Activity: Tooth Experiment (Parts I & II)
Activity 4. Tooth Experiment, Part I (15 - 20 mins)

Key Messages
Some ingredients in sugary drinks other than sugar, such as acid and caffeine, can damage our health.

Objectives
• To connect dental health with healthy drink choices
• To follow the scientific method and report observations on the effect of acid on dental health

Preparation
You need:
• 1 can regular cola
• 1 can diet pop
• 1 can clear pop
• 1 can energy drink
• 1 apple juice box
• 1 glass of water
• 6 clear containers (about 200 mL), ideally with lids.
• 6 pieces of bone

Make overhead transparency Overhead 9: Acid in Drinks (page 79).
Copy Handout 16: Observations of “Tooth” Experiment (page 93) for each student.
Review Backgrounder: The “Tooth” Experiment (page 54).
Review Assessment Tool: Observations of “Tooth” Experiment (page 115).

Activity
• Ask students to suggest reasons why acid may harm their teeth.
• Use Overhead 9: Acid in Drinks to explain the impact of sugar and acid on our teeth.
• Put students into 6 groups and assign one drink and one piece of bone to each group.
• Distribute Handout 16: Observations of “Tooth” Experiment.
• Ask students to do the following:
  1. Write the drink they are observing on the sheet.
  2. Hypothesize what they think will happen where it says “Based on what I already know, I think…”
  3. Draw a picture of their “tooth” and make observations of what they see, smell and feel.
  4. Place one bone piece in their plastic container.
  5. Fill their container with approximately 125 mL of their drink to be observed (e.g. pop).
  6. Write the liquid used on the plastic container.
  7. Leave the container untouched until the next Sip Smart! BC™ lesson.
  8. Hold on to their handout; it will be completed in the next lesson.
  9. Ask each group to share their hypothesis and collect the ideas on Overhead 10: Tooth Experiment Report. (Overhead will be completed in Lesson 4)
**Activity Tips**

This is a scientific experiment that is to be carried out in groups. Students will observe how sugary drinks affect teeth.

**Instead of teeth**, you will be using a small piece of bone, which contains calcium and shares many of the same materials as teeth. See Backgrounder: *The “Tooth” Experiment* (page 54) for information about bone preparation. In this lesson, students will set up the experiment. To obtain best results, the pieces of bone should sit submerged for approximately two weeks.

Through testing, we've discovered that using: water, cola, diet cola, clear pop, energy drink, and apple juice will likely get you the most interesting variety of results (see details on page 54). While students may find it boring to observe the tooth in water, it is important as a comparison and for drawing conclusions.

*What is the impact of acid and sugar on our teeth?*

- Sugar + bacteria (in our mouths) \( \Rightarrow \) acid. This acid attacks our teeth, and, over time, causes decay.
- Many sugary drinks are very acidic, which adds even more acid to what our mouths produce.
- The combination of acid and sugar in sugary drinks can lead to severe tooth decay.

It is important to be sensitive to students’ backgrounds. If using an animal bone as a “tooth” is not appropriate for a student’s culture and/or religion, see Backgrounder: *The “Tooth” Experiment* for alternate material or use the video demonstration (page 133).

---

**The Punchline!**

This is an experiment, following the scientific method, to find out the effect of drinks (with different amounts of acid in them) on teeth. We will check the teeth to observe changes after two weeks.

**Teachers say:**

“This experiment is well worth the effort!”
Activity 2. Tooth Experiment Part II (25 mins)

Key Messages
Some ingredients in sugary drinks other than sugar, such as acid and caffeine, can damage our health.

Objectives
• To discuss the results of the tooth experiment
• To recognize that acidic and sugary drinks are damaging to teeth

Preparation
You need:
• Paper towels
• Sink to drain off liquid
• Overhead 9: Acid in Drinks (page 79)
• Overhead 10: “Tooth” Experiment Report (page 81)
• Containers with “Teeth” from Tooth Experiment Part 1

Make overhead transparency of Overhead 11: Tricky Questions for Advanced Scientists (page 83).
Review Backgrounder: “Tooth” Experiment (page 54).
Review Assessment: Observations of “Tooth” Experiment (page 115).

Activity

• Ask students to
  1. Drain off the liquid and place “tooth” on a paper towel.
  2. Find Handout 16: Observation of “Tooth” Experiment.
  3. Write down observations. Helpful cues are: change of colour, shape, texture, size.
  4. Draw a (coloured) picture of their “tooth.”
  5. Discuss in their group what happened to their “tooth” and write their conclusion.
  6. Compare results with “tooth” in water.

• Let each group share their observations and present them using Overhead 10: “Tooth” Experiment Report.
Discuss if the hypothesis was supported by the observations.

Use the questions on Overhead 11: Tricky Questions for Advanced Scientists to check the students’ understanding. Show Overhead 9: Acid in Drinks again, while discussing results.
Assessment
To assess this activity, please review the assessment tool Observations of “Tooth” Experiment (page 115).

Activity Tips
After at least two weeks the students will probably have the following observations:

<table>
<thead>
<tr>
<th></th>
<th>Texture</th>
<th>Colour</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>No changes</td>
<td>No changes</td>
<td>• Neither acid, nor colour in water</td>
</tr>
</tbody>
</table>
| Apple Juice | Softer texture, squishy, moldy | Light brown         | • Teeth with some organic material on their surface make a great substrate for mold to grow, in the presence of moisture and sugar.  
|        |                                  |                      | • Acid causes dental erosion. Teeth soften and dissolve.                    |
| Clear Pop | Softer, holes, dissolves, squishy | Slight changes, yellow | • Food colouring in drinks stains and colours teeth.  
|        |                                  |                      | • Acid causes dental erosion. Teeth soften and dissolve.                    |
| Diet Cola | Softer, holes, dissolves, squishy | Dark, almost black (same colour as cola) | • Acid causes dental erosion. Teeth soften and dissolve.  
|        |                                  |                      | • Food colouring in drinks stains and colours teeth  
|        |                                  |                      | • There is no sugar in diet cola. It is the acid that causes erosion! |
| Cola  | Softer, holes, dissolves, squishy | Dark, almost black   | • Acid causes dental erosion. Teeth soften and dissolve.  
|        |                                  |                      | • Food colouring in drinks stains and colours teeth.                      |
| Energy Drink | Softer, holes, dissolves, squishy, shrinks | Dark, depending on brand: dark brown, red, yellow, green or black, white deposit | • Acid causes dental erosion. Teeth soften and dissolve.  
|        |                                  |                      | • Food colouring in drinks stains and colours teeth.                      |

It is important to note that the tooth experiment is different from what occurs in our mouths when we drink sugary drinks because:

1) The bone or “tooth” sits in each acidic sugary drink for two weeks or more, but we don’t usually hold drinks in our mouths for this long;

2) When we place the bone or “tooth” in different acidic sugary drinks, the only factor acting on the “tooth” is the acidity of the drink. Recall that when we sip a sugary drink, the sugar interacts with the bacteria in our mouths to produce acid. Once this acid is made, it lasts for about 20 minutes, after which the saliva in the mouth neutralizes the acid, and the “acid attack” ends.

**Dental Erosion**: the loss of the hard mineralized surface of the tooth structure due to chemical dissolution by acids

**Acids** that may be found in drinks:
- Ascorbic acid (also known as vitamin C)
- Phosphoric acid
- Citric acid
- Lactic acid

**The Punchline!**
The ingredients in some drinks (sugar and acid), along with naturally occurring bacteria in your mouth, affect your teeth. The combination of bacteria and sugar in sugary drinks form acid which can lead to tooth decay.
Part 1: Sipping Sugary Drinks and Acid Attacks

Acids are chemicals that are sometimes added to foods and beverages to alter taste and act as a preservative. One of the properties of acid is that it dissolves things.

When a person sips a sugary drink, an ‘acid attack’ occurs in the mouth for up to 20 minutes. The acid demineralizes the tooth during the attack and weakens the tooth. After about 20 minutes, saliva remineralizes the tooth and strengthens it. This balancing act becomes greatly challenged when a person snacks frequently on sticky foods, or sips regularly on sugar-laden drinks.

A case-in-point:

- A child takes a drink of pop and there is a 20 minute acid attack.
- The body is about to remineralize the tooth but the child takes another sip so there is another 20 minute acid attack.
- This pattern continues throughout the day. The balance is offset and the demineralization time outweighs the remineralization time and tooth decay begins.

The good news is that children can sip water all day with no worries of acid attacks on their teeth. However, if children are having their one serving (1/2 cup or 125 mL) of 100% fruit juice during the day (which contains a significant amount of naturally occurring sugar and is acidic), then they should drink it in as few sips as possible. The same applies to sugary drinks, when they are consumed as a once-in-a-while treat!

After having a sugary drink health professionals recommend rinsing your mouth with water, a fluoride mouth rinse or chewing sugarless gum. Anyone of these actions will help neutralize the acid found in the drink.

Interestingly, brushing of the teeth is not recommended. The enamel of the teeth is in a weakened state because of the erosion caused by the acid in a drink, so the mechanical abrasion of the brush actually exacerbates the problem.

Part 2: The “Tooth” Experiment

It is important to note that the tooth experiment does not simulate the processes occurring in the mouth after sipping a sugary drink. In placing the bone or “tooth” in different acidic sugary drinks, the only factor acting on the “tooth” is the acidity of the drink. There are no normal mouth bacteria present. Recall that when a child sips a sugary drink, the sugar interacts with the bacteria in the mouth to produce acid. Once this acid is made, it lasts for about 20 minutes, after which the saliva in the mouth neutralizes the acid, and the “acid attack” ends.

The tooth experiment does show the process of tooth erosion, whereby an acidic liquid chemically erodes away the hard mineralized surface of the “tooth”. Although the experiment cannot accurately capture all of the factors in the mouth that contribute to tooth decay, it is currently the best tool that we have to demonstrate the harmful effects on teeth. This hands-on approach gives an idea of the harmful effects of sugary drinks on their teeth.

In the spirit of experimentation, other drinks could be used, but we haven’t tested these or provided information in the resources. Milk may be used but it should be refrigerated and the experiment completed before the best before date, to simulate real drinking conditions. We trialed 100% orange juice and noticed that it often grew mold.

References

Sharon Melanson, Dental Hygienist, Interior Health, B.C.
Preparing Bones For The “Tooth” Experiment:

1. Shopping

Ask a butcher to cut a beef marrow bone (soup bone) into 1 cm thick slices.

You will get about 6 - 10 “teeth” per slice and to carry out the experiment as described, 6 pieces are necessary.

2. Cleaning

Soak the gristly bones in warm water overnight.
Remove the gristle of the bone gently with a paring knife.

3. Cutting

To quickly cut bones into pieces, use a bolt cutter. You can also use a band saw or hit the bone with a hammer or a hammer and chisel (wear eye protection).

If you use a bolt cutter it works best when the bones are wet and soft.

Cut the bones in a safe environment as pieces may fly off in several directions.
Alternatives:

Demonstration using extracted adult teeth

Oral surgeons may be willing to save extracted adult teeth (usually un-erupted wisdom teeth) for classroom experiments. After extraction, the oral surgeon will rinse the teeth with water to remove blood before sending them to you. They should be stored in a dilute solution of bleach (9 parts water to 1 part bleach) to act as a disinfectant. Once received, the teeth can then be thoroughly cleaned with a toothbrush. Any remaining tissue will not interfere with this experiment. The teeth should then be stored in new dilute bleach solution until required. The teeth should be rinsed with water to remove traces of bleach before starting the experiment. For protection against such things as viruses, the teacher should use gloves when handling the teeth.

If using bone or extracted adult is not appropriate for some students’ culture and/or religion, or if you don’t have enough time to do the entire experiment, you could use the video clip What Do Sugary Drinks Do to Your Teeth? to teach this key message. You can find the video clip on our website www.bcpeds.ca/sipsmart/teachers.

Teachers have also demonstrated the acidic nature of sugary drinks by placing a copper penny in an acidic liquid such as cola. Although the penny will become shinier, this is essentially due to the top layer of metal being etched away. This is an important distinction to be made as students could easily confuse this corrosive result with cleaning (or erroneously believing that drinking cola will clean their teeth).
bacteria + sugar = acid

tooth decay!

Sip Smart! BC™
MEANS SIPPING WATER
- NOT OTHER DRINKS!
### Drink Hypothesis Observation

<table>
<thead>
<tr>
<th>Drink</th>
<th>Hypothesis</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular cola</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet cola</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear pop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy drink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apple juice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Overhead 10: “Tooth” Experiment Report
Use your senses to observe your tooth. What does it look like? What colour is it? How big is it? What does it feel like? How does it smell?

**FIRST OBSERVATION:**

<table>
<thead>
<tr>
<th>What I observe:</th>
<th>Drawing of tooth before the experiment:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis:

Based on what I know, I think...

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**FINAL OBSERVATION:**

<table>
<thead>
<tr>
<th>What I observe:</th>
<th>Drawing of tooth after the experiment:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusion:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### Tricky questions for advanced scientists:

1. Which drink damages our teeth the least?

2. If we want a sugary drink once in a while, what can we do to reduce the “acid attack”?

3. Diet Pop has no sugar. Why does the tooth in diet cola look exactly like the tooth in cola?

---

<table>
<thead>
<tr>
<th>Drink</th>
<th>Conclusion (= explain what happened to your tooth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular cola</td>
<td></td>
</tr>
<tr>
<td>Diet cola</td>
<td></td>
</tr>
<tr>
<td>Clear pop</td>
<td></td>
</tr>
<tr>
<td>Energy drink</td>
<td></td>
</tr>
<tr>
<td>Apple juice</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
</tbody>
</table>
Teacher Assessment Rubric

→ Observations of “Tooth” Experiment

| Level 1 and Level 2 |

Name: ________________________________

| First observation addresses colour, texture and shape of “tooth” | 8 | 6 | 4 | 2 |
| First drawing matches first observation | 8 | 6 | 4 | 2 |
| Identifies ingredients of assigned drink in hypothesis (Does it contain sugar or acid?) | 8 | 6 | 4 | 2 |
| Predicts impact of ingredients on “tooth” | 8 | 6 | 4 | 2 |
| Second observation addresses clear differences in colour, texture and shape of “tooth” | 8 | 6 | 4 | 2 |
| Second drawing matches second observation | 8 | 6 | 4 | 2 |
| Conclusion demonstrates understanding of how the ingredients in the drink contribute to “tooth” erosion and theoretical decay | 8 | 6 | 4 | 2 |

Score ______ / 56

Key:
8 = Exceeding expectations
6 = Meets expectations
4 = Approaching expectations
2 = Not yet meeting expectation