change in the public's diet
- Processed, pre-made food items began to replace traditional, prepared foods
- (1938) Cumberland Packing Corp. introduced Sweet 'N Low, a blend of saccharin and cyclamate. Due to its more sugar-like taste, the use of artificial sweeteners increased dramatically.
- (1963) The introduction of artificially sweetened, "calorie-free" soft drinks saw a threefold growth of the industry.
- (1966) The discovery of aspartame, now the primary sweetener in diet sodas



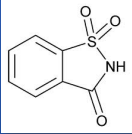
### A Closer Look at Artificial Sweeteners

### The 5 Most Common Sweeteners: What Are They?

- 1) Saccharin
- 2) Aspartame
- 3) Acesulfame K
- 4) Sucralose
- 5) Neotame

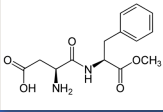


### Saccharin



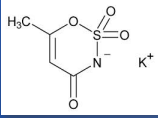
- Oldest sugar substitute—discovered 1878
- ~200-700x sweeter than sugar
- Known for stability—long shelf life!
- Known to have a bitter/metallic aftertaste at high concentrations
- Unstable at high temperatures; limited use in baked goods
- Sold under Sweet 'N Low, NutriSweet
- Approved as a "special dietary sweetener" by the FDA

### Aspartame



- Discovered in 1965
- ~200x sweeter than sugar
- Not stable at high temperatures; limited use in certain products
- Composed of aspartic acid and phenylalanine—NOT safe for those with Phenylketonuria (PKU)
- Sold under Equal, NutriSweet
- Considered safe by FDA, Joint Expert Committee on Food Additives (JECFA), World Health Organization, and Scientific Committee for Food of the EU (SCF)

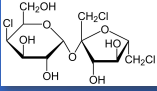
### Acesulfame K



- Discovered in 1967
- Listed as "acesulfame potassium" or also known as "ace K"
- Exists as a potassium salt
- ~200x sweeter than sugar
- Stable under high temperatures; very versatile—used in many kinds of products
- Sold under Sunette, SweetOne
- Considered safe by FDA, JECFA, and SCF

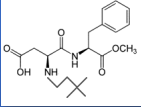
### Sucralose

- Discovered in 1976
- Derived from sugar (sucrose)—3 hydroxyl groups replaced by chlorine atoms
- ~600x sweeter than sugar
- Most heat-stable sugar substitute
- Sold under Splenda



### Neotame

- Newest artificial sweetener—approved by FDA in 2002; not widely used yet
- ~8000x sweeter than sugar
- Possesses a clean, sweet taste like sugar
- Similar structure to aspartame; release of phenylalanine during breakdown is reduced



## The Artificial Sweetener Market

### Products Containing Artificial Sweeteners

- Dark chocolate chips
- Sugar alcohols: xylitol, mannitol, sorbitol, lactitol, erythritol
- Ice cream
  - Usually contains sucralose (or Stevia)
  - "Guilt-free" ice cream



### Products (cont.)

- Canned goods
  - Typically sucralose (heat stable!)
  - Ideal for diabetics
- Gum
  - Xylitol (prevents tooth decay)
  - Sorbitol (cheaper than xylitol)




### Marketing: Splenda vs. Equal

Splenda	Equal
<ul style="list-style-type: none"> <li>Derived from sugar—"natural"</li> <li>"Tastes like sugar"</li> <li>Misconception: Splenda is sugar, but without calories</li> <li>Only sugar substitute that measures/bakes like sugar</li> </ul>	<ul style="list-style-type: none"> <li>Aspartame (not derived from sugar)</li> <li>Promoted as an artificial sweetener</li> <li>"Sweet, clean taste, like sugar"</li> </ul>


### "Splenda Essentials"

- New, "improved" version of original Splenda
- Splenda Essentials with B Vitamins
  - "Helps support a healthy metabolism"
  - "Helps with weight loss"
- Marketed as a weight loss product



### "Splenda Essentials" (cont.)

- Splenda Essentials with Antioxidants
  - Consumers made to believe it will offer the same benefits as fruit
  - "20% daily value of antioxidants"
  - Vitamins C & E from real fruit
  - Fortified with other chemically synthesized vitamins




### "Splenda Essentials" (cont.)

- Splenda Essentials with Fiber
- Package has pictures of whole grain cereals
- "Small boost of healthy fiber"
- Contains refined corn fiber
- Lawsuit:
  - Violates Consumers Legal Remedies Act
  - Violates Sherman Food, Drug, Cosmetic Law



### Foods Containing Artificial Sweeteners

- Tend to also contain masking flavors
- Mask lingering sweetness/bitter aftertaste
- Added acidity (such as citric acid)
  - Rare food intolerance
- Chemosensates added to increase saliva production
  - Reduce bitterness
  - Induce cooling/warming effects



### Artificial Sweetener Market

- Aspartame: highest global production
  - Rising due to safety concerns of sucralose
- Significant demand for sugar alcohols
- Potential to reach \$1.5 billion by 2015
- Lack of education:
  - General public does not read food labels
  - Conflicting information on artificial sweeteners

### Marketing Strategies



- Nutrition claims:
  - Sweeteners do not lead to increased sugar/calorie consumption
  - Increased obesity rate, so consume more "diet" soda?
  - "Guilt-free"
    - Consume more to satisfy cravings!
- Sweeteners aid in weight loss
- Partner with other healthy product development companies
- Splenda and nutrition bars

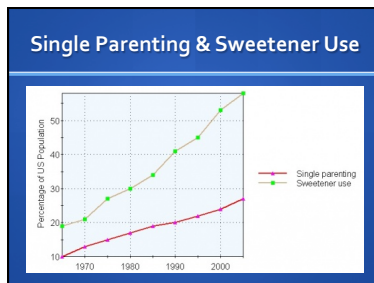
### Physiological Effect & Safety

### Sweeteners to Examine:

- Sucralose (Splenda)
- Aspartame (Equal)
- Saccharin (Sweet 'N Low)
- Neotame (NutraSweet)
- Stevia (Truvia)

### Sugar vs. Artificial Sweeteners

- Sucrose = disaccharide
- Energy source from carbohydrate
- ^Blood glucose → Pancreas → Insulin → Glucose storage
- Harmful to the gut microbiome:
  - Feeds bacteria such as *C. difficile*
  - Harms bacteria such as *Lactobacillus rhamnosus*
- Carbohydrate (sugars) contain 4 kcal/g
- Artificial sweeteners contain (nearly) 0 kcal



### Splenda

- Splenda contains sucralose
- Top selling packaged sugar substitute—side effects?
- Splenda is *not* calorie-free!
  - Sucralose is 600x sweeter than sugar; <1% in Splenda
  - Other 99% is filler: maltodextrin (polysaccharide) and dextrose (D-glucose)
  - 4 kcal/serving

### More About Sucralose (Splenda)

- Covalently bonded chlorine atoms (C-Cl) as opposed to ionically bonded (Na-Cl)
- Some is excreted via digestive and pulmonary elimination; remainder is stored in adipose tissue (fat soluble)
  - Implications for fat storage and release
- Linked to:
  - Headaches, GI/vision problems, allergies, weight gain

### Equal

- Equal contains *aspartame*
- Most prevalent artificial sweetener in processed food supply
- Chemical composition:
  - 40% aspartic acid, 50% phenylalanine, 10% methyl ester
- Biochemical and metabolic dangers:
  - Methanol byproduct is different than naturally occurring methanol in fruits/vegetables
  - Formaldehyde accumulation, decreased serotonin, & many others

### More About Aspartame (Equal)

- Linked to:
  - Migraines
  - Asthma
  - Leukemia
  - Brain tumors
  - Irritable bowel syndrome
  - Parkinson's disease
  - Multiple sclerosis
  - Epilepsy
  - Cancer metastasis
- Heavily linked to weight gain: stimulates release of insulin and leptin
  - Insulin triggers energy storage
  - Leptin inhibits appetite
  - Risk of leptin resistance

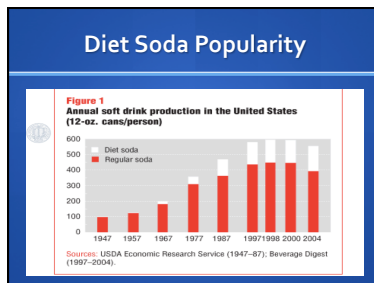
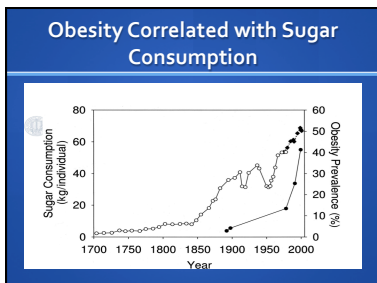
### Other Artificial Sweeteners

- Saccharin* (Sweet 'N Low) has been linked to weight gain and bladder cancer (similar to aspartame)
- Neotame*
  - Nearly identical structure to aspartame
  - Added 3,3-dimethylbutaldehyde blocks enzyme responsible for cleaving aspartic acid and phenylalanine
  - Formation of formaldehyde still present
- Stevia* (Truvia)
  - Steriol vs. stevia
  - Overwhelming consensus that stevia is safe

### What Does It All Mean?

### Where Are We Now?

- Exponential increase of artificial sweeteners in the food supply
- FDA has approved recommended daily intakes
- In the media:
  - Controversies explored in documentaries, in the news, and online

### Acceptable Daily Intakes (FDA)

- Aspartame (Equal):
  - 50mg per kg body weight
  - ~18-19 cans of diet soda
- Saccharin (Sweet 'N Low):
  - 5mg per kg body weight
  - ~10 packets of Sweet 'N Low
- Sucralose (Splenda):
  - 5mg per kg body weight
  - ~6 cans of diet soda
- Acesulfame K:
  - 15mg per kg body weight
  - ~6 cans of diet soda
- Neotame:
  - 2mg per kg body weight



### Where Do We Go From Here?



- *Moderation* is key!
- Education of the public is needed!
- Make healthy choices!

### Get Informed!

- Various documentaries explore the issue of artificial sweeteners
- Children must be taught about the sweeteners in their food, and which foods to avoid



### To Eat, or Not to Eat?

- The massive amount of evidence suggests that, when used correctly and in moderation, artificial sweeteners are perfectly safe
- However, the correlation between sugar substitute consumption and obesity shouldn't be dismissed!
- As a consumer, YOU have the choice to use the knowledge available to make the best decision for yourself.