

How Much Sugar Is in Bubble Gum?

Synopsis

Most of the flavoring in gum is due to the sugar or other sweetener it contains. As gum is chewed, the sugar dissolves and is swallowed. After a piece of gum loses its flavor, it can be left to dry at room temperature and then the difference between its initial (unchewed) mass and its chewed mass can be used to calculate the percentage of sugar in the gum. This demonstration experiment is used to generate new questions about gums and their ingredients, and students can then design and execute new experiments based on their own questions.

Objectives

Students will be able to design their own experiments, based on their own, original questions, with little or no teacher help. In particular, they will recognize the need for multiple trials, controls, and results that can be reported quantitatively.

By designing their own experiments, students will develop the following abilities necessary to do scientific inquiry outlined in the *NSES Content Standard A (Science as Inquiry)* for levels 5-8:

- ask questions that can be answered through scientific investigations;
- design and conduct a scientific investigation;
- use appropriate tools and techniques to gather, analyze, and interpret data;
- use mathematics in all aspects of scientific inquiry;
- develop descriptions, explanations, predictions, and models using evidence;
- communicate scientific procedures and explanations; and
- think critically and logically to develop the relationship between evidence and explanation

Background

The combination of hands-on activity and junk food is nearly irresistible to middle school students. Bubble gum, which is considered an illicit item in most schools, is an especially attractive material that can be used to teach the scientific method within the classroom.

A quick read of the nutrition label on a typical pack of bubble gum will show that one piece has a mass of about 8 grams, and of that mass, about six grams is sugar. Sugar dissolves readily in water, and about equally well in saliva. Did you ever wonder why gum loses its flavor so quickly? Most of the flavor in gum is due to the sugar, which dissolves in saliva and is swallowed, never to be tasted again. You may have also noticed that the size of a wad of gum decreases considerably in the first 10 or 15 minutes of chewing. This change in volume is due to that same loss of sugar. In the case of sugarless gum, the sweetener used is typically a synthetic compound known as sorbitol, which may be listed as "sugar alcohol" on the nutrition label. It occurs in about the same proportion as does sugar in regular gum.

In this activity, students conduct an initial, teacher-led experiment to test the hypothesis, "It is sugar that gives gum its flavor, and during chewing, the sugar is lost, which makes the gum get smaller as it loses flavor."

After analyzing the results of the initial experiment, students are then in a position to generate their own questions about gum, many of which can be answered with similar, simple experiments. It is when

students ask their own questions, and devise ways to answer them scientifically, that students begin to truly appreciate the scientific method.

Materials Needed

- a few sheets of aluminum foil (or small plastic weighing boats, if available)
- one piece of gum per student; bubble gum containing sugar works best for the initial experiment
- several triple-beam balances accurate to 0.1 g (or electronic balances)

Procedure for Initial Experiment

1. Make a small weighing boat out of a few square inches of foil. This can be made by folding two or three layers of aluminum foil into a 1-2 inch square, and then turning the edges up to make sides about 1/4 to 1/2 inch high. Label your boat with your name or initials and the date.
2. Find the mass of an unwrapped but unchewed piece of gum, using the weighing boat. Measure to the nearest 0.1 g. Do not discard the weighing boat.
3. Chew the gum for exactly 15 minutes. By this time it should have little or no flavor left.
4. Put the gum back on the weighing boat. Collect all the chewed gum pieces in their boats on a cafeteria tray and leave them in a dry place for at least 48 hours.
5. Find the mass of the dried, chewed gum.
6. Determine the amount of mass lost due to chewing. Calculate the percentage of mass lost.

Discussion of Initial Experiment

Let students compare their results with those of other students. Then show students the original gum package, which lists the ingredients and gives nutritional information. Have the students calculate the percent of sugar in the gum based on the package information. Compare this "theoretical" percentage to the "experimental" percentages.

Discuss sources of error for the experiment. Then ask if there was a control for the experiment. The answer is no -- how do they know that an unchewed piece of gum wouldn't lose just as much mass by sitting and drying for the same amount of time in the same place that their chewed pieces did?

Ask also which variables were controlled and which were not. Everyone chewed for the same amount of time, but did everyone chew at the same rate or with the same vigor? Did some students chew less because they spent a lot of time blowing bubbles? Did everyone chew the same type of gum? Might some people have more or "stronger" saliva than others?

Designing the Next Experiment

If students don't already know they will have another opportunity to chew gum for the sake of science, it is likely that at least some students will ask if they can do another gum experiment. Suggest that they work in small groups (3-4 students) to make a written proposal. The proposal should answer these questions:

1. What is the question you are asking?
2. How will you try to answer it?
3. How many trials will you do?
4. How will you report your results quantitatively?
5. What will be your control(s)?
6. What is your hypothesis?

It is a good idea to model answering these questions by applying them to the initial gum experiment they just did.

The following are some examples of student questions that turned into successful experiments in the past:

- How will the weight losses compare in sugared gum versus sugarless gum?
Hypothesis: Sugared gum will lose more mass than sugarless gum.
- Would gum chewed in saliva lose more mass than gum chewed in water?
Hypothesis: Saliva will cause more sugar, and thus more mass, to be lost than water. After a discussion of controls and variables, this group wisely changed their question to, "Will gum *mashed* in water lose as much mass as gum *mashed* in an equal volume of saliva?"
- Do different flavors of the same brand of gum contain different amounts of sugar?
Hypothesis: Fruit flavored gum tastes sweeter than cinnamon or mint flavored gum, so the fruit flavors will lose more mass.
- Does the amount of mass lost depend on how long you chew the gum?
Hypothesis: The longer you chew, the more sugar will dissolve and the more mass will be lost.
- Do some brands have more sugar than others?
Hypothesis: Sweeter gum tastes better, so the most popular brands will lose more mass

After the teams get your approval, have them submit their shopping lists, including brand names and number of pieces required. Obtain the gum (students could be asked to provide it if necessary) and let them go!

Acknowledgement

Louis Gotlib is a remarkable high school physical science teacher, and the basic idea and method of this activity, although much modified here, originated in a newsletter of the NC Science Teachers Association. "Finding the Percentage of Sugar in Gum" first appeared in NCSTA Teaching Notes #5, 1997.

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