Comparing the Quantity of Sucrose in Normal and High Sucrose Soybeans by Using Invertase

Student Instructions

Background Information

High sucrose soybeans offer improved flavor and digestibility of soy milk and other soy food products. These newly developed soybeans contain 90% less of the indigestible carbohydrate sugars raffinose and stachyose that can produce abdominal discomfort and gas. The beans also contain 40% more sucrose and lack the lipoxygenase-2 enzyme that is responsible for “beany” flavor. Because they taste better and produce less gas, they allow the manufacturers of soy products to increase the percentage of soy in beverages, bakery products, pasta, and other foods.

As suggested by their name, high sucrose soybeans are 40% higher in sucrose, a carbohydrate sugar that is made up of two simpler sugars, glucose and fructose. In this lab you will produce evidence that high sucrose soybeans contain more sucrose than normal soybeans. You will use a sucrase enzyme called invertase. Invertase breaks down (hydrolyzes) sucrose into the monosaccharides glucose and fructose. A commercial glucose test used by diabetics to monitor the sugar levels in their urine will be used to measure the glucose in the soybeans because the test is designed to be very specific for glucose.

Note: If you are allergic to soy products, you should not participate in this experiment.

Doing the Pre-Lab

Materials:

- High sucrose soybeans
- Normal soybeans
- Two 400-600 ml beakers or containers
- Tap water
- Marker and two labels

Procedure:

1. Add 75 grams (1/2 cup) of normal soybeans to a container and add at least twice the volume of regular tap water. Label the container “Normal.”

2. Repeat step 1 with the high sucrose soybeans. Label the container “High Sucrose.”

3. Let the soybeans soak overnight until the next day’s lab time. The soybeans will begin to swell as they absorb the water. The soybeans should stay covered with water for 24 hours. A student from your group and/or your teacher should check periodically to make sure the
beans stay covered. Make sure to add a sufficient amount of water to cover the soybeans overnight. You cannot add too much water.

Doing the Laboratory

Day 1

Materials:

- High sucrose soybeans from pre-lab prep
- Normal soybeans from pre-lab prep
- Two blenders
- Distilled water
- Two large wire strainers
- Four #6 coffee filters
- One 600-1000 mL beaker or collection containers
- Four 1.5 ml Microcentrifuge tubes
- Aluminum foil or plastic wrap to cover container
- Marker and six labels
- Clock, watch, or timer

Procedure:

1. Your teacher may select two groups to do the following procedure.

2. Drain the water from the normal and high sucrose soybeans.

3. Place the “Normal” soybeans in a blender and add an equal volume of distilled water.

4. Blend the mixture on high for 1 minute.

5. While the mixture is blending, place two #6 coffee filters in the strainer positioned over another container to collect the liquid (filtrate).

6. After a minute of blending, pour the mixture into the coffee filters and let filter. Label this container “Normal.”

7. Repeat steps 3-6 with the high sucrose soybeans. Label the collection container “High Sucrose.”

8. Let the soybean mixtures drain completely (15-20 minutes).
9. While the soybeans are draining, make the following labels:

   a. Label two test tubes. Label one test tube “Normal” and the other test tube “High Sucrose.”
   b. Label two additional tubes as “C Normal” and “C High Sucrose.”
   c. Create a data table for the Day 2 lab. Your teacher will show you how.

10. Cover the containers and place in the refrigerator overnight.

**Make A Hypothesis:**

1. Which of the four mixtures do you think will test positive for glucose? Why?

2. Of the mixtures that test positive for glucose, which one(s) do you think will have the largest amount of glucose? Why?

**Day 2**

- Four 1.5 ml Microcentrifuge tubes labeled “Normal,” “High Sucrose,” “C Normal,” and “C High Sucrose” prepared on Day 1
- Test tube rack for 1.5 ml Microcentrifuge tubes
- Glucose test strips for urine (Bayer’s Diastix® strips were used in the original lab tests)
- Four 1 ml transfer pipettes or medicine droppers
- 0.05 grams of invertase in a 1.5 ml Microcentrifuge tubes
- Distilled water
- 50-55°C water bath
- Forceps
- Clock, watch, or timer
- Paper towel and pen or marker

**Procedure:**

1. Fill each 1.5 ml microcentrifuge tube with 1.0 ml of each mixture as it corresponds to the label on the tube. Use a different pipette for each mixture.

2. Test each mixture for glucose by dipping a glucose test strip into the mixture in each test tube. Use a different test strip for each mixture. Shake the excess mixture off each test strip and lay it on a paper towel. Write the name of the test tube mixture, “Normal,” “High Sucrose,” “C Normal,” or “C High Sucrose” on the towel near the corresponding test strip.
3. Let the glucose test strips sit for 1 minute or the amount of time stated in the directions that came with the glucose strips.

4. Read the concentration of glucose by comparing the color of each strip with the chart on the glucose strip container.

5. Record your results on your data table.

6. Get from your teacher a tube of the enzyme invertase. Add 1 ml (20 drops) of distilled water to the invertase tube and dissolve the enzyme. **If your group is the control group, you should skip steps 7-9. You will not add the enzyme to the control “C” tubes.**

7. Using a transfer pipette, add half of the invertase mixture or about 10 drops to the “Normal” mixture and the other half to the “High Sucrose” mixture.

8. Mix the contents of each tube by placing a stopper in the mouth of the tube and inverting it several times.

9. Place the test tubes in the 37°C water bath.

10. After five minutes, test the mixture with the glucose test strips and record the results on the data table. Read each strip exactly 30 seconds after dipping.

11. Repeat the glucose test every five minutes or as often as your teacher directs.

12. Record your results on the data table.

13. Clean up the lab area according to your teacher’s directions.
Reflect and Apply

Name ______________________________

1. Why is it important to read the test strip in 30 seconds?

2. Explain what is happening chemically in this activity.

3. Explain the presence of glucose in both normal and high sucrose soybean samples.

4. On a commercial scale, what is the importance of developing a high sucrose soybean?

5. As a consumer what other traits would you consider valuable enough to want in soybeans, if the technology were available?

This activity was developed by Mike Zeller for the ISU Office of Biotechnology. The activity is used with permission.
# Student Data Table

Name_______________________ Group/ Lab# ____________________

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<th>Readings</th>
<th>Initial Trial (no invertase)</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
<th>Trial 5</th>
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<td>Normal (mg/ml)</td>
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<tr>
<td>High Sucrose (mg/ml)</td>
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