

APPLE OXIDATION

Hey, that apple and those bananas pictured here don't look so good. What's wrong with them?



Have you ever wondered why some fruits and vegetables turn brown and look yucky after they are sliced? What about that banana that turns brown after it sits for a few days? These changes happen because of a chemical reaction called **oxidation**. The name of this type of oxidation reaction is called **enzymatic browning**. It occurs when an **enzyme** called **polyphenol oxidase (PPO)** and oxygen come into contact.

In enzymatic browning, certain compounds react with other compounds to form **melanin**. This can happen when a fruit is cut, gets bruised from a fall, or when damage occurs due to heat, age, or other stresses. The cells within the fruit break open and release PPO, which then mixes with oxygen in the air. The damaged tissue quickly turns brown.

Here is a simple activity to demonstrate this process and to give you some ideas about how to keep your apples slices fresh and yummy. (IMPORTANT NOTE: Please ask an adult to help you slice the apple!)

Materials needed:

- Apple Cutting board
- Knife
- Fork
- Lemon juice
- Vinegar
- Milk
- Water
- Five small bowls
- Five plates

Part 1:

1. Ask a grown-up to cut two slices from an apple
2. Place the slices on their sides on a plate. How do they look?
3. Poke **one** of the slices with a fork a few times. Observe both slices for about 20 minutes.
4. How have the apples changed?

Part 2:

1. Cut five more apple slices and place each on its side on a plate.



2. Right after cutting, sprinkle milk on one slice, distilled vinegar on another, lemon juice on another, and water on another. Do not do anything to the last slice.
3. Poke each apple with a fork several times.
4. Observe all five slices for at least 20 minutes.

Part 3:

1. Place five more apple slices in small bowls.
2. Cover each slice with either lemon juice, vinegar, milk, or water.
3. Leave one in a bowl without any liquid

What happened?

When an apple is cut, its tissue is damaged and the apple cells are broken. This releases phenolic compounds. Poking the apple slices with a fork damages even more cells. The slices poked with the fork probably turned even darker than the apple that was not poked because more cells were damaged. Some fruits and vegetables contain even more of these compounds, and they become darker than others.

What happened after sprinkling your apple slices with lemon juice, water, vinegar, and milk?

Acidic liquids like vinegar and lemon juice help to prevent browning because PPO doesn't work well in an acidic environment. Pineapple and lime juice are also acidic, so you can also use them to help keep your fruit looking fresh after it is cut. Keeping fruit covered with water helps because it stops the oxygen in the air from getting to the PPO enzyme. Heating your fruit slices in boiling water for a few minutes will also stop the process.

Although enzymatic browning causes a lot of food to be thrown away, it can also be useful. Chocolate, tea, and coffee get their characteristic rich brown color from enzymatic browning during processing.

Definitions:

enzymatic browning: a reaction that occur in fruits and vegetables, usually with negative effects on color, taste, flavor, and nutritional value.

enzyme: substances that speed chemical reactions. They work to build up or break down other molecules.

melanin: any black, brown, reddish-brown, or yellow pigments found in animals and plants. Melanin is the same pigment that gives color to our skin, hair, and the irises of our eyes.

oxidation: a chemical reaction caused by moving electrons. The substance that gives away electrons is oxidized.

ADDITIONAL RESOURCES:

Books available from the Washoe County Library System

[A to Z of Science: a Visual Dictionary for Curious Scientists](#) by Simon Basher and Tom Jackson



[How to Be a Scientist](#) by Steve Mould

[Kitchen Science Experiments: How Does Your Mold Garden Grow?](#) By Sudipta Bardhan-Quallen and Edward Miller

[Kitchen Science for Kids: 26 Family-Friendly Experiments for Fun Around the House](#) by Liz Lee Heinecke

[Kitchen Science Lab for Kids: 52 Family Friendly Experiments From Around the House](#) by Liz Lee Heinecke

[Step-by-Step Science Experiments in Chemistry](#) by Janice Pratt VanCleave

Videos

BrainStuff – HowStuffWorks, “Why Do Apples Turn Brown When You Slice Them?”

https://www.youtube.com/watch?v=IsXgoYL8YIo&ab_channel=BrainStuff-HowStuffWorks

SciShow, “Why Do Apples Turn Brown?”

https://www.youtube.com/watch?v=gArE5dv0W4&ab_channel=SciShow

Websites

American Chemical Society, Food and Cooking Chemistry

<https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/food-and-chemistry.html>

Chemistry World, Podcasts: Melanin <https://www.chemistryworld.com/podcasts/melanin/3008682.article>

Royal Society of Chemistry, Education, Kitchen Chemistry <https://edu.rsc.org/resources/collections/kitchen-chemistry>

Ted-Ed, Lessons, “The science of skin color - Angela Koine Flynn”

<https://ed.ted.com/lessons/the-science-of-skin-color-angela-koine-flynn#watch>

