Activity 6

1–2 CLASS SESSIONS

Vitamin C Titration

Activity Overview

Students titrate a drink solution containing vitamin C to determine the relative amount of vitamin C in two different solutions. They compare the amount of vitamin C found in a powdered drink that has been freshly made to one that was prepared the previous day. This is used as a model to introduce some of the trade-offs involved both in preserving foods with methods that reduce the nutrient value and in using foods that are not fresh. It is intended to help students think about how to preserve the nutritive value of foods.

CONCEPTS, PROCESSES, AND ISSUES

(with NSES 5–8 Content Standards Correlation)

1. Conducting multiple trials of an experiment produces more reliable data. *(Inquiry: 2)*
2. The concentration of a solution can be accurately determined through titration. *(Inquiry: 1, 2; PhysSci: 1)*
3. Chemical additives can be used to prevent microorganisms from growing, to prevent chemical reactions that alter the taste or appearance of food, and to increase the nutritional value of food. *(Inquiry: 1, LifeSci: 3, PhysSci: 1, Perspectives: 4, 5)*

TEACHING SUMMARY

Step 1.
Predict whether fresh or day-old fruit drink will contain more vitamin C.

Step 2.
Introduce the process of titration and the use of iodine as an indicator.

Step 3.
Titrate fresh and day-old fruit drink to determine which contains more vitamin C.

Step 4. *(Assessment)*
Share results as a class.

MATERIALS

For the teacher

- 2 packets of lemon drink mix
- * 2 large pitchers (or other 1-liter containers) with at least one lid
- * 1 long-handled spoon
- * 1 100-mL graduated cylinder
- 1 250-mL bottle
- 16 empty 20-mL amber plastic bottles labeled "Dilute Iodine"
- 1 bottle of Lugol's (iodine) solution (in foil bag)
- 1 3-mL syringe
- * access to water
- * paper towels
- * 1 overhead projector
- 1 Transparency 6.1, "Class Results from Investigation 6"

For each group of four students

- 1 plastic cup containing fresh fruit drink
- 1 plastic cup containing day-old fruit drink
- 1 30-mL dropper bottle of 20% starch solution

For each team of two students

- 1 SEPUP tray
- 1 dropper
- 1 stir stick
- 1 bottle of dilute iodine with dropper
- 1 cup containing water

For each student

* 1 pair of safety goggles

1 Student Sheet 6.1, "Recording Results" (optional)

Advance Preparation

Preparing the day-old drink mix

At least one day before doing the activity, mix one of the lemon drink mix packets with 1 liter of water. This will produce a more concentrated punch than is normally made for drinking, but it will yield better results. Leave this punch out overnight uncovered in a wide-mouthed container.

Note: Vitamin C reacts with oxygen in the air, reducing the amount of vitamin C. At higher temperatures, the vitamin C loss is greater. If your room is cold, you may want to store this solution in a warmer area.

Preparing the Dilute Iodine Solution (1:100 dilution)

On the morning of the investigation, prepare the dilute iodine solution (1:100 dilution). Using the syringe provided, measure out 2.5 mL of the concentrated Lugol's (Iodine) Solution and add it to 248 mL of distilled water (up to the neck of the dilution bottle provided). Mix thoroughly. Fill the 16 bottles labeled "Dilute Iodine."

Note:

Lugol's Solution is very sensitive to both heat and light and must be stored upright in dark bottles. Yet even with proper storage, the dilute iodine will lose activity in a month or two. The concentrated Lugol's solution has a shelf life of approximately one year if stored in a cool dark place. After you open the bottle, note the current date so you know when to reorder.

Preparing the Fresh Drink Mix and Dispensing Materials

On the morning of the investigation, mix the other lemon drink mix packet with 1 liter of water, making sure to keep the container covered after mixing.

Label 8 cups "day-old fruit drink," and 8 cups "fresh fruit drink." Just before, or at the beginning of each class, pour a small amount of the appropriate fruit drink into each of the cups.

Students should be instructed to designate one of their droppers to the iodine solution. Even dilute iodine tends to stain the clear plastic of the dropper. While this does not affect results, it can easily contaminate other solutions.

Safety

Iodine solution tends to evaporate quickly, and its fumes should not be inhaled in large quantities. Keep lids on iodine bottles when they are not in use.

Iodine stains clothes and skin. Students should avoid direct contact with the solution, and clean any spills immediately. Caution students against leaving the droppers in the bottles because they will tend to tip over and spill. Safety goggles should be worn during this activity, and chemical spill aprons should be provided if available. Remind students that they should not eat or drink while performing the Procedure.

Teaching Suggestions

GETTING STARTED

Step 1. Predict whether fresh or day-old fruit drink will contain more vitamin C.

Ask students how many of them drink orange juice regularly. Ask a few of those who raise their hands to describe why they drink it. If the idea of getting vitamin C does not come up, ask if anyone has thought of orange juice as a good source of nutrients. Ask students if they have any ideas about what types of foods have the most vitamins. Make a list of their responses on the board or on an overhead transparency. Encourage the class to think about whether fresh or prepared foods are more likely to contain vitamins.

Explain to students that you have prepared two identical solutions of vitamin C drink mix. One solution has been left out overnight, and the other solution has been freshly prepared. Ask students to predict which solution contains more vitamin C. Students should record their predictions in their science notebooks and explain why they are making this prediction. For example, some students may say that most fresh foods have more vitamins than preserved foods because vitamins deteriorate over time. Some students may reason that both solutions will contain the same amount of vitamin C, since they were prepared identically from the same drink mix. Other students may reason that the day-old lemon drink contains more vitamin C since it has had more time to absorb nutrients from the powder.

After students have had a chance to make predictions, ask them to share their ideas within their groups. Have a student representing each general opinion share his or her prediction and reasoning with the class. Then tell students that they will be conducting an experiment to determine which of the solutions contains more vitamin C.

Appendix A

MATERIALS

CONTENTS OF MATERIALS KIT

- 16 stir sticks
- 16 30-mL graduated cups
- 16 droppers
- 16 empty 20-mL amber plastic bottles labeled "Dilute Iodine"
- 16 plastic knives
- 16 copies of the Additives List
- 32 9-oz. plastic cups
- 200 packets of sugar
- 8 empty 30-mL bottles, labeled "Ascorbic Acid, 10%"
- 8 30-mL dropper bottles of:
  - sodium benzoate solution
  - sodium carbonate solution
  - vinegar
  - distilled water
  - 20% starch solution
  - pesticide test solution: 2,000 ppm iron (III) nitrate
- 2 vials containing 25 grams solid ascorbic acid
- 2 packets of lemon drink mix
- 1 250-mL bottle
- 1 bottle of Lugol's (iodine) solution (in foil bag)
- 1 3-mL syringe
- 1 2-lb. bag of baker's rapid rise yeast
- 1 bag of dried apricots preserved using sulfur dioxide
- 1 bag of dried apricots preserved without using sulfur dioxide
- 1 roll of plastic wrap
- 1 bag of dried black-eyed peas containing approximately 400 peas
- 1 180-mL bottle of 0.1 M potassium iodide solution
- 1 240-mL bottle for preparation of ascorbic acid stock solution

ITEMS NOT SUPPLIED IN THE KIT

(denoted with an * in the Materials list in the Teacher's Guide)

- 16 SEPUP trays
- 2–10 bananas, medium-sized
- 4 coverslips (optional)
- 1 knife
- 1 large container (for soaking peas)
- 2 large pitchers (or other 1 liter containers) with at least one lid
- 1 long-handled spoon
- 1 100-mL graduated cylinder
- 4 microscopes (optional)
- 4 microscope slides (optional)
- 1 overhead projector
- 1 pair of scissors
- 16 pairs of safety goggles
- 1 thermometer (optional)
- access to warm water
- labels or empty boxes of various processed foods
- paper towels
- transparency pens

MATERIAL REPLENISHMENT

Replacements for any kit item, including those items listed below, can be purchased from Lab-Aids. The following information is for your use if you want to prepare your own replacement solutions or obtain items locally. Use appropriate caution if you prepare the solutions yourself.

Each recipe will produce enough solution to refill eight 30-mL bottles.

Teachers should wear safety goggles and a face shield as well as a lab apron and plastic or rubber gloves when handling acids with a concentration greater than

1 mole. Students should not be allowed to handle or assist in the preparation of corrosive solutions, such as acids or bases greater than 1 molar concentration.

If acid or another chemical is splashed into the eyes, it should be flushed out immediately. Flush the eyes at an eyewash fountain that meets the specifications of the American National Standard for Emergency Eyewash and Shower Equipment, ANSI Z358.1-1990 (or later edition) for at least 15 minutes. While flushing, hold the eyelids away from the eyeball and instruct the victim to continuously move his or her eyes up, down, left, and right so as to permit the flowing water to flush out the space around and behind the eyeball. Meanwhile, call a local physician to determine whether further treatment is necessary.

Chemicals splashed on skin should be flushed off with copious running water for at least 15 minutes. If reddening or blistering appears, take the victim to a physician as soon as possible.

Chemicals that have splashed on clothing but that have not yet penetrated fabric through to the skin should be treated by rinsing the fabric free of the chemical with water. If it is necessary to remove the clothing to conduct the rinsing, do so promptly. Wearing a lab apron is recommended to avoid chemical spills on clothing.

10% ascorbic acid solution

Dissolve 25 grams solid ascorbic acid (available in health food or grocery stores) in 225 mL tap or distilled water.

Pesticide testing solution: 2,000 ppm iron (III) nitrate

Dissolve 3.7 grams of $Fe(NO_3)_3 \times 9H_2O$ in enough distilled water to make 250 mL of solution.

Note: It is important that the water be distilled.

Potassium iodide

Dissolve one packet or equivalent weight (1.6 grams) of reagent-grade KI in 100 mL distilled water. This should provide enough solution to prepare 30–40 black-eyed peas.

Sodium benzoate solution, 10%

Dissolve 25 grams solid sodium benzoate in 225 mL tap or distilled water.

Sodium carbonate solution, 10%

Dissolve 25 grams solid sodium carbonate (technical grade will suffice) in 225 ml distilled water.

Vinegar

Use household vinegar, which is a 5% acetic acid solution by weight. It is available in most grocery stores.