

What's in a Potato?

Have you ever used a 3% hydrogen peroxide solution to disinfect an open cut? If so, you probably noticed the formation of bubbles. Although hydrogen peroxide decomposes into water and oxygen gas very slowly at room temperature, the rate increases significantly in the presence of the enzyme catalase. Common substances containing catalase include blood, saliva, and potatoes. Does temperature affect the functioning of catalase?

Materials

- 3–4 slices of fresh, raw potato or turnip
- 2 tablespoons 3% hydrogen peroxide solution
- 2–3 toothpicks or an eyedropper
- sauce pan or microwave-safe container
- stove, hot plate, or microwave
- tablespoon measure

Getting Ready

Step 1 Cool 1 tablespoon of 3% hydrogen peroxide in the refrigerator for several hours.

Step 2 Boil a slice of potato or turnip until it is just slightly soft (several minutes); allow it to cool to the temperature of the other slices.

Exploration

Step 1 Use a toothpick or eyedropper to place several drops of room temperature 3% hydrogen peroxide solution onto a slice of fresh, raw potato or turnip. Observe for several minutes and record your observations. Does the behavior change with time? Write the balanced equation for the reaction.

Step 2 Place several drops (same amount as in Step 1) of cooled 3% hydrogen peroxide onto a slice of fresh, raw potato or turnip. Compare your observations with those from Step 1. How can any differences be explained?

Step 3 Place several drops (same amount as in Step 1) of room temperature 3% hydrogen peroxide onto a slice of previously-boiled potato or turnip. Compare your observations with those from Step 1. How can any differences be explained?

Step 4 Spit into a sink. Put several drops of hydrogen peroxide onto the saliva. What do you observe? Explain.

Challenge

How does temperature affect the ability of catalase to quicken the decomposition of hydrogen peroxide? How is the reaction affected by a change in hydrogen peroxide temperature?

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Concepts

enzymes, kinetics, denaturation

Expected Student Responses to Exploration

- Step 1 (a) Gas bubbles form almost immediately.
(b) With time, the rate of bubble formation decreases and the potato turns red.
(c) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
- Step 2 (a) It takes a little time for gas bubbles to begin forming and the rate of bubble formation is less.
(b) The rate of this reaction is directly related to temperature—when the temperature is lowered, the rate is slower.
- Step 3 (a) No gas bubbles form.
(b) When a potato is boiled, its catalase loses its ability to increase the rate of decomposition of hydrogen peroxide. The enzyme has been denatured.
- Step 4 (a) Gas bubbles form almost immediately (or do not) depending on when student last ate.
(b) If bubbles form almost immediately, saliva contains catalase (at this time). If not, saliva does not contain catalase.

Expected Student Answer to Challenge

Enzymes work within a specific temperature range. Above that range the enzyme is denatured.

Reference

Kotz, J.C.; Joesten, M.D.; Wood, J.L.; Moore, J.W.; *The Chemical World: Concepts and Applications*; Saunders College Publishers: Fort Worth, 1994; p 315.

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