

Enzyme Chemistry

Taken from IFT Mini- Experiments in Food Science Series

Enzymes are involved in a variety of chemical reactions in food systems. They act as catalysts (substances that speed up a chemical reaction but are unchanged by the reaction) that break down or build up biological compounds. Each enzyme is very specific for a particular chemical reaction. All enzymes are proteins that have a particular area (active site) that attaches to the chemical(s) destined to undergo the chemical change. These chemicals are called substrates, and their shapes are complementary to the active site of the enzyme.

Typically, enzymes are named for the specific reaction they catalyze. Often the beginning of the enzyme's name is the same as the substrate, and the ending "ase" indicates that it is an enzyme. Therefore a lipase will break down lipids (fats), a protease attacks protein, and lactase hydrolyzes the milk sugar lactose. However, several enzymes that were discovered before this nomenclature was adopted retain their original names (e.g., trypsin, pepsin, papain, bromelin).

Amylase

The breakdown of starch to its constituent sugar (glucose) occurs as a result of the action of amylase. Starch digestion begins in the mouth. As the food is chewed, amylase in the saliva hydrolyzes the bonds that link the long chains of glucose.

Demo 1. Conversion of starch to sugar – flavor determination

Preparation Time	5 minutes
Laboratory Time	5 minutes

Provide student with an unsalted saltine cracker or a piece of bread.

Ask students to chew the cracker or bread while noting any change in flavor.

Students should observe an increase in sweet taste as their salivary enzymes hydrolyze the bland starch to sweet sugar.

Demo 2. Conversion of starch to sugar chemical determination

Preparation Time	5 minutes
Laboratory Time	30 minutes

Place 1 g of potato starch in a labeled test tube containing 16 ml of water; mix; then place the tube in a 37°C water bath.

In a second labeled test tube, mix 1 g of potato starch, 15 ml of water, and 1 ml of saliva and then place in a 37°C water bath.

Incubate the tubes for 15 minutes, then remove from the water bath and add 1 drop of iodine solution to each test tube.

Students should observe that starch will bind iodine and thus acquire a blue-black color. However, in the tube that contains the saliva, the amylase in the saliva will have hydrolyzed the starch into sugar, which is unable to bind iodine.

Protease

Many fruits contain naturally occurring enzymes that have the ability to break down or hydrolyze protein. This can be demonstrated using the protein in gelatin as the substrate. (Note: These demonstrations could be setup beforehand).

Demo 3. Enzymes breaking down (hydrolyzing) protein

Preparation Time	90 minutes
Laboratory Time	2-3 hours

Prepare the gelatin dessert according to the package directions and fill 100 ml graduated cylinders to the 90 ml level.

Place in a refrigerator. After the gel is formed, add 10 ml of fresh pineapple, kiwi, or papaya juice and label the cylinder.

Place a marble on the gelatin and observe over several hours.

Students could observe that the marble will sink as the enzyme in the juice breaks down the gelatin.

Variations

1. Incubate the cylinders at different temperatures to determine the effect of temperature on enzyme action.
2. Heat the fruit juice to 100°C for 2 minutes before adding to the gelatin to demonstrate the concept of enzyme denaturation.
3. Mix the fruit juice with an equal volume of vinegar before adding it to the gelatin dessert to demonstrate the effect of pH on enzyme action. Like heat, acid can cause denaturation of enzymes with a resultant loss of activity.

Direct the student to read the preparation instructions for a package of gelatin dessert. Ask the students to comment on the precaution statement:

TO ADD FRUIT OR VEGETABLES:

*Refrigerate gelatin 1 ½ hours or until thickened. Stir in 1 ½ to 3 cups
Chopped fruit or vegetables (well-drained, if using canned). Refrigerate
4 hours or until firm.*

NOTE: DO NOT use fresh or frozen pineapple, kiwi, gingerroot, papaya, figs, or guava.
Gelatin will not set.