How Sweet It Is! Measuring Glucose in Your Food

https://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci_p049/cooking-food-science/measuring-glucose-in-food (http://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci_p049/cooking-food-science/measuring-glucose-in-food)

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Experimental Procedure

1. To start this science fair project, you should first collect all of the foods and juices that you plan to test.
2. Based on your research, predict which foods will have the highest glucose levels. List the foods in your lab notebook in order from highest to lowest predicted glucose concentration.
    a. One place to start your research is www.nutritiondata.com (http://www.nutritiondata.com), which reports glucose levels for some raw ingredients (nuts, fruits, vegetables, etc). To get to that information, search for the ingredient, scroll down to "Nutrition Information" and click the "More details" tab under "Carbohydrates". Remember that for processed food, the labels on most products list total sugar, which is a mixture of several sugars such as sucrose, fructose, lactose, maltose, galactose and glucose. The test strip only measures glucose concentration.

Making the Positive and Negative Controls

Controls are samples with known ingredients that should give clear, expected results. They are used to test the procedure. Using a **positive control**, there should be a clear "signal," or color change, showing that the glucose strips are working properly. Using a **negative control**, there should be no "signal," or color change. Tap water is a suitable negative control (because it has no glucose).

1. First, make the positive controls using water and the glucose powder. To do this, make a **dilution series** using sequential twofold dilutions to create the following concentrations: 2%, 1%, 0.5%, 0.25%, 0.125%, and 0.0625%.
    a. Label six cups: 2%, 1%, 0.5%, 0.25%, 0.125%, and 0.0625%.
    b. Add 4 grams (g) of glucose to 200 mL of water in the cup labeled 2% and stir until the glucose dissolves.
    c. Optional: Add 2–5 drops of food coloring to the 2% glucose solution. The color does not matter. *Note*: The food coloring will allow you to keep track of your dilution levels as the color of each dilution will get less intense. It does not interfere with the glucose measurements.
    d. Add 100 mL of water to the other five cups.
    e. Measure 100 mL of the 2% solution and add it to the cup labeled 1% to make a 1% solution. Stir well.
    f. Measure 100 mL of the 1% solution and add it to the cup labeled 0.5% to make a 0.5% solution. Stir well.
        i. Between each dilution, make sure to rinse and shake the excess water from the graduated cylinder or container you are using to transfer the 100 mL volumes. Also, use a clean stirrer.
    g. Repeat this process for the remaining dilutions.
        i. When you are done, each cup should have 100 mL of liquid, except for the 0.0625% solution, which should have 200 mL.
2. Fill an extra cup with 100 mL water. Do not add any of the glucose solutions to it. Label it 0%. This will be your negative control.
3. If you used food coloring for your dilution series, you should now have seven cups that look similar to the ones in Figure 2.

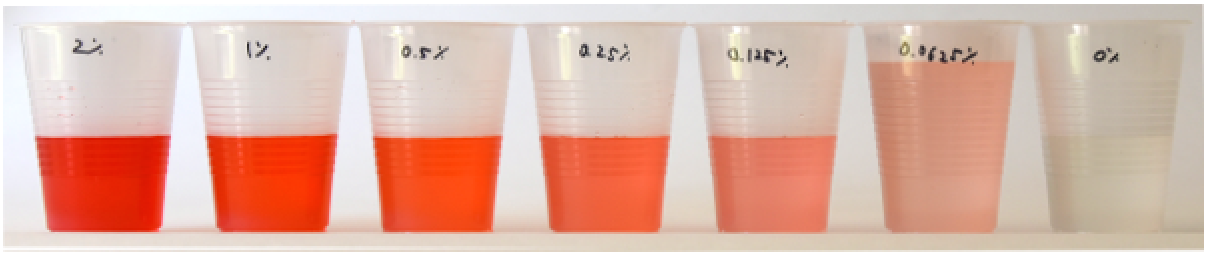

Figure 2. If you used food coloring (in this picture, red food coloring was used), the glucose dilution series should look like the ones in this picture (arranged by most concentrated to least, from left to right). (Each cup should have 100 mL of liquid, except for the 0.0625% solution, which should have 200 mL.) A seventh cup, serving as the negative control, should only contain water (on the far right in this picture).

4. Dip a test strip into each of the seven cups, one at a time. After 1–2 seconds, remove the test strips from each of the solutions and watch them for 30 seconds (which should be the time recommended in the test strip instructions). Then match the color of the glucose marker on the test strip to the color on the bottle shown in Figure 3. Do the colors match what you would expect? Write down your observations in your lab notebook. *Note*: For high glucose concentrations, it might take up to 60 seconds until the color matches the actual concentration. Therefore it is recommended to dilute your samples once they approach a glucose concentration of 1%.
    a. See the Technical Note for guidance on matching the color of the glucose test strips to the color on the bottle.
    b. If the color changes to the maximum range (2%) before 30 seconds, list it as greater than 2% (">2%"). You do not need to perform a dilution.
    c. If you do not have a clear color change for any of the positive control solutions with a concentration greater than 0.0625% repeat the procedure. If the second time it is still problematic, you might have to buy new test strips. It is ok to have a slightly lower reading for the pure glucose solutions. Remember, these test strips were designed for measuring low concentrations of glucose in a urine sample so the results might be slightly different for pure glucose solutions. If the test strips for the glucose solutions at 30 seconds are more than one color off from what it is expected to be (for example, if the 1% solution reads less than 0.5% or the 0.25% solution reads greater than 0.5%), you could adjust the readout time accordingly (for example to 60 seconds). However, you have to make sure, that throughout the experiment, you keep the same readout time for all of your samples.

Technical Note

When matching the color of a glucose test strip to a color on the bottle, keep in mind these helpful tips:

- The colors on the bottle will not exactly correspond to the percent glucose solutions you made. There will probably be colors for 0% ("Negative"), 0.1%, 0.25%, 0.5%, 1% and 2% glucose solutions, as shown in Figure 3.
- Some test strip colors may fall between two of the colors on the bottle, for example between 0.5% and 1%. If this happens, write down the two numbers in your lab notebook and calculate their average.
- If the color changes to the maximum range (2%) before 30 seconds, list it as greater than 2% (">2%"). Depending on where this happens in the Experimental Procedure, you may need to then perform a 1:10 dilution and re-test the sample. You will get more accurate results if you start diluting your samples once the glucose concentration is getting close to 1%. There are two ways in which you may perform a 1:10 dilution, and the preferred way will be specified in the text:
    - Use a transfer pipette to add 9 drops of water and 1 drop of the test solution on a bottle cap. Rinse the transfer pipette in between each sample.
    - Mix 1/2 teaspoon (tsp.) (2.5 mL) of the sample with 22.5 mL water to make a 1:10 dilution. (Note: You will only test 15 mL of this dilution.)

Remember that if the 1:10 dilution reading reports 1% glucose, then the glucose in the sample is really 10%, because it was diluted tenfold.

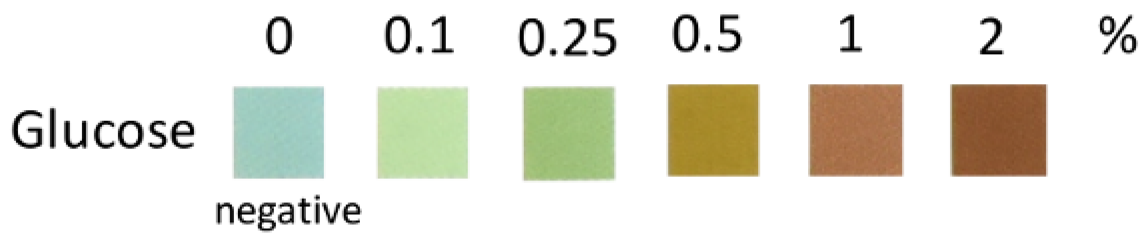

Figure 3. This is the color chart for glucose on the test strip bottle. After a glucose test strip is dipped in a glucose solution and removed, its color should change and match a color on its bottle (or be between two colors). The color on the bottle will indicate the percentage of glucose in the solution tested.

Testing the Foods for Glucose Concentration

1. Pour a small amount of liquid that you plan to test into a cup.
2. Get ready to start the stopwatch.
3. Dip the test strip into the liquid.
    a. For the fresh fruits and vegetables, press the test strip against a freshly cut slice until the test strip is thoroughly wet.
    b. For very high-glucose liquids, such as honey or soft drinks (not diet), or viscous substances, such as peanut butter, molasses, or baby food, dilute the samples in water prior to testing as described in the third bullet point of the Technical Note. For example, mixing 2.5 mL (0.5 teaspoon [tsp]) of honey with 22.5 mL (4.5 tsp.) water makes a 1-to-10 dilution. Multiply the concentration of glucose in the diluted solution by 10 to obtain the concentration of glucose in the original sample.
4. After 1–2 seconds, remove the test strip from the liquid or food and immediately start the stopwatch.
5. Wait for the amount of time specified on the test strip directions, usually 30 seconds.
6. Compare the color on the test strip with the color on the side of the container to determine the glucose concentration.
    a. If the color changes to the maximum range (2%) before 30 seconds, list it as greater than 2% (">2%").
    b. To determine the actual percent of glucose in samples with over 2 percent, dilute the sample as described in step 3b to bring the glucose level down within the range of the test strips. You will get more accurate results if you start diluting your samples once the glucose concentration is getting close to 1%.
    c. Test the diluted sample. If it has 1 percent glucose, then the glucose in the sample is really 10 percent, because you diluted it 10-fold.
7. Repeat steps 1–6, of this section, for all of your foods and juices.
8. Make a data table of your results in your lab notebook. Table 1 is an example, with a "predicted" column for what you expected to find, and an "experimental" column for your actual results.
9. Use < 0.5% for "low," 1%–2% for "medium," and >2% for "high."
10. Repeat the glucose measurements for a total of at least three trials (three samples of each type of food).
11. Graph your results. Put the type of food on the x-axis and the glucose concentration on the y-axis.
12. Did your results match your predictions? Were some foods surprising in the amount of glucose they contained?

Type of Food	Glucose Level: Predicted	Glucose Level: Experimental	Notes
Mixed fruit drink	High	10% (1% in diluted sample)	Diluted 1:10 (example)
Orange juice	Low	1%	Tropicana

Table 1. In your lab notebook, make a data table like this one to record your results in.