The Browning Apple

sead : stem

Subjects

Chemistry

Topics

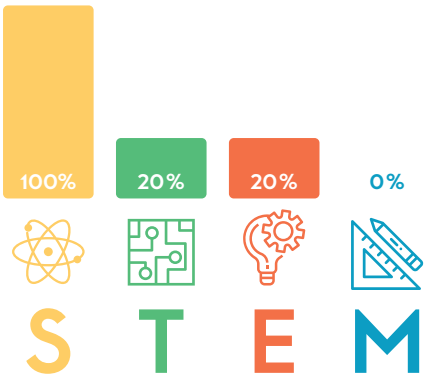
Acids | Base and Neutralization | Acid–Base Indicator | pH Scale | Effect of pH on Enzyme Activity | Oxidation Process in Nature | Food Science | Plant Science

Key Words

Acids | Base | pH | Enzyme | Enzyme Reaction | Oxidation | Enzymatic Browning | Polyphenol Oxidase | Melanin | Oxygen | Food Preservation

Connection to SDG

STEM Chart



Time for Activity

75 minutes

Introduction

Liquids all around us may be acidic or basic (alkaline) or neutral in their properties. For examples, acids taste sour; while bases taste bitter and feel slippery. However, both strong acids and strong bases can be very dangerous and burn our skin. So, it is very important to be very careful when using such chemicals. In order to measure how acidic or basic a liquid is, chemist use pH scale. pH scale ranges from 1 to 14, where 1 to 6 is classified as acidic, 7 neutral (neither a base nor an acid) and 8 to 14 is classified as base. pH paper or universal indicators are used to determine if a solution is acid, base or neutral. Natural indicator like juice from red cabbage is used as pH indicator to determine pH values by observing color changes.

Some fruits such as apple, pears, banana and vegetables like potatoes turn brown when peeled and exposed to air. This is called enzymatic browning. Enzymes are substances produced by all living organisms that speed up different chemical reactions. Acidity (pH) of a fruit effects the rate of enzymatic browning reaction of cut apples and you will see how it effects the color of apple in this experiment. Fruit turns brown when exposed to air because a reaction is happening when a cut piece of fruit is exposed to oxygen. This is called enzymatic browning. The name enzymatic browning comes from the fact that an enzyme located in the fruit reacts with oxygen from the air to turn the fruit brown.

Key Objectives

1. To explore the chemical reaction behind apple browning.
2. To understand enzyme in the fruits reacts with oxygen in the air to tern fruits brown.
3. To understand how fruits can be protected from browning using natural acidic juice such as lime.
4. To get the idea of natural preservation of fruits.

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Guiding Questions

1. Have you noticed what happens to fruit - like apples - if it is cut and left in the air?
2. Do you see this with all fruit? how about vegetables? other fruit?
3. Is brown apple safe to eat? or does it go to waste?
4. Is brown apple safe to eat?
5. What other materials change when exposed to the air?
6. How might these observations be related?
7. Does all cut fruit change colour - go brown - when doesn't it go brown?
8. What is it about these conditions that might be stopping it from happening?
9. How can we test to find out?
10. Why doctors and dieticians advise to eat more fresh fruits?
11. Do you want to eat a brown, soft piece of apple slice or a fresh, crispy apple slice? Would you like to eat a brown fruit?
12. Can anyone think of a way to prevent this from browning?
13. Have you ever seen rusting of iron material?
14. Do you think that apple slices are rusting after being cut?
15. Do you think that reason for rusting of iron and browning of apple are the same?
16. How do you prevent rusting?

Materials

1. Fresh apple slices (A student can cut the apple for the class)
2. Lemon juice
3. Water
4. White vinegar
5. Tongs
6. Paper towels
7. Paper plates
8. Paper Bowls
9. Clock or timer (use a cell phone stop watch for timing)

Tasks

1. Take out 3 bowls and put water, lemon juice, and vinegar in the bowls respectively.
2. Label a paper plate "water."
3. Using the tongs dip apple slice(s) into water for 40 seconds.
4. Take out the apple slice(s) and place the paper plate labeled "water."
5. Label a paper plate "lemon juice."
6. Using tongs, place apple slice(s) into the lemon juice for 40 seconds.

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7. Take out the apple slice(s) and place on the paper plate labeled "lemon juice." (make sure to rinse the tongs after each use to avoid cross contamination!)
8. Label a paper plate "control."
9. Place apple slice(s) on this plate without dipping them into anything.
10. Using tongs, dip apple slice(s) in vinegar for 30 seconds.
11. Place on a paper plate labeled "Vinegar."
12. Record your observations every 10 minutes for three intervals.

Observation Sheet

Process	What do you observe?
Apple dipped in water for 40 seconds.	
Apple dipped in lemon Juice for 40 seconds.	
Apple dipped in vinegar for 40 seconds.	
Apple slice without dipping into anything.	

1. Which apple slice is not turning brown? Why?
2. Which apple slice turns brown? Why?
3. Why an apple slice is kept without dipping into anything.
4. What is the scientific term of it?

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Fostering Discussions

The treatment group of apple slices that were dipped in the water should have some browning, but not as much as the control. This is due to the water restricting the amount of oxygen coming in contact with the fruit tissues. If there isn't as much oxygen available, then less reacts with PPO to convert the phenolic to melanin (brown coloring on the surface of fruits). The control was not treated with any solution and therefore the reaction was able to proceed and the fruit turned brown. The treatment group of apple slices dipped in the lemon juice solution should inactivate the browning enzyme. Polyphenol oxidase (the enzyme) is pH dependent. The pH of lemon juice is between 2.0-2.5. A lower pH means the substance is more acidic. The acid in lemon juice inactivates polyphenol oxidase to prevent browning. The treatment group of apple slices dipped in the white vinegar should prevent browning as well. The vinegar has a pH between 2.4-3.0. Vinegar should be similar to the lemon juice apples, however they could be slightly more brown. Again, the definition of enzymatic browning is: Enzymatic browning a chemical reaction that occurs when the enzyme polyphenol oxidase inside of the fruit/vegetable comes in contact with oxygen.

Possible Extensions

In the food industry, various types of chemicals called preservatives are used. Prepacked slices of apples are treated with sulfites that act as an antioxidant to keep the fruits crispy and prevent browning. Drying fruits is the oldest method of preserving food. Drying fruits is safe because moisture is removed and this prevent microorganism from growing in it. Dry fruits are more compact and take less space for storage. Light color fruits apple, apricots, banana, peaches tens to darken during drying and storage. This process is called oxidation and it takes way flavor, color and nutrients. Cold freeze-dry process are consider as better option.

Safety

1. Should do under appropriate setting under adult supervision.
2. Must not taste, eat or drink all the material used in experiment
3. Must listen to teacher instructions carefully.
4. Before beginning ANY investigation, you should put on your safety goggles and apron. It is important to avoid getting chemicals on your body. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Following questions lead students to think and do research:

1. Can you suggest a method to stop browning of fruits?
2. Are commercial preservatives good or bad for you?
3. What about using carbon dioxide to prevent oxidation?
4. What about using nitrogen to prevent oxidation?
5. An excursion to a food preservation factory
6. How pH and temperature effect on enzyme?

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Table A Enzymatic Browning Observations

Fruit	0 minutes	5 minutes
Apple		
Orange		
Banana		
Lime		
Lemon		
Potato		

Conclusion

Compare and contrast the fruits' chemical reactions.
Infer why this reaction is occurring in some fruit types and not others.

Authors/Source
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Tasks

1. Prepare your fruit types. Cut the apple and orange into thirds using a different knife for each fruit. Cut the banana into small slices.
2. Separate each fruit type onto separate plates (you should have a total of three plates). Make sure the flesh of the fruit is facing upward.
3. Once your fruit samples have been prepared, you are ready to begin. Describe your visual observations of each fruit in Table A under "0 minutes". DO NOT smell or taste any of the samples.
4. Allow each fruit to sit for 5 total minutes (set your timer). While you wait, predict what you think will happen to each fruit after 5 minutes have passed and provide evidence to support your prediction. Will you observe changes in texture? Changes in color?

	After 10 minutes, I predict...	Because...
The apple will….		
The apple will….		
The banana will….		
The lime will…		
The lemon will….		
The potato will…		

5. Describe your observations after 5 minutes in Table A. While you wait, proceed to Part B of the lab investigation.
6. Set aside one sample of apple for Part B.