CAN MICROBES TELL THE DIFFERENCE?

FACILITATOR

Can you tell which foods are good for you just by tasting? Do two sweet-tasting foods have the same nutritional value?

Goal

To compare the energy content of various sweeteners by measuring yeast's production of carbon dioxide when using sweeteners as food.

Activity Time

60 minutes

Time to Get Ready

20 minutes

What You Need

Have the following for each team of 3 or 4:

1 microviewer or microscope (optional)
1 slide and cover slip if using microscope (optional)
photographs of yeast (optional)
4 to 7 zippered, plastic freezer bags
10 teaspoons rapid rise yeast
1 permanent marking pen
1 measuring teaspoon
1 metric ruler
1 8-ounce measuring cup
1 small container of very warm water
1 L clear, regular soda
1 L clear, diet soda
2 packets sugar (2 teaspoons)
2 packets of Sweet 'n Low® (saccharin)
2 packets of Equal® (aspartame)
variety of other "sweet" products such as grape juice, lemon juice, non-fruit drinks which contain fructose
4 3-ounce paper cups
1 roll of masking tape
1 1-L container (optional)

Getting Ready

Set out materials for each group, or set up a central area for one member of each group to collect materials for the group.

Useful Information

Yeast are living organisms and have similarities to humans. They consume sugar for energy and release carbon dioxide. The amount of carbon dioxide produced indicates the amount of energy provided. Artificial sweeteners like aspartame and saccharin, though sweet-tasting, do not contain sugar. Only small bits of these sweeteners are needed to give the same taste as a large amount of sugar. Yeast can break down aspartame, but it provides little energy because so little energy is present. Saccharin's structure is different, however. Neither we nor yeast can break it down.

Suggestions to Modify the Activity for Those Who Are Exceptional

Specific modifications for this activity are found here. For common considerations when modifying activities for exceptional participants, see page V of the **Introduction**.

Blind or Visually Impaired

- Provide a wealth of references on the speed of the gas production. The participant will appreciate the detailed observations. Holding the bags before, during, and after the activity will give the participant an excellent understanding of the activity.
- Construct a tactile diagram of "yeast budding." See the **Introduction** for suggested materials for construction. See Figure 1.

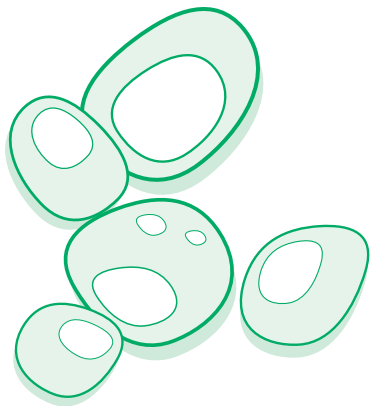


Figure 1. Yeast budding.

Deaf or Hard-of-Hearing

- Introduce the relationship between the number of calories in sweeteners as an energy source. Emphasize this relationship when participants taste the sweeteners.

Mobility Impaired

- See the ***General Modifications*** for *Mobility Impaired* listed in the **Introduction**, page V.

Physically Impaired

- See the ***General Modifications*** for *Physically Impaired* listed in the **Introduction**, page V.

Cognitively Impaired

- See the ***General Modifications*** for *Cognitively Impaired* listed in the **Introduction**, page V.

For More Information

Brody, J.E. (1997). The restaurant at the edge of the universe. *The New York Times, CXLVI*(50,797).

Nisimoto, K. (1993). Fermentation laboratory: All living organisms need food. *Favorite Labs from Outstanding Teachers, Volume II.* Reston, VA: NABT Publications, 83-88.

Stolberg, S.G. (1998). Bid to absolve saccharin is rebuffed by U.S. panel. *The New York Times, CXLVIII*(51,328).

Wilford, J.N. (1996). Beer of kings was no brackish brew, archaeologist says. *The New York Times, CXLV*(50,470).

Wu, C. (1997). Yeast make berry sweet sugar substitute. *Science News, 151*(19), 284.

How to Start the Activity

Provide each group of participants with a few granules of yeast. Some participants may be aware that it is yeast. Others may not be. Even if they are aware that it is yeast, they may never have thought of it as a living organism with the basic needs of water and food for energy. Ask them to discuss the following questions.

- How would you describe what I just provided to you?
- Do you know what it is?
- Have you seen it before?
- Do you think it is alive?
- What do living organisms need to survive?
- What provides living organisms with their energy to carry on life functions?
- Are some energy sources better than others?

Let's Make a Hypothesis

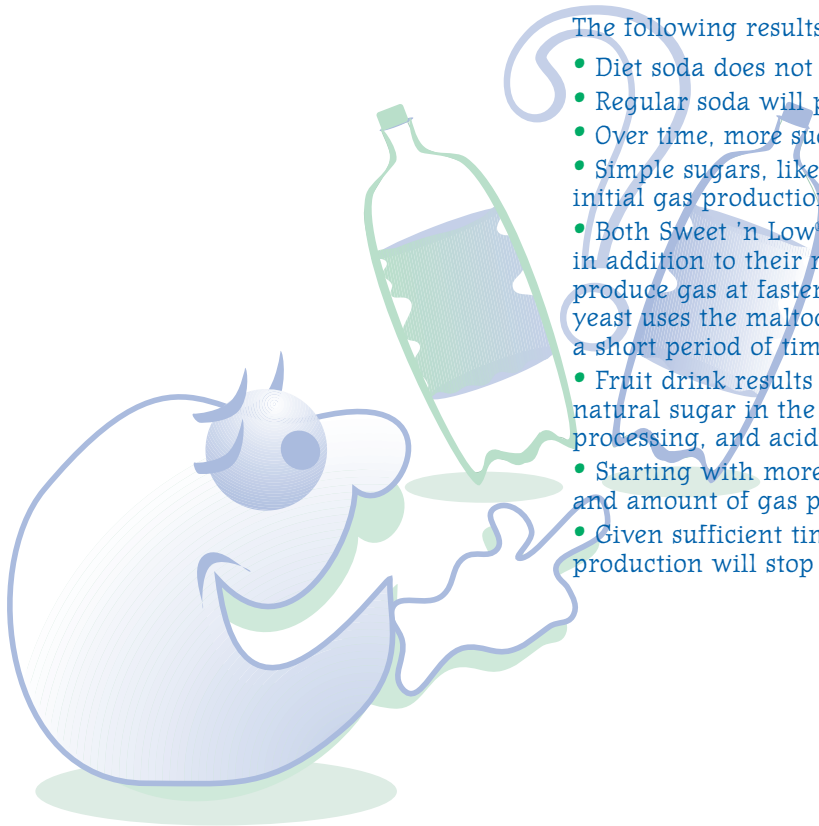
Discuss the following questions to help guide the participants to make hypotheses.

- What will happen if we add water to these granules? Sugar and water?
- If yeast is a living organism, what does it use for an energy source?
- Do diet foods supply the same amounts of energy as natural foods?
- How can you measure the by-products of yeast metabolism?

What the Data Mean

The following results may be seen in the various bags.

- Diet soda does not produce gas.
- Regular soda will produce slightly less gas than sugar.
- Over time, more sugar will permit more gas generation.
- Simple sugars, like dextrose and fructose, cause faster initial gas production than sucrose.
- Both Sweet 'n Low® and Equal® contain maltodextrose in addition to their respective artificial sweeteners. Both produce gas at faster rates than sugar initially as the yeast uses the maltodextrose. Gas production stops after a short period of time.
- Fruit drink results will vary due to the amount of natural sugar in the fruit, amount of sugar added in processing, and acidity.
- Starting with more yeast will initially increase the rate and amount of gas production.
- Given sufficient time and expansion space, gas production will stop in each of the bags.



CAN MICROBES TELL THE DIFFERENCE?

PARTICIPANT

Questions to Think About

Can you tell the difference between food and non-food substances? What is a food? Why do we eat it? How do you know the difference between food and non-food substances? What is in diet drinks? What would happen if you consumed only diet cola for a week? What is in sugar substitutes? Yeast are microscopic living organisms. Do yeast need food? If they do, what food do they use? What else besides food, would yeast require to live?

Safety Notes

- Wash hands before and after the activity.
- Food and gum are not allowed.
- Discard used plastic bags in the trash at the conclusion of the activity.

What to Do

1. Closely examine some of the granular yeast. Record your observations. Put a small number of grains of yeast and a few teaspoons of water in a zippered, plastic freezer bag. What happened to the grains? Is the water mixture clear or cloudy? If a microscope is available, put a drop of the water mixture on a slide with a cover slip and examine it under magnification. What do you see? What did the water do to the granules? Is water necessary for life? Are the granules you placed in the water actually single yeast cells? Yeast are very small and have a definite structure which can be seen under a microscope. If no microscope is available, study photographs of yeast cells.

2. Water is not the only requirement for life. To live, organisms must have an energy source. In front of you are several sweeteners and zippered, plastic freezer bags. The sweetener sugar is a known quick energy source. Are the other sweeteners energy sources? How would you test to see if they are energy sources using yeast and the bags?

3. Before you begin your experiment, determine whether your bags will leak when filled with water. Fill each bag part way with water, seal the bag, and turn it in every direction to make sure there are no tears in the bag. If water leaks from any tear in the bag, you will need to cover the tear with tape. If the leak comes from the zippered seal, cover the seal with tape once you have added the ingredients.

4. A possible experimental setup would include 4 bags: 1 control and 3 experimental bags. Each bag should have the same amount of liquid and 1 teaspoon of yeast. Bag #1 would be the control and contain warm water, yeast, and no sweetener. Why? Bags #2, #3, and #4 would each have a different sweetener such as sugar, Sweet 'n Low®, Equal®, diet soda, regular soda, or fruit juice. If you are testing one of the powdered sweeteners, use warm water with your sweetener and yeast mixture. If you are testing a sweetened liquid, just include the liquid and yeast without water. Why? See Figure 1.

5. After adding a different sweetener to each of the bags, carefully seal the bags trapping as little air as possible. Mix the contents well. Keep the contents of the bags at a constant temperature by placing them on an overhead, or holding them in your hands or under your arms. You will monitor the bags every 10 minutes, so make note of the time.

6. While you wait, taste a sample from the unused portions of each of the sweeteners you tested. Which is sweetest? Which do you think will provide the most energy for the yeast? Write down your predictions.

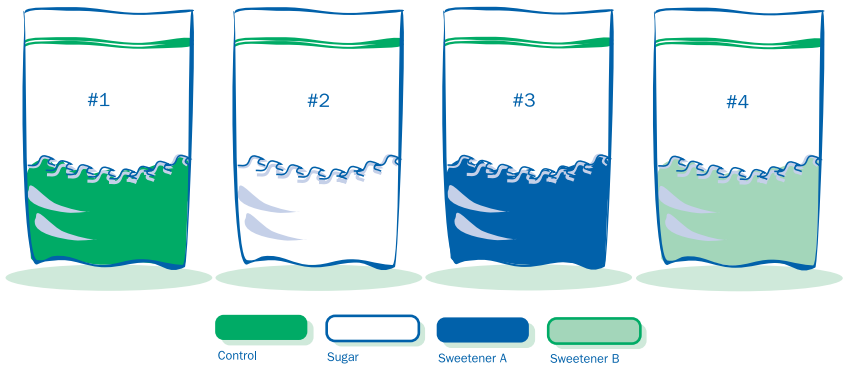


Figure 1. Possible experimental setup.

7. After 10 minutes, determine the amount of gas created in each of the bags. Record your observations. One way to measure the amount of gas produced is to measure the diameter of each bag with a ruler. Squeeze each bag to collect the gas in the bottom portion of the bag. Roll the flattened part of the bag around the bottom. Measure the diameter of each rolled bag. See Figure 2. How do the results compare to your predictions? Graph your results. Repeat the process after 20, 30, and 40 minutes. An alternate method for measuring the gas produced is water displacement. See Figure 3. Fill a 1-L container with 0.5 L of water. Measure the water level. Submerge the bags one at a time into the container of water. Mark the new level of water and remove the bag. Fill the container up to the new water level mark. Pour out 0.5 L of water, and pour the remaining amount into a 16-ounce measuring cup. Follow this procedure for each bag to measure the amount of water displaced.

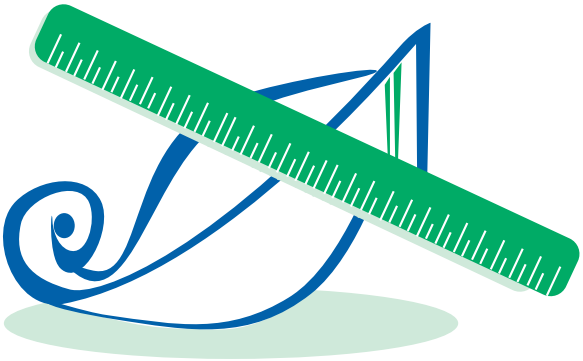


Figure 2. Procedure for measuring gas production.

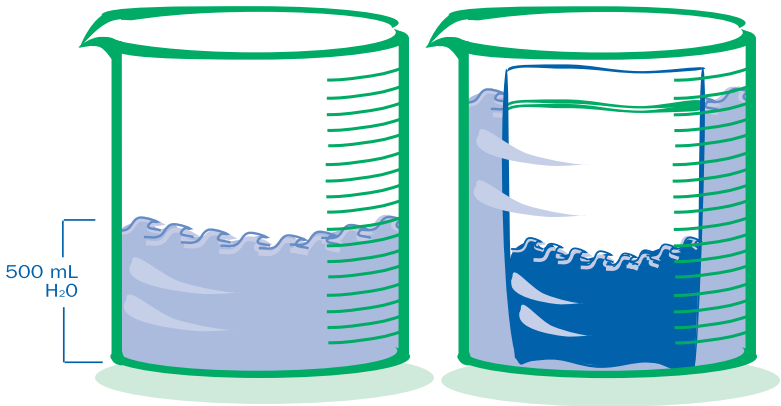


Figure 3. Measuring gas produced by water displacement.

8. Where did the gas in the bags come from? We produce carbon dioxide just like yeast. Could you design a test to prove that the gas is, in fact, carbon dioxide? How can you find out how much energy is available in different foods? How much food did the yeast in the bags use?

9. Compare the labels of the sweeteners you used. How many calories were in each? Do you see a relationship between the number of calories and the results you got?

10. How can you learn more about the chemical and energy activities of yeast? What procedures would you use? What would you measure? What if you added other ingredients? What if you changed the amounts of the ingredients? Could you design an experiment to test a new hypothesis or question?

What Did You Find Out By Doing the Activity?

Before doing "Can Microbes Tell the Difference?" did you know:

- what yeast are?
- that yeast are living?
- what living organisms need to survive?
- that living organisms produce energy from foods they eat?

From this activity, did you discover:

- how to show that yeast are living?
- how yeast are similar to humans?
- that living organisms produce energy to survive?
- how your body uses sugar?
- what your body does with things that it cannot use?
- how to measure small amounts of gas?
- which foods you eat give you energy most quickly?
- how dieting affects the body?