Topic
Food: sweeteners and flavorings in gum

Key Question
What happens to the mass of gum after it has been chewed for ten minutes?

Focus
Students will use the scientific method to discover what happens to the mass of gum when it is chewed.

Guiding Documents
NCTM Standards
- Make and use measurements in problems and everyday situations
- Construct, read, and interpret displays of data

Project 2061 Benchmarks
- No matter how parts of an object are assembled, the weight of the whole object made is always the same as the sum of the parts; and when a thing is broken into parts, the parts have the same total weight as the original thing.
- Measurements are always likely to give slightly different numbers, even if what is being measured stays the same.

Math
Measurement
- mass
Whole number operations
- Fractions
- Percent
- Graphs

Science
Life science/health
- nutrition
Physical science
- changes in matter

Integrated Processes
Observing
Hypothesizing
Collecting and recording data
- Interpreting data
Comparing and contrasting
- Drawing conclusions
Generalizing

Materials
For each group:
- balance
- metric masses
- pack of gum (see Management 5)
- calculator
- crayons or markers

Background Information
There are three things that could happen to the mass of gum when it is chewed. One possibility is that the gum might gain mass since it is picking up saliva from the mouth. Another possibility is that the mass of the gum might stay the same since saliva is being added while sweeteners are being swallowed. A third possibility is that the mass of the gum will decrease since sweeteners and flavorings are being dissolved and swallowed.

What actually happens may be surprising. Sweeteners and flavorings provide the majority of the gum's mass. Most gums containing sugar lose 60-75% of their mass after being chewed for ten minutes. Sugar-free gum will lose about 50% of its mass in ten minutes.

Gum labels list all ingredients by amount, with the substances having the greatest amount being listed first. The mass that is lost while gum is being chewed is dissolved in saliva and swallowed in the form of sugar and artificial flavorings. Many brands of gum contain more than one type of sugar, with corn syrup, dextrose, and glucose often listed as ingredients. Sugar-free gum will contain artificial sweeteners such as aspartame, sorbitol, or saccharin.

The Center for Science in the Public Interest sells two posters with great nutritional information for this activity: Chemical Cuisine and How Sweet Is It? CSPI's Sugar Scoreboard (see Curriculum Correlation).

Management
1. Caution: Be aware that the sugar in gum may cause problems for students with diabetes or hypoglycemia.
2. Some teachers like to use the small, half-teaspoon sized sugar cubes instead of gram masses.
3. Students should work in groups of five so that each member chews one stick of gum.
4. Use a variety of brands and flavors of gum. Bubble gum works well since it has the greatest mass per piece to begin with and loses more mass than other types of gum.
5. While it is possible to find the before-and-after mass of individual pieces of gum, the results are much more accurate and impressive if the before-and-after mass of a pack of gum is found. For sanitary reasons, place the gum on the individual wrappers whenever finding the mass.

6. This activity has three parts, each taking 20-30 minutes. In Part 1, students use the scientific method when they make and test hypotheses. In Part 2, students use the data collected by each group to calculate the percent of sweetener and flavorings. In Part 3, students make a bar graph of the before-and-after masses of each group’s pack of gum.

7. Overhead transparencies of the activity sheets are helpful for recording class data.

Procedure

Part 1:
1. Discuss the Key Question and the three possible hypotheses (see Background Information).
2. Instruct students to record their hypotheses on the activity sheet.
3. Have the class discuss ways to test the hypotheses.
4. Decide on a class plan (or let each group come up with their own) for finding out what happens to the mass of gum after chewing. It is important that the before-and-after mass of the gum is quantified in some way so that Part 2 of the activity can be done.
5. Have students record their plan. One such plan might direct each group to:
   a. Get a balance, masses, and a pack of gum.
   b. Save the outside wrapper for checking on ingredients later.
   c. Find and record the total mass of the five pieces of gum with individual wrappers.
   d. Chew the gum for ten minutes and then put it back in the wrappers.
   e. Find and record the mass of the chewed gum.
   f. Analyze data to check hypotheses.
6. Have students do the activity.
7. Discuss the results. Students should share their hypotheses and how they were either validated or shown to need revision.
8. Direct students to read the list of ingredients on the outside labels of the various packs of gum and discuss what mass was lost in chewing.
9. Have students write their conclusions.

Part 2:
1. Hand out the activity sheet. Share and record the data for each group: brand, flavor, mass before chewing, and mass after chewing.
2. Have students do the calculations with or without a calculator for the difference, ratio, and percent of sweetener and flavorings in each pack of gum.
3. Discuss the results.

Part 3:
1. Students should construct a bar graph showing the mass before and after chewing for each pack of gum.
2. Discuss the graph.

Discussion

Before doing the activity:
1. What could happen to the mass of gum after it is chewed? [increase, decrease, stay the same]
2. What could cause the mass to increase?...decrease?...stay the same?
3. How can you find out what happens?

After doing the activity:
1. What does happen to the mass of the gum after it is chewed for ten minutes?
2. Why do you think this happens?
3. What are the ingredients in your pack of gum?
4. What ingredient in your gum has the most mass?
5. What do you think happens to this ingredient as you chew? How can you tell?
6. How did the brand or flavor of gum affect the amount of mass lost?
7. What other questions can you think of that stem from this activity?

Extensions

1. Do By Golly, By Gum, By Time.
2. Chew gum for twenty minutes; compare results.
3. Do the activity using different types of gum, including sugar-free.
4. Students can make math word problems from data.

Curriculum Correlation

Music:

Language Arts:
1. Have students write to The Center for Science in the Public Interest, 1875 Connecticut NW #300, Washington, DC 20009 for information on gum ingredients.
2. Find out sources of sugar and how it is processed.

Science/Health:
1. Have students research the various gum ingredients.
2. Ask the school nurse to discuss the nutritional value of sugar on the body.

Home Link

At home, have students examine food labels in which sugar is the first ingredient. Make a bulletin board to record the findings, along with packages, labels, and facts about the nutritional value of sugar.
What happens to the mass of gum after it is chewed for ten minutes?

HYPOTHESIS: I think the mass will ___________ because

PLAN for testing hypothesis:

RESULTS:
Mass of gum before chewing _____
Mass of gum after chewing _____

CONCLUSIONS:
<table>
<thead>
<tr>
<th>Brand</th>
<th>Flavor</th>
<th>Total Mass of Pack (grams)</th>
<th>Chewed Mass of Pack (grams)</th>
<th>Difference</th>
<th>Ratio Difference Total</th>
<th>% Sweetener &amp; Flavorings Ratio X 100 - %</th>
</tr>
</thead>
</table>