Through Thick or Thin

The effects and specificity of enzymes for a substrate

Introduction

Open a can of soup, mix up frozen orange juice or open a bag of chips and a bottle of salsa! What had to be done to the raw ingredients in order to get them into the can, bag or bottle? Help students determine at least one answer to an important question faced by all food processing companies—What happens to the leftover waste material that is not canned, bagged or bottled?

Concepts

- Cellulose
- Enzymes
- Food processing

Materials

Cellulase enzyme solution, 1%, 0.5 mL
Methyl cellulose solution, 3%, 50 mL
Water, distilled or deionized (DI)
Beakers, 50 mL, 4
Clamps
Glass stirring rod, 2
Graduated cylinder, 10 mL, 2
Ring stand
Stopwatch
Syringes, 30 mL, 2

Safety Precautions

Students should wear chemical splash goggles, and follow all other normal lab safety guidelines.

Pre-Lab Preparation

Prepare the 1% cellulase solution—Add 0.1 g of cellulase to 10 mL of DI water.

Remove the plungers from each of the large syringes

Prepare the 3% methyl cellulose solution—Add 3 g of methyl cellulose powder to 100 mL of warm DI water. Stir constantly while cooling in an ice bath. Methyl cellulose is soluble in cold water but it tends to form lumps if not evenly dispersed in warm water first.

Procedures

1. Attach both of the large (30 mL) syringes to a ring stand with a clamp approximately 10 cm above the countertop.
2. Add 25 mL of the 3% methyl cellulose solution to two beakers.
3. Add to one beaker, 0.5 mL of DI water and mix thoroughly.
4. Add to a second beaker, 0.5 mL of the 1% cellulase solution and mix thoroughly.
5. Carefully pour the entire contents of each beaker into the two syringe barrels at the same time. *Note:* Place a syringe cap or piece of masking tape over the opening at the bottom to prevent the solutions from leaking out before the timing starts.
6. Place an unused beaker below each syringe, remove the tape and start timing. Record the time required for the two solutions to run through the syringes.
7. When the cellulose–cellulase solution with enzyme has run through, stir it up and pour it in the syringe once again. Record the time it takes to run through again.
8. Repeat step 7 until three similar times have been recorded.
9. Use the data to plot a graph showing what happened to the flow rate (in seconds) at trial #1, #2, etc.

Publication No. 10709
061616

Disposal

Clean out the contents of both syringe barrels and place in the trash. Wash each thoroughly with soap and water.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard C: Life Science, structure and function in living systems
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard C: Life Science, interdependence of organisms
Content Standard F: Science in Personal and Social Perspectives, science and technology in local, national, and global challenges

Tips

- The decrease in the flow rate in the enzyme-containing tube may be calculated as follows:

$$\% \text{ decrease} = \frac{F - F_t}{F - F_w} \times 100$$

where F is the flow rate of untreated wallpaper paste (syringe w/water)
F_t is the flow rate of the paste solution after incubation (syringe w/enzyme)
F_w is the flow rate of distilled water (through the syringe)

- The cellulase–methyl cellulose mixture runs through the syringe faster with each trial as the cellulase enzyme cleaves more bonds. The first trial took three minutes during testing. By the fourth trial the same 25 mL of solution took <1 minute.

Discussion

The importance of this activity will become apparent during a discussion of how food is processed. All food processors that use plant materials to make their products inevitably have unusable left over material-composed primarily of cellulose that can clog pipes and "gum up" machinery. Without an effective method of dealing with these waste products as quickly as possible, the plant may have to shut down to clean machinery and clear out pipes in the middle of a production run, which could be costly to the company.

Extension

- To determine the cellulolytic activity of soil microorganisms, bring in samples of soil from various locations. Incubate 25 mL of methyl cellulose solution with 1 gram of soil at room temperature (20 °C) for 24–72 hours. Then pour the mixture into a syringe barrel, without adding any additional enzyme. Record the time as indicated in the procedures. A discussion of how landfills are designed and work may follow.
- Perform the same experiment as above; only incubate the methyl cellulose-soil mixture at a warmer temperature. Why does the decomposition of organic, cellulose-containing material occur much more rapidly in the tropics than in temperate climates?
- Perform the experiment using enzymes other than cellulase, i.e., amylase, pectinase—and compare the results to demonstrate the specific nature of enzymes.

Materials for the *Through Thick or Thin* activity are available from Flinn Scientific, Inc.

Catalog No.	Description
C0172	Cellulase Enzyme
AP1732	Syringe, without Needle, 30 mL
M0057	Methyl Cellulose, 100 g

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.