Genetically Engineering Cleaner Clothes?

Introduction

What would happen if you added detergent to gelatin'? Have you ever heard that fresh pineapple should never be added to gelatin? What if you added a cup of fresh pineapple juice to your laundry, instead of detergent'? Would your clothes "get clean" or would they just smell like pineapple? In this experiment, you will learn something about detergents that you probably never knew or realized!

Concepts

- Genetic engineering
- Enzymes
- Proteolytic enzymes
- Chemical reactions—hydrolysis

Pre-Lab Activity

Complete the following statement before gathering the materials to do the lab:

(Teacher Check)

If the primary ingredient in gelatin is a (choose one): carbohydrate, fat, protein,

And drops of detergent are put on the surface of gelatin,

Then . . . (Predict the results by writing a complete sentence!)

Materials

Detergent, different brands, liquid or non-liquid
Gelatin, unflavored, 2 g
Water, distilled or deionized
Beaker tongs
Beakers, 100-mL
Foam plugs or Parafilm®
Graduated cylinder
Hot plate
Pipet, plastic or glass
Ruler
Stirring rod
Test tube rack
Test tubes, 16 × 150 mm, 5

Safety Precautions

The materials used in this lab are considered nonhazardous. Follow all normal safe laboratory guidelines.

Procedure

1. Add 50 mL of distilled water to a 100 mL beaker and bring to a boil.
2. Slowly add 2 g of gelatin to the boiling water while stirring. Stir and heat until all materials are dissolved and the solution has briefly boiled.
3. Use beaker tongs or gloves to pour approximately 10 mL of the gelatin solution into five test tubes. Try to minimize the number of air bubbles on top of the gelatin in each test tube by pouring the hot gelatin down the side of the test tube. Any bubbles on the surface of the gelatin can be removed using a long pipet. Plug each test tube with a foam plug or cover with Parafilm. Set the tubes aside to cool for 24 hours.
4. Make a data table to record the results of the experiment. Label columns with the following headings: *Ingredients; Measurement-Initial; Gelatin Description–After 24 Hours; Measurement–After 24 Hours; Gelatin Description–After 48 Hours; Measurement–After 48 Hours.* Label the rows with the names of the types of detergent to be tested plus the water.

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5. Make 10% solutions of the liquid or non-liquid detergents selected for testing. (Mix 10 mL or 10 g of detergent in 90 mL of distilled water.) Locate the ingredient labels on the containers of detergent being tested. Write down all of the listed information in the data table.
6. After the gelatin has hardened, use a wax pencil to mark on the outside of each test tube the location of the top of the gelatin. Add 15 drops of distilled water to one tube of gelatin. To each of the remaining tubes, add 15 drops of the detergent solutions made in step #5. Label each tube with the solution that was added to it and give each tube a number. Record the number next to each solution in the data table. Set the tubes aside again for 24 hours.
7. After 24 hours, examine each of the test tubes. In the data table, briefly describe what you observe about the gelatin in the tubes. Next, use a ruler and measure from the initial mark on the tube to the point where the gelatin is still solid. *Make measurements to the nearest mm.* Record measurements in the After 24 hours column of the data table for each solution. If continuing the experiment, set the tubes aside for an additional 24 hours. Repeat this step and record the results in the column: *After 48 hours.*
8. Record the group's results in a class data table for each type of detergent tested and the water.
9. On a piece of graph paper, graph both the data obtained by the group and the class data using the appropriate type of graph. Do not forget to include labels on each axis, a descriptive title and a graphing key/legend.
10. Use the class or individual group data to answer the following questions on a separate sheet of paper:

    a. What was the purpose of the test tube containing the 15 drops of water?

    b. Was your hypothesis supported? (The *If* part in the *Pre-Lab Activity*) If the hypothesis was not supported, and you're still not sure of the answer, what kinds of tests could be performed or where could you look to determine if gelatin is primarily a carbohydrate, fat, or protein?

    c. Was your prediction correct? Explain.

    d. Which detergent(s) affected the gelatin the most?

    e. Which detergent(s) affected the gelatin the least?

    f. How do the results of the group compare to the class results? Briefly explain.

    g. Compare the ingredients of the detergents that affected the gelatin the most. Are there any ingredients that are common to each of them? If yes, list them.

    h. Did any of the most effective detergents not contain any of the common ingredients listed in letter g?

    If yes, which one(s)?

    How do you explain the effectiveness of those detergents if those common ingredients are not listed?

    i. Based on the results, which type of organic substance in gelatin must also be found on or in "dirty" clothes? Support your answer using data from the experiment.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. All materials can be flushed with volumes of water or placed in the solid waste disposal bins for your school.

Tip

- This activity is great for relating biology to the "real" world. Carefully reading the ingredients of other products can be very revealing. Send students on a hunt to find enzymes in products at the local market. Household and/or contact lens cleaners, meat tenderizers, or personal care items are good places to start.

Discussion

The breaking apart of proteins, called *catabolism*, begins with the separation of the covalent peptide bonds, which link the amino acids together that form the polypeptide chains. This process is called *proteolysis* and globular proteins, called enzymes, are responsible for this reaction. The specific enzymes that break apart proteins are called *proteases*. Through a process known as genetic engineering, a number of proteases have been altered to be more stable as well as more effective in environmental conditions which easily denature "ordinary" proteases. These conditions, which include extremes in temperature and pH, i.e., high concentrations of bleach, are very common inside washing machines. When these "engineered" proteases are added to detergents, clothes get cleaner.

Gelatin, the main ingredient in Jell-O®, is formed when fibrous proteins, like tendons, are *denatured*. If proteins are denatured, they lose the structure that makes them able to function in a particular way. For example, when raw chicken is boiled in water, the muscle (meat) falls off the bones because the structure of the tendons, which connect muscles to bones is destroyed by the heat. As the liquid cools, it still contains the amino acids which formed the tendon's original structure, but the amino acids cannot reform that structure. This semi-solid fluid is called gelatin. Jell-O® is simply purified gelatin with sugar and flavoring added.

Extensions

- One excellent suggestion is to add fresh pineapple juice as one of the test solutions. How does the "cleaning power" (the proteolytic enzyme activity) of pineapple juice compare to the detergents? What do fresh pineapple juice and the most effective detergents appear to have in common?
- Prepare the juice beforehand by the following method: Cut up a fresh pineapple into chunks (remove the outer rind first) and then use a food processor or large mortar and pestle to extract/squeeze out the juice. Filter the juice through chees cloth or a colander to remove the pulp and then store in a tightly closed container in a refrigerator until needed.
- Have students test canned and fresh pineapple juice to compare their effects on the gelatin.
- Either purchase or have students bring in a variety of gelatins, i.e., Jell-O® brand, both with and without sugar, to compare to the unflavored gelatin. Does the presence or absence of sugar and/or flavoring affect the enzyme's activity? Do enzymes seem to "prefer" a particular flavor of gelatin?

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
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard C: Life Science, structure and function in living systems
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions
Content Standard C: Life Science, the cell

Materials for *Genetically Engineering Cleaner Clothes?* are available from Flinn Scientific, Inc.

Catalog No.	Description
G0037	Gelatin
GP6066	Test Tubes
AB1395	Plugs, Foam
AP4417	Test Tube Rack
FB1755	Using Bacteria to Clean Clothes?—Genetic Engineering in Action

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