Putting the "Squeeze" on Apples

Introduction

The use of enzyme to extract juice from apples was first introduced 30 years ago and today apple juice processing throughout the world utilizes about five million tons of apples. Test one or combinations of enzymes, different types of fruit and environmental factors, such as temperature, to discover the ideal conditions for maximum juice production.

Concepts

- Controlled experiments
- Enzymes

Materials

Amylase enzyme (optional)
Apples
Cellulase enzyme (optional)
Pectinase enzyme
Water, distilled
Balance
Beakers, 200-mL, 2
Beakers, 500-mL, 2
Coffee filters
Cutting board
Funnels, 2
Graduated cylinders, 100 mL, 2
Hot plate
Incubator or commercial water bath (optional)
Knife
Plastic wrap
Spoons

Safety Precautions

Students should wear chemical splash goggles and follow all other normal laboratory safety procedures. Wash hands thoroughly with soap and water before leaving the laboratory.

Pre-Lab Preparation

Depending on the number of groups in the class, chop up apples into small chunks, approximately 5 mm × 5 mm × 5 mm, with a knife or a commercial food chopper.

Store apple chunks in air-tight containers in the refrigerator until ready to use.

Make a 10% solution of pectinase enzyme by adding 1 g of enzyme to 9 mL of distilled water. Solutions should be made fresh throughout the day.

Procedures

1. Students should mass two 50 g quantities of apple chunks and place into two 200-mL beakers.
2. Label one Beaker A (the control) and the other Beaker B (experimental).
3. Add 2 mL of distilled water to Beaker A and 2 mL of diluted pectinase solution to Beaker B.
4. Thoroughly stir the enzyme solution and water into the fruit in each beaker and cover each with plastic wrap to prevent evaporation.
5. Place each beaker inside a larger 500-mL beaker of water on a hot plate and maintain the temperature at 40 °C for 20 minutes. Alternatively, place both beakers inside a commercial water bath or incubator.
6. Construct a data table with two columns labelled Beaker A and Beaker B. The data table will have five rows representing time in minutes labelled 0, 5, 10, 15, and 20.
7. Set up two funnels lined with a coffee filter on two 100-mL graduated cylinders.
8. After 20 minutes, pour the contents of each beaker into the corresponding large funnels.
9. Immediately record the amount of juice in the data table (0 time).

Publication No. 10708
061616

10. Every 5 minutes, record the new volume of juice in the cylinder.
11. When finished, make a graph showing the total volume of juice produced (mL) by each treatment as a function of time (minutes).

Disposal

The juice from the lab may be poured down the drain with the water running. Do not drink it! Wash with soap and rinse all equipment that came in contact with the juice. Coffee filter and pulp may be discarded in the trash according to Flinn Suggested Disposal Method #26a.

Teaching Tips

- This activity lends itself well to allowing student groups to design their own controlled experiments, as there are many variables that could be investigated, namely:
  Enzyme Concentration
  The effects of other enzymes or combinations of enzymes
  Type/variety of apple used
  Incubation time
  Incubation temperature
  The age and/or condition of the fruit before juice extraction
- Data collected from testing other variables should be pooled together so that students can identify the optimum conditions necessary for maximum juice extraction.

Discussion

The inner portion of the cell wall of many fruits contains pectin. Pectin is a "gum" found in plant cell walls and is the main ingredient responsible for formation of the gel in jams and jellies. Tart apples, cranberries, sour plums, concord grapes, quinces, gooseberries, red currants, and crabapples are especially high in pectin. Underripe fruit has more pectin than fully ripe fruit. Small amounts of the enzyme Pectinase form while the apple is ripening. Adding more pectinase can speed up the process of breaking down the pectin molecules in the cell wall, thereby releasing more juice. Since there is also cellulose in all plant cell walls, adding Cellulase will break down the cellulose and should release even more residual juice.

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
Form and function
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard E: Science and Technology
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, chemical reactions
Content Standard E: Science and Technology

Materials for *Putting the "Squeeze" on Apples* are available from Flinn Scientific, Inc.

Catalog No.	Description
A0303	Amylase, 25 g
C0172	Cellulase, 25 g
P0285	Pectinase Enzyme

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