TEACHER'S GUIDE OBJECTIVES

Students should be able to

- measure the amount of vitamin C (ascorbic acid) in foods by titration.
- list the factors that affect the amount of vitamin C in foods.
- design and conduct an experiment relating one factor to vitamin C content.
- explain the effect different factors have on vitamin C.
- develop strategies for ensuring sufficient vitamin C levels in foods.

EQUIPMENT

- Goggles
- Food for testing
- Orange juice
- Iodine potassium iodide solution
- Vitamin C standard solution
- Starch solution
- Graduated cylinders, 10 mL, 25 mL
- Flask, 250 mL
- Beaker (size depends on vitamin C tablets)
- Beakers, 100 mL
- Eye dropper or optional micropipet or buret
- Distilled water
- Stirring rod or magnetic stirrer, if available
- Filter funnel, holder, and stand (for foods with particulate material)
- Filter paper (fast, ashless; for foods with particulate material)
- Lab balance
- Mortar and pestle (may help students conduct own investigation)

SUMMARY

The iodine in an iodine potassium iodide solution easily oxidizes the vitamin C, and any additional iodine reacts with starch to produce a blue-black color. The number of drops of iodine potassium iodide solution before the color change is proportional to the amount of vitamin C oxidized in the sample. The students should devise their own experiment in which they measure the amount of vitamin C in foods in relation to various factors.

PREPARATION

1. Starch solution: In a small dish, make a paste with 10–20 mL of distilled water and 1.3 g corn starch. Heat 250 mL of distilled water to boiling, then add the corn starch paste. Continue heating until mixed. Once mixed, allow to cool to room temperature.
2. Vitamin C standard solution: Put a vitamin C tablet in enough water to produce a 1 mg/mL solution and use a glass stirring rod to crush and mix it. For example, if the tablet contains 500 mg of vitamin C mix with 500 mL of distilled water. Tablet may have a mass of approx. 600 mg but contain 500 mg vitamin C.
3. Divide the students into groups of two to four.

PROCEDURE

Note: Students should record all notes, hypotheses, data, calculations, analyses, and conclusions in a project log.

Testing the Standard Solution

1. Each group will use a 25 mL graduated cylinder to measure 25 mL of the vitamin C solution and pour it into the 100 mL beaker, then add 10 mL of the starch solution.
2. The mixture should be stirred continuously. If a magnetic stirrer is available, the students should put a stir bar in the mixture, place the beaker on the stirrer, and turn it on.
3. If using a graduated micropipet or buret, the student should note the volume of liquid in the tube, then add iodine potassium iodide solution dropwise, counting the drops until the solution turns dark blue and, when stirred continuously, stays blue.
4. The students should determine the number of drops that equals 1 mL, as well as the volume (or number of drops) of iodine solution per mg of vitamin C needed to change the color.

Testing a Food (Orange Juice)

1. By repeating the previous steps, the students will test a sample of orange juice for its vitamin C content.
2. Based on the results with the vitamin C standard, calculate the amount of vitamin C in mg. (This can be done by setting up a ratio of mg vitamin C in the standard solution over drops (or mL) of iodine solution to cause color change. Set this ratio equal to the unknown mg of vitamin C in the orange juice over number of drops (or mL) of iodine solution to cause a color change. Students shoule be able to figure this out but be ready to give them pointers if necessary.) Divide the mass of vitamin C by the volume of juice in mL so that comparisons are on an equivalent basis.

Conduct Independent Investigation

1. As a class, brainstorm different factors that could affect the amount of vitamin C in foods.
2. Each group should choose a factor that they would like to test. (Encourage groups to test a variety of factors to benefit the entire class.)
3. Each member should write a hypothesis.
4. Using what they have learned, each group will devise an experiment to test the factor they chose.
5. The experiment should test each student's hypothesis. Emphasis should be on obtaining quantitative data to support each hypothesis.
6. Each group should describe completely the experiment devised including the factors tested and record all data and calculations.
7. Each group should give conclusions from their data and justification for whether it supported each hypothesis or not.
8. Have a class discussion in which each group presents their findings to the class.

TEXTBOOK CONNECTIONS

- Algebra I—Ch. 3
- Fundamentals of Math—Ch. 5
- Pre-Algebra—Ch. 5
- Life Science—Ch. 21, 23
- Biology—Ch. 21
- Chemistry—Ch. 16

ASSESSMENT RUBRIC

	4–Mastery	3–Competent	2–Emerging	1–Poor
Analysis	The relationship between variables is discussed. Trends or patterns are described and analyzed. Predictions are made regarding vitamin C content.	The relationship between variables is discussed. Predictions were made regarding vitamin C content.	The relationship between variables is discussed. No patterns or trends mentioned or predictions made.	The relationship between variables is not discussed.
Drawings/Diagrams	Experiment design clearly connects with the factors under investigation. Experiment design clearly tests the stated hypothesis. Procedure is easy to understand. Variables are properly controlled.	Experiment design clearly connects with the factors under investigation. Experiment design clearly tests the stated hypothesis. Procedure is easy to understand. Variables are not sufficiently controlled.	Experiment design addresses the factors under investigation and the stated hypothesis, but the connection is not clear. Variables are not controlled.	Experiment design is not described or design is identical to that of several other classmates with only minor tweaks. Factors and hypothesis are not adequately described.
Calculations	All calculations are shown, and the results are accurate and correctly labeled.	Some calculations are shown, and the results are accurate and correctly labeled.	Some calculations are shown, and the results are labeled correctly.	No calculations shown or they are inaccurate.
Conclusion	Evidence is cited to support the conclusion drawn from the activity, and possible reasons are given for errors or success.	Evidence is cited that supports the conclusion drawn from the activity.	What was learned from the experiment was stated.	No conclusions recorded; no evidence of reflection.
Organization/Appearance	All entries are organized, neat, and easy to follow. Numbers, bullet points, and spaces are always used to separate different items.	Most entries are organized, neat, and easy to follow. Numbers, bullet points, and spaces are usually used to separate different items.	Some entries are organized, neat, and easy to follow. Many are not. Numbers, bullet points, and spaces are sometimes used to separate different items.	Entries are not organized or neat. Order is difficult to follow. Numbers, bullet points, and spaces are rarely used to separate different items.
Collaboration with Peers	Always listened carefully to others and offered detailed, constructive feedback. Participated fully and shared the workload fairly.	Usually listened to others and usually offered constructive feedback. Participated most of the time and usually shared the workload fairly.	Sometimes listened to others, occasionally offered constructive feedback. Participated but sometimes did not share the workload fairly.	Did not listen to others and often interrupted them. Did not offer constructive feedback. Did not participate and relied on others to carry the workload most of the time.