Sweet Calories

Chaya Gopalan, PhD
History/Background

- > 2000 years ago, sugar cane juice → cane sugar granules in India
- Spread of cultivation to Islamic world, West Indies and other tropical parts of the Americas (16\textsuperscript{th} century) and further improvements in the process (17\textsuperscript{th}-19\textsuperscript{th} centuries)
- Beet sugar, high fructose corn syrup (19\textsuperscript{th} to 20\textsuperscript{th} centuries)
Natural Sugar

Besides sugar, these sources contain fiber and various micronutrients that makes it healthy!
Sugar used to be a Fine Spice

Through the medieval period, sugar was expensive.
Added Sugars

• Most common added sugars are sucrose (table sugar) and high fructose corn syrup
• Refined sugar is ingested at high potency than natural sugar.
Added Sugar is the Worst Ingredient in the Diet!

Energy balance is central to maintaining healthy body weight.

- Free sugar provides calories with no added nutrients and limits one from eating healthy nutrients
- Too much total caloric intake $\rightarrow$ unhealthy diet, weight gain and increased risk of diseases.
# Simple Sugars

<table>
<thead>
<tr>
<th>Monosaccharides</th>
<th>Dissacharides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>Sucrose = glucose + fructose</td>
</tr>
<tr>
<td>Fructose</td>
<td>Lactose = glucose + galactose</td>
</tr>
<tr>
<td>Galactose</td>
<td>Maltose = glucose + glucose</td>
</tr>
</tbody>
</table>

- 80% of the glucose is used by body cells; 20% to the liver → glycogen.
- 100% of the fructose to the liver as the liver is the major processor of fructose unlike glucose.
- → fat → released into blood → dyslipidemia or remains in the liver → fatty liver.
Fructose is Worse!

- Fructose does not have the same kind of satiety effect as glucose (leptin resistance).
- Fructose does not suppress the secretion of ghrelin like glucose does. It signals the body as it is hungry.
- Fructose intake ↑ triglycerides, LDL, fatty liver ↑ abdominal obesity (metabolic syndrome).
- Fructose ↑ uric acid and causes hypertension.
Why High Fructose Corn Syrup?

- Sugar tariffs and sugar quotas in the United States (1977) increased cost of importing → Government subsidies to farmers → low corn price → high-fructose corn syrup became a substitute.
- Less expensive than sugar/high sugar strength of fructose.
- *Coca-Cola* and *Pepsi* switched to high-fructose corn syrup in the United States in 1984.
Drowning in a Sea of ’Sweet Calories’?

Average intake of sugar in the US: 22 teaspoons (355 calories) per person per day [a 12 oz can of coke has 39 grams of sugar (130 calories)].
<table>
<thead>
<tr>
<th>Nutrition Facts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Serv. Size</strong></td>
</tr>
<tr>
<td><strong>Calories</strong></td>
</tr>
<tr>
<td><strong>Total Fat</strong></td>
</tr>
<tr>
<td><strong>Total Sodium</strong></td>
</tr>
<tr>
<td><strong>Total Carb</strong></td>
</tr>
<tr>
<td><strong>Sugars</strong></td>
</tr>
</tbody>
</table>

Not a significant source of fat cal., sat. fat, trans fat, cholest., fiber, vitamin A, vitamin C, calcium and iron.

*Percent Daily Values (DV) are based on a 2,000 calorie diet.

**Ingredients:**
- CARBONATED WATER, HIGH FRUCTOSE CORN SYRUP, CARAMEL COLOR, PHOSPHORIC ACID
- NATURAL FLAVORS, CAFFEINE
- LOW SODIUM

**Caffeine Content:** 57 mg/20 fl oz

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www.coke.com

please recycle

**Barcode:**

2010-1293 20 FL OZ PROOF OF PURCHASE
How much Sugar is Too Much?

WHO recommendation:
• No more than 10% of your daily calories from sugar.
• Could be reduced to 5% which is 25 grams or about 6 teaspoons of sugar for adult female and 9 teaspoons for adult male (100 calories) per day.
High-fructose corn syrup usage in processed foods increases added sugar calories → metabolic syndrome, hypertension, dyslipidemia, hepatic steatosis, insulin resistance and obesity.
The Mayans of Central America
• Diabetes was virtually unknown among the Mayans of Central America till the 1950s.
• Switching to a Western diet → rate of diabetes skyrocketed!
• Siberian nomads and Yakut ate diets heavy in meat, yet they had almost no heart disease until after the fall of the Soviet Union.
• Some settled in towns and now half the Yakut living in towns are overweight and almost a third have hypertension!
Alternative Sweeteners

- Aspartame is a low-calorie sweetener resulting from the combination of two amino acids
  - Aspartic acid and phenylalanine

Marketed as NutraSweet® or Equal®

![Chemical structure of aspartame](image-url)
Substituting Sweeteners

Differences in color, flavor and browning will result when using some of the substitutions

<table>
<thead>
<tr>
<th>Table 8.7</th>
<th>Substitutions for One Cup of Selected Household Sweeteners&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingredient Stated in Recipe</td>
<td>Substitution Equivalent to 1 Cup of the Sweetener in the Recipe</td>
</tr>
<tr>
<td>Granulated sugar</td>
<td>1 cup brown sugar, gently but firmly packed</td>
</tr>
<tr>
<td>Granulated sugar</td>
<td>1 cup corn syrup, minus ¼ cup of liquid specified in recipe&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Granulated sugar</td>
<td>1 ½ cups unsulfured molasses, minus ⅓ cup liquid specified in recipe, minus baking powder in the recipe, plus ⅗ teaspoon baking soda</td>
</tr>
<tr>
<td>Granulated sugar</td>
<td>2/3 cup honey, minus 2 2/3 tablespoons liquid in recipe, plus ⅛ teaspoon baking soda</td>
</tr>
<tr>
<td>Granulated sugar</td>
<td>2/3 cup honey, plus 2 2/3 tablespoons flour (if no liquid in recipe), plus ⅛ teaspoon baking soda</td>
</tr>
<tr>
<td>Light brown sugar</td>
<td>½ cup dark brown sugar, plus ½ cup granulated sugar</td>
</tr>
<tr>
<td>Turbinado sugar</td>
<td>1 cup granulated sugar</td>
</tr>
<tr>
<td>Honey</td>
<td>1 ¼ cups sugar, plus ¼ cup liquid</td>
</tr>
<tr>
<td>Corn syrup</td>
<td>1 cup granulated sugar, plus ¼ cup liquid (same type of liquid as specified in recipe)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Products resulting from the suggested substitutions will exhibit color and flavor changes, according to the substitution being made.

<sup>b</sup>Substitute for no more than half of the sugar specified in the recipe.
# Substituting Sweeteners

Functional and nutritional considerations may determine selection of sweeteners.

## Table 8.8 Guidelines for Using Sugar Replacements

<table>
<thead>
<tr>
<th>Sweetener</th>
<th>Substitution Equivalent</th>
<th>Brand Name</th>
<th>Recommended Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharin</td>
<td>1 packet = 2 tsp sugar</td>
<td>Sweet’N Low®</td>
<td>Hot or cold</td>
</tr>
<tr>
<td>Aspartame</td>
<td>1 packet = 2 tsp sugar</td>
<td>Equal®, NutraSweet®</td>
<td>Cold beverages</td>
</tr>
<tr>
<td></td>
<td>1 cup = 1 cup sugar</td>
<td>Equal® Spoonful</td>
<td>Limited baking</td>
</tr>
<tr>
<td>Neotame</td>
<td></td>
<td></td>
<td>Cold beverages</td>
</tr>
<tr>
<td>Acesulfame-K</td>
<td>1 packet = 2 tsp sugar</td>
<td>Sweet-One®, Sunett®</td>
<td>Use hot or cold</td>
</tr>
<tr>
<td>Sucralose</td>
<td>1 cup = 1 cup sugar</td>
<td>Splenda®</td>
<td>Hot or cold</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Limited baking</td>
</tr>
<tr>
<td>Thaumatin</td>
<td></td>
<td>Talin®</td>
<td>Cold</td>
</tr>
<tr>
<td>Alitame</td>
<td></td>
<td>Aclame™</td>
<td>Cold</td>
</tr>
<tr>
<td>Tagatose</td>
<td>1 cup = 1 cup sugar</td>
<td>Gaio® Tagatose</td>
<td>Hot or cold</td>
</tr>
<tr>
<td>Trehalose</td>
<td>$\frac{1}{2}$ cup as sweet as sugar</td>
<td>Naturlose™</td>
<td>Beverages, purees</td>
</tr>
<tr>
<td>Dihydrocalcones</td>
<td></td>
<td></td>
<td>Gum, toothpaste, candy</td>
</tr>
<tr>
<td>Glycyrrhizin</td>
<td></td>
<td></td>
<td>Candy (licorice)</td>
</tr>
<tr>
<td>Stevioside</td>
<td>$\frac{1}{2}$ cup = 1 cup sugar</td>
<td>Sun Crystals®</td>
<td>Soft drinks, gum</td>
</tr>
</tbody>
</table>
Are We Biologically Drawn to Sugar?

Yes! We are drawn to sugar as it helps the body store fat (which helped survive winter in Paleolithic times). Chimpanzees are drawn to hives in spite of the bees! We are ignoring the stinging consequences of too much sugar!
Why Not Before? Why Now?

• Digestive system’s craving for sugar was not a serious matter when sugar was rare in the stone age.
• Technology in processing sugar, abundance of pure sugar at less cost → two-thirds of Americans are now obese!
Physiology of Sugar Addiction

• Ingestion of sugar $\rightarrow$ immediate release of dopamine.
• Once a certain consumption threshold is reached, dopamine levels $\downarrow$, withdrawal of sugar.
Cavities
Weight Gain

- Sugary foods are full of calories, do not suppress satiety.
- In order to lose weight, reduction in sugar intake is a good place to start.
Insulin Resistance

• High-sugar meal $\uparrow$ insulin release $\uparrow$ fat content in the cells $\downarrow$ sensitivity $\rightarrow$ build up of glucose in the blood.
• Symptoms: fatigue, hunger, brain fog, high blood pressure and central obesity.
• No symptoms during insulin resistance until it develops into full-blown diabetes.
Diabetes

Between 1988 and 2008 (20 years), the prevalence of diabetes in the U.S. increased by 128%.

Diabetes affects about 25 million people in the U.S. (8.3% of the population).

A study that followed 51,603 women between 1991 and 1999, found that those who consumed more sugar-sweetened beverages not only gained weight but also developed type 2 diabetes.

Portion control is crucial with sugar. Duration and degree of exposure to sugar is correlated with diabetes prevalence.

Decline in sugar exposure is correlated with significant subsequent declines in diabetes rates.
Obesity

Just one can of soda can lead to 15 lbs of weight gain in a single year!!
Each can of soda ↑ the odds of becoming obese.

Source: Centers for Disease Control
Liver Failure

Metabolism of fructose creates a stress response in the liver that can exacerbate inflammation. Excess fructose → development of nonalcoholic fatty liver disease → scarring in the liver and eventually progress to liver failure. People with this diagnosis have been found to have almost double the soda intake of the average person.
Kidney Disease

Rats fed extremely high-sugar diets (about 12 times the percentage of sugar recommended in the WHO’s new guidelines) developed enlarged kidneys and other problems with normal kidney function.
Heart Disease and Hypertension

Conditions associated with excess sugar consumption, like diabetes and being overweight, are known risk factors for heart disease and hypertension.
Cancer

Insulin is important in regulating growth. Continuously ↑ insulin levels (a consequence of sugar consumption) may contribute to cancer. Metabolic problems associated with sugar consumption are a known driver of inflammation, another potential cause of cancer. An analysis of 30 years of cancer incidence among Inuit (Thule culture) in the western and central Arctic showed a striking ↑ in the incidence of cancers of modern societies.
Paleo Diet

- Stone Age (caveman) menu based on the idea that modern humans evolved to eat the way hunter-gatherers did during the Paleolithic period (2.6 million years ago).
- Eating the foods we were designed to eat: fruits, vegetables, tubers, unrefined grains, nuts, honey, fish and lean meat.
Summary

• Less intake of sugar is important in avoiding its harmful effects.
• There is no one ideal human diet. We have the ability to adapt to many habitats and combine different foods to create healthy diets but the modern Western diet is not one of them.
• Exercising at least 30 minutes a day improves healthy lifestyle.
References

Please refer to these readings prior to taking the quiz

• *The Evolution of Diet* by Ann Gibbons in National Geographic (September 2014 issue)
  http://www.nationalgeographic.com/foodfeatures/hunger/

• WHO Draft guideline: Sugars intake for adults and children
  http://who.int/nutrition/sugars_public_consultation/en/

  http://www.nytimes.com/2011/04/17/magazine/mag-17Sugar-t.html?_r=0
Questions?