Why Did the Eggplant Turn Brown?

Focus/Overview

This lesson focuses on the browning of an eggplant (oxidation) when it is cut or bruised. In a simple controlled experiment, students will test different processes that they believe will inhibit the browning of eggplant slices. The desirability and acceptability of browning on eggplants should also be discussed. Students will brainstorm, discuss, plan, and test different processes that could inhibit eggplant browning. Before this activity, students should understand that a chemical reaction occurs when two or more substances combine to form a new substance.

Grade Level
5th grade

Duration
Two or three 40-to-50-minute classes

Subject Area
Science

Setting
Classroom

Vocabulary
Oxidation, process, chemical reaction

Learning Objectives

The learner will …

- Correctly identify the browning on eggplant slices exposed to air as a chemical reaction called oxidation. (LO#1)
- Correctly conduct a controlled experiment to test different techniques that would inhibit eggplant browning. (LO#2)

Next Generation Science Standards (2013)

5-PS1-4	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Louisiana Student Standards for Science (2017)

5-PS1-4	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Advance Preparation

1. **Eggplant preparation**
   One day before lesson. Supplies needed: apple; two large, dark-purple-skinned eggplants; variety of differently shaped and colored eggplants (if possible); plastic wrap; salt; flour; juice (apple or lemon); milk; aluminum foil; two bowls.
   - Purchase an apple, two large, dark-purple eggplants and a variety of eggplants in different shapes and colors (one of each variety when possible). Fruit stands, farmers markets, and friends would be a good place to find a variety of eggplants. However, you may have to substitute with images or pictures. Grocery stores usually have only the traditional large, oblong, dark-purple eggplant. Cut a one-half-inch slice off the bottom of one eggplant, peel the skin off the slice and leave it exposed to air overnight. Wrap the rest of the eggplant in plastic wrap and refrigerate overnight. Do the same for the apple.
   - Purchase or collect different liquids (e.g., lemon or apple juice or a lemon and milk), dry ingredients (e.g., salt and flour), and a variety of wraps (e.g., aluminum foil and plastic wrap) for students to use to engineer a process for preventing browning on their eggplant slices.

   Day of the lesson.
   - Cut the eggplant into one-half-inch slices (two slices for each group of students) and immediately pass the slices to each group of students.

2. Preview the YouTube videos recommended for this lesson. Cue them up at the beginning (past the commercials).
   https://www.youtube.com/watch?v=RAwUgQ9W-qQ (This video doesn't have sound.)
   https://www.youtube.com/watch?v=uIOPC_FWmQM
   https://www.youtube.com/watch?v=Ko8S4NFJZTs

Blackline Masters

1. **Engineering Design Process: Engineering a Process**
2. **Check for Understanding (and Key)**

Background Information

The subject of this lesson is the eggplant (*Solanum melongena*), which is a member of the Solanaceae, or nightshade, family along with tomatoes, potatoes, and peppers. Eggplants have perfect flowers (individual flowers with both female and male parts) and are primarily self–pollinated, with flowers giving rise to large, solid fruit that is botanically a berry. Although most people think of eggplants as large, dark-purple vegetables, the eggplant is a fruit that comes in several colors, including white, yellow, green, brown, red, and black and a mixture or colors. They also can be solid-colored or streaked. The fruit shape may be round, pear-shaped, oblong or elongated. The eggplant is believed to have originated in India, where it still grows wild in its original form, a pea-sized orange fruit. Eggplants have been cultivated in India and China for 1,500 years, developing the many varieties we find today (below left). Europeans gave it the name “eggplant” because the white and yellow varieties that they grew were the size and shape of a goose egg (below right).

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Eggplants are a rich source of vitamin A, thiamine, riboflavin, niacin, ascorbic acid and polyphenols. Because of these attributes, the eggplant is high in antioxidants, which help to prevent chronic diseases. Eggplants are highly perishable when their flesh is exposed through peeling and cutting. When eggplant flesh is exposed to the air, it combines with oxygen in the air, causing the flesh to brown, which consequently reduces its lifetime.

Browning results in loss of eye appeal for consumers and may adversely affect nutritional and sensory properties of a freshly cut eggplant (Oms-Oliu et al., 2010). This browning process is called oxidation. **Oxidation** is a chemical reaction that takes place when a substance combines with oxygen. The oxidizing enzyme polyphenol oxidase (PPO) is a key player in the browning process of various raw and cut fruit and vegetables (Mishra et al., 2012). Other examples of oxidation are the browning of a cut apple and rust on metal.

Both slices were cut from the same eggplant.

The eggplant slice on the left has been exposed to air and not refrigerated. The flesh shows signs of oxidation (browning). The eggplant slice on the right is a freshly cut slice.

To prevent oxidation of the eggplant flesh, the eggplant can be dipped into a solution of water and 1 tablespoon of salt, milk, or lemon juice, **but do not tell your students this trick. The goal of this lesson is to get them to use the Engineering Design Process to design their own process for preventing oxidation of sliced eggplant.**

A ***process*** is defined as a series of actions needed to achieve a particular goal or end. Chemical engineers often use the **Engineering Design Process** to design and improve processes to solve a problem. When creating a process, chemical engineers must decide what materials will be used, and in what order those materials are combined, so that they create the desired properties. In this lesson, the desired property is eggplant flesh that does not brown or oxidize. Like chemical engineers, your students will need to apply their understanding of the chemical and physical composition and properties of different substances, as well as an understanding of chemical reactions to solve a problem.

References

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Sarkar, P. V. (June 9, 2018). Cutting eggplant without discoloration. Available at https://www.thespruceeats.com/preventing-cut-eggplant-from-turning-black-1957660.

The World's Healthiest Foods. (no date). Eggplant. Available at http://www.whfoods.com/genpage.php?dbid=22&tname=foodspice.

Materials List

Engage

- 1 apple — Cut so that the slices turn brown.
- 2 large dark-purple (traditional-looking) eggplants.
- Examples or images of different types/varieties of eggplants.
- Projector for videos.

Explore

- The two large eggplants (a dark purple variety)
- Two plastic bowls per group — large enough to hold one slice of the eggplant.
- Permanent marker. One per group.
- An assortment of liquids (e.g., milk, lemon juice, apple juice).
- An assortment of dry food ingredients (e.g., flour, salt).
- An assortment of wraps (e.g., plastic, aluminum foil).

Extend

- Projector for videos.

Procedure

Engage

1. **Let's see how many of you know these fruits.**
   - Hold up a dark-purple, traditional-looking eggplant. **What is this one called?** (*Eggplant*)
   - **Yes, this eggplant is a fruit because it has seeds**. Cut it and show your students the seeds inside.
   - Hold up a long/skinny dark-purple (or green) eggplant (Asian type). **What about this one?**
   - Hold up a lavender-colored eggplant. **What about this one?**
   - Hold up an unusual-looking eggplant (round, or green, white). **Is this an eggplant too?**

2. **I am going to pass these eggplants around. As you observe the eggplants, think about what characteristics these eggplants have in common.** Give the students about three to four minutes to

examine at least two of the different types of eggplants. Then cut a slice off the different eggplants and lay the slices next to the type of eggplant it was cut from. Give the students time to examine the slices.

- **What are some things that the eggplants you saw had in common?** *There will be any number of answers to this question. The one we would like the students to observe is that although the skins of these eggplants are different, the flesh inside of the different varieties are a similar color (off-white flesh and have seeds).*
- **This white flesh is what we are going to investigate today.**
  Show students the slice that has browned overnight. Let students speculate what causes the eggplant to brown. Some may compare it to an apple browning. If students do not mention an apple, show them the browned apple slice and ask them if they have ever had an apple slice brown like this.
- Ask students, **"Would you want to eat this browned apple slice? Or a browned eggplant slice?"**
  Show your students the time lapse video of an apple browning:
  https://www.youtube.com/watch?v=RAwUgQ9W-qQ

Explore

1. Have students sit in groups of four. Hand out a copy of the Engineering Design Process Sheet to each group and introduce the Engineering Design Process.
2. Tell students, "**Students, today you will be chemical engineers. You will use the Engineering Design Process to design a process that will prevent the browning of a cut eggplant."**
3. Have students complete steps 1-4 on their **Engineering Design Process Sheet (BL#1).** Circulate and provide assistance as needed. **Is the order of the steps important?** *(Yes)* **What do you think would happen to the eggplant if someone does not follow the steps of the process in the correct order?** *(It would brown.)* **What could you do to make sure people follow the steps in the right order?** *(Number the steps.)*
4. Remind students that they will be able to improve their process the next day.
5. Students will collect their materials, including two bowls, which they will label A (treated) and B (untreated). Then treat only one slice of eggplant (A) according to the steps of their process. The other eggplant slice (B) will be left untreated. Students should place both bowls (A & B) on a counter overnight and exposed to the air in their classroom, unless part of their anti-browning treatment is to prevent the slice from being exposed to the air.

Explain *(The following day)*

1. Have students complete step 5 on their **Engineering Design Process Sheet.**
2. Discuss with the students:
   - **How did your untreated eggplant slice look? How did your treated eggplant look?**
   - **What worked well? What could work better? How could you improve your process?**
   - Students share strengths and weakness of their processes. Students brainstorm ideas to improve their own and their peers' processes.
   - Discuss with students who did not successfully prevent oxidation of their eggplant slice how they might improve their process based on class suggestions. If time allows, have these students treat a new eggplant slice using their improved process.
3. *(The third day)* Students observe their treated (with the improved process) eggplant slices. Discuss oxidation with students.
   - Watch oxidation video with your students: https://www.youtube.com/watch?v=uIOPC_FWmQM
   - **Remember when we discussed chemical and physical changes? Do you think the oxidation of your eggplant slices was a chemical or physical change? Why?**

Extend

1. (The third day) Watch the iron oxide video with your students:
   https://www.youtube.com/watch?v=Ko8S4NFJZTs
2. Make eggplant fries. Peel and cut the varieties of eggplants used in the **Explore** step into fries. Use a successful process or processes developed by your students to treat the eggplant fries. Fry the treated eggplant fries in an air fryer. Salt lightly and serve with marinara sauce or ketchup.
3. Another issue when cooking eggplant is its spongy texture. Unless treated, it can soak up a large amount of oil, making it greasy and high in calories. There are several suggestions for preventing this process. Students could engineer a process to prevent high oil absorption of an eggplant slice.

Evaluate

1. A short evaluation (**Blackline Master 2**) is provided.

Recommended Children's Books

Wiley, C. and Carbone, C. (2018). Violet and the Eggplant Painting Problem. New York, NY: Rodale Books.
This book follows a girl who grows an eggplant for her class and tracks the eggplant's growth through paintings. Ages 4-8.

Gonick, L. and Criddle, C. (2005). The cartoon guide to chemistry. New York, NY: William Morrow Paperbacks (HarperCollins).
Explanations of "the history and basics of chemistry, atomic theory, combustion, solubility, reaction stoichiometry, the mole, entropy, and much more—all explained in simple, clear, and yes, funny illustrations" (HarperCollins website).

Weakland, M. and Billiau, L. (2017). Kaboom! Wile E. Coyote experiments with chemical reactions. North Mankato, MN: Capstone Publishers.
"The author presents the science concepts and practical applications within the text of the familiar cartoon characters who continue their well–known adventures" (Capstone website). Reading level: grades 3-5.

Blackline Master 1.

Name_____

Date_____

Engineering Design Process Sheet

1. ***Ask.*** *What is the PROBLEM?*

2. ***Imagine.*** *Brainstorm solutions and write your best idea here.*

3. ***Plan****: Write the steps of your process, then gather your materials.*

4. ***Create.*** *Draw your setup.*
Set up your controlled experiment and test your process.

5. ***Improve.*** *Observe your eggplant. Did it brown? What worked well? What could be improved?*

Blackline Master 2.

Name _____

Date _____

Check for Understanding:
Why Did the Eggplant Turn Brown?

Write the letter of the correct answer on the line in front of the question.

_____. 1. The browning of the slice of eggplant when exposed to air is a(n) _____ _____. (LO#1)
A. physical change.
B. chemical reaction.
C. insect damage.

_____. 2. This browning process is caused by something in the eggplant (enzymes) reacting with_____. (LO#1)
A. oxygen.
B. water.
C. hydrogen.

_____. 3. The name given to this browning in eggplants is _____. (LO#1)
A. hydrophobia.
B. oxidation.
C. dehydration.

_____. 4. Another fruit that browns like the eggplant when it is exposed to air is a/an _____. (LO#1)
A. potato.
B. apple.
C. both an apple and a potato.

_____. 5. The browning of an eggplant slice makes people _____. (LO#1)
A. sick.
B. not want to eat the eggplant (unpalatable).
C. laugh.

_____. 6. _____ _____ develop processes to help preserve or keep our food fresh. (LO#1)
A. Mechanical engineers.
B. Aerospace engineers.
C. Chemical engineers.

Describe one of the processes that successfully prevent the browning of an eggplant slice.

_____

_____

_____

Blackline Master 2. **KEY**

Name _____

Date _____

Check for Understanding:
Why Did the Eggplant Turn Brown?

Write the letter of the correct answer on the line in front of the question.

B_____. 1. The browning of the slice of eggplant when exposed to air is a(n) _____ _____. (LO#1)
A. physical change.
B. chemical reaction.
C. insect damage.

A_____. 2. This browning process is caused by something in the eggplant (enzymes) reacting with ____. (LO#1)
A. oxygen.
B. water.
C. hydrogen.

B_____. 3. The name given to this browning in eggplants is _____. (LO#1)
A. hydrophobia.
B. oxidation.
C. dehydration.

C_____. 4. Another fruit that browns like the eggplant when it is exposed to air is a/an _____. (LO#1)
A. potato.
B. apple.
C. both an apple and a potato.

B_____. 5. The browning of an eggplant slice makes people _____. (LO#1)
A. sick.
B. not want to eat the eggplant (unpalatable).
C. laugh.

C_____. 6. _____ _____ develop processes to help preserve or keep our food fresh. (LO#1)
A. Mechanical engineers.
B. Aerospace engineers.
C. Chemical engineers.

Describe one of the processes that successfully prevents the browning of an eggplant slice.
Accept any successful process described by students.

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